KARL MARX'S THEORY OF TECHNOLOGICAL UNEMPLOYMENT

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ABSTRACT

The primary objective of this dissertation is to present and analyze Marx's theory of technological unemployment. Chapter I is a brief evaluation of the modern perspectives on this question. The levels of analysis in Marx are also identified. Chapter II considers Marx's short term model on technological unemployment when no net accumulation occurs. It includes a discussion of different measures and types of technological change. Chapter III complements the previous chapter. A theoretical definition of compensation is advanced, and the different forms of compensation in Marx are evaluated. This chapter also includes a broader discussion of the compensation controversy. Chapter IV constitutes Marx's long term model when technological change, population growth and accumulation occur simultaneously. Here, crises are ignored. Chapter V identifies the linkages between crises and technological unemployment. Throughout the dissertation, the short term, long term and crisis models are developed and compared. Included are two appendices, one dealing with the neo-classical approach, and the other with the role of wage flexibility in Marx's theory of technological unemployment.

RESUME

L'objectif principal de cette thèse est de présenter et d'analyser la théorie de Marx sur le chômage technologique. Chapitre I est une brève évaluation des perspectives modernes concernant cette question. Les niveaux d'analyse de Marx sont également identifiés. Chapitre II considère le modèle court terme de Marx sur le chômage technologique quand il n'y a pas d'accumulation qui se produit. Y est inclu également une discussion des différentes mesures et changements technologiques. Chapitre III est un complément du chapitre précédent. Une définition théorique de la compensation y est présentée et les différentes formes de compensation chez Marx sont évaluées. Egalement, une discussion élargie de la controverse en ce qui a trait à la compensation y est incluse. Chapitre IV constitue le modèle long terme de Marx quand le changement technologique, la croissance de la population et l'accumulation se produisent simultanément. Dans cette discussion les crises sont ignorées. Chapitre V identifie les liens entre crises et le chômage technologique. Dans la thèse, au fur et à mesure que nous développons les modèles de court terme et de long terme ainsi que des crises, nous en faisons également la comparaison. La thèse comprend deux annexes, l'une qui traite de l'approche néo-classique et l'autre du rôle de la flexibilité des salaires dans la théorie de Marx sur le chômage technologique.

PREFACE

The question of technological unemployment attracted considerable attention among the classical economists such as Ricardo, McCulloch and J. S. Mill. The possible displacement of labour and forms of reabsorption have led to what has been called the compensation controversy. The optimists maintained that the displacement of workers through the adoption of superior machines was a temporary inconvenience and that the market forces would fully compensate for such loss of employment in the long run. The pessimists, on the other hand, held that the problem would be a permanent one and that the automatic market forces would not be adequate to provide full compensation. Marx offers the clearest pessimistic argument. There were, however, and still are several variants of the optimistic and pessimistic views.

It is important to note that the academic interest in this controversy virtually disappeared with the development of the neo-classical and Keynesian paradigms. Yet, the public's concern about automation and works by non-economists indicate that the question is still alive. Chapter I is a brief survey of the modern approaches and popular concerns. With very few exceptions, the economists have not treated the question at a theoretical level in modern times. It is the virtual absence of such treatment that led me to choose Marx's views on this matter as the

subject of this dissertation. Any theoretical study of the question of technological unemployment must take him into consideration. With the possible exception of Schumpeter, no other economist has so emphasized the effects of technological change. The race between machines and employment is a central theme in Marx's analysis of the development of capitalism. He does not, however, present his arguments in a systematic manner.

The originality of this dissertation lies in the fact that it is, I believe, the most comprehensive study of Marx's arguments on technological unemployment. Moreover, it brings together and integrates many arguments which have virtually been overlooked in economic literature. The dissertation is not only a synthesis of Marx's arguments but also a critical analysis of his theoretical apparatus and assumptions as these relate to the discussion of technological unemployment. It does not treat Marx in isolation but also refers to alternative approaches of modern, as well as, earlier economists in order to place his theory in a broader framework. Particular emphasis is placed on some German economists such as Kruse, Mitnitzky, Kähler, and Lederer whose writings on the question have appeared in the earlier part of this century. The main purpose behind analyzing Marx while drawing from a wide group of economists is to arrive at conclusions which not only help provide a clearer interpretation of Marx, but which also serve to shed light on the compensation controversy in general.

I should like to express an intellectual debt to Professor Earl F. Beach who guided me in the preparation of this dissertation. He, himself, has published a number of articles on the question of technological unemployment and believes that the modern theory has not answered

the theoretical question. Several of his arguments have been used in this dissertation in order to underline some of the major weaknesses in Marx's theory. In fact, my interest in the particular topic goes back to the time when I took a graduate course offered by him. This course focussed exclusively on the theoretical approaches to technological unemployment. I must, however, indicate that much of the theoretical approach and many of the conclusions reached in this study have no direct counterparts in his work. He has allowed me to pursue my research freely so that the essence of Marx's arguments can be presented in the clearest manner possible.

I also wish to thank Professor George Grantham who made many valuable comments concerning substantive deficiencies which had been overlooked. In addition, he carefully indicated many grammatical and stylistic errors. Since my mother tongue is not English, these corrections were immensely helpful.

Furthermore, I would like to acknowledge the indispensable help I have received from several individuals. Janet Smith spent many hours with me in proof-reading the final draft. Bruce Smith offered valuable insights whenever I encountered problems in understanding Marx. Ilsedore Jeremie must have spent many days in Germany in order to locate most of the German writings that have been used in this study.

Finally, I thank Lorie Casbourne and Joanne Ten Eyck, who were the most patient typists.

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CHAPTER I

INTRODUCTION AND GENERAL ASPECTS OF MARX'S THOUGHT ON TECHNOLOGICAL CHANGE AND UNEMPLOYMENT

1. Introduction

This introductory chapter will prepare the framework of this thesis. Consequently, most of the fundamental arguments to be developed in full later will be stated in a summary form.

Objectives and Scope of the Study

This study is an analysis of the technological unemployment model in Karl Marx's major works. Our objective is to present and synthesize Marx's arguments on the short term, long term and cyclical employment effects of technological change and to critically analyze them.

The present topic has been chosen for two reasons: First, with a few exceptions such as Joan Robinson,[1] Marx's pessimistic predictions with respect to the effects of technological change on employment have attracted little attention in the non-Marxist school of economics. In Technology and Jobs by Jaffe and Froomkin, the authors state: "Possibly the most original and significant contribution to classical economics on the effect of technological change on employment was made by Karl Marx."[2] However, they allocate only one paragraph to him.

Several theoretical and historical dissertations have been written on the relationship of technological change to employment. Yet Marx's role in the controversy has not received adequate attention. Nathan Belfer, in his work, undertakes a critical analysis of the historical perspectives until the 1940's. He makes references to Marx for comparative purposes, but he does not develop the inner logic of Marx's argument.[3] In another study, M.A. Stephenson discusses the role of technology in the English classical school and relates it to agriculture, income shares, and employment.[4] Both of these authors present and analyze particularly the ideas of Ricardo, J.S. Mill and Malthus on the question of machinery and employment. Shou Shan Pu's dissertation on Technological Progress and Employment is a study of the investment expenditures associated with technological change.[5] It is an attempt to supplement the Keynesian theory of employment. Even though he makes some references to Ricardo, Sismondi and J.S. Mill, he does not include Marx. Finally, David P. Levine, in Accumulation and Technical Change in Marxian Economics, deals primarily with accumulation.[6] He analyzes the role of technical change, organic composition of capital and employment. However, the Marxian technological labour displacement and Marx's specific arguments on the question are not an important part of his study.

The foregoing comments are not intended to be critical of these studies which, within their specified limitations, fulfill their objectives. We will refer to them throughout our work. We only wish to underline the fact that Marx's arguments on technological unemployment have not been presented and analyzed in a comprehensive manner. In fact, Ricardo's views on machinery and employment have drawn much more attention in the non-Marxian economics. It is well-known that Ricardo, in the third edition of his Principles, revised his earlier optimistic view and

stated: "...I am convinced that the substitution of machinery for human labour, is often very injurious to the interests of the class of labourers."[7] His short chapter "On Machinery" has been the major source of academic interest on the question. The magnitude of emphasis on Ricardo's chapter appears to be out of proportion to the importance Ricardo seems to have given to the issue.[8] On the other hand, Marx makes the introduction of new machines and their effects on employment a central theme in his analysis of capitalist development.

It is not our objective to compare and contrast Marx and Ricardo. Ricardo's influence on Marx is particularly obvious in Marx's treatment of the machinery question. However, his criticisms of Ricardo and Barton must be noted in Theories of Surplus-Value.[9] Some of these differences will be an integral part of our study.

The attention accorded by economists in the Marxist tradition to Marx's views on technological unemployment is mixed. It should suffice, for now, to note that a systematic and comprehensive analysis of the different aspects of Marx's arguments on this question is not available.[10] When it is discussed specifically, it is stated in a general fashion without subjecting it to a critical evaluation. On the whole, it is treated in a fragmented manner to supplement Marx's arguments on the labour theory of value, exploitation, the falling rate of profit, crisis, etc. Technological unemployment per se is not a central part of these concerns. Part of the reason for this is that Marx himself did not give the issue a systematic presentation. His comments, sometimes contradictory, are scattered throughout his work. There is, thus, a need for compilation and synthesis.

The second reason for choosing the present topic is that the question of technological unemployment has received little consideration in modern economic theory. It is either assumed away or treated in a theoretical framework which, due to particular assumptions, such as perfect wage-price flexibility and easy factor substitution, has not been able to deal with it satisfactorily.[11] As our analysis of Marx indirectly will show the major weakness is that the question has not been clearly posed. This appears to be a consequence of the tools, assumptions and values shared in both the Keynesian and neo-classical paradigms.[12]

We will, next, undertake a brief summary and evaluation of the views prevalent in modern economic theory. The following presentation is not intended to be exhaustive for two reasons:

(i) These views have been treated extensively in several studies. Some major works in this area are by Heertje,[13] Gouryitch,[14] and Kähler.[15] Other survey studies will be referred to in the course of this study as they relate to Marx's analysis.

(ii) The present study will have achieved its aim by focusing on the Marxian model and by demonstrating its difference from the more familiar approaches. We will attempt, as much as warranted, to avoid the "intellectual's disease...to treat one thing by discussing everything which bears the slightest resemblance to it."[16]

In modern economic theory, which is a partial synthesis of the Keynesian and neo-classical paradigms, the approaches to technological change and unemployment can be summarized under three headings:

Keynesian Approach

The economists who share this paradigm differ significantly within

the limits of their tradition. However, excluding some economists such as Joan Robinson, the usual approach to the present question can be seen from Professor Samuelson's treatment in his Economics. After having referred to the use of fiscal and monetary policies to cure unemployment, he states: "Better still, this approach means you do not have to decide whether the pessimists are right who argue that inventions will kill off more jobs than they create. Why care? In every case we know that high employment will require monetary and fiscal policies of the correct magnitudes and mixed economies know what needs doing."[17] The same view that demand management is what matters is commonly observed in the writings of other Keynesians.[18]

Unemployment is seen as a consequence of deficient aggregate demand. The bottleneck is not a shortage of capital to employ labour but an excess of savings which needs to be offset through expansionary public policies. In a long term growth economy, the condition for full employment is that the rate of growth in demand should be maintained so as to equal the sum of the rate of increase in productivity and the rate of increase in the labour force.[19] The relationships between these three variables are not made clear. Marx, as we will see, treats them in a theoretical framework where their relationships are determined by the nature and pace of technological change.

The foregoing brief summary of the Keynesian approach is obviously too sketchy and incomplete. However, in its barest form, it constitutes a compensation theory; it indicates how the displaced workers can be reabsorbed. Moreover, these comments should not be interpreted to mean that the Keynesian saving-investment approach is irrelevant to Marx's analysis of the present question. In fact, certain elements of this approach would

have improved Marx's long term analysis of technological unemployment which, despite his attacks on Say's Law, appears to have been carried out in a framework which maintains it.

The Keynesian approach does not define technological unemployment. This arises from the fact that the theory does not emphasize the relationship of investment to technological change and to changing capital-labour coefficients over time. The multiplier effects of investment are given predominance over the structural changes caused by technological change and their effects on employment. Concern over excess savings makes it difficult to raise the possibility of capital shortage as a cause of unemployment. The incompleteness of this analysis has been elaborated upon by Adolph Löwe[20] and Paul Mandy.[21]

Keynes appears to have been concerned about the question of technological unemployment prior to The General Theory. He says: "We are being afflicted with a new disease of which some readers may not yet have heard the name, but of which they will hear a great deal in the years to come -- namely, technological unemployment. This means unemployment due to our discovery of means of economising the use of labour outrunning the pace at which we can find new uses for labour."[22] However, he calls this "only a temporary phase of maladjustment."[23]

As it will become clear, Marx's analysis in terms of a relative capital shortage to employ the displaced workers is fundamentally different from the Keynesian arguments both in the short and long terms.

Neo-Classical Approach

The neo-classical economists, like the Keynesians, have paid little attention to the analysis of the employment effects of technological

change. In general, the beneficial effects have been taken for granted. When the issue has been specifically considered, input substitution due to wage-price flexibility has been shown to be a compensation process that will offset the initial labour displacement effects of the machines. The best expositions of this approach are those by Mentor Bouniatian and Nicholas Kaldor.[24] These two authors, it should be noted, wrote in response to the pessimistic views of Emil Lederer.[25] Otherwise, there appeared to be no cause for concern.

The neo-classical compensation mechanism to absorb all the displaced workers, and even more, has its origin in Say's Law of Markets. As Gourvitch states: "All theoretical notions of a tendency toward automatic reabsorption of displaced workers may be traced back to Say's Law of Markets, which proclaims the possibility of an infinite expansion of production without assignable limits."[26] The first elaboration of this mechanism is by McCulloch.[27] It has been restated by P. Douglas in more modern times.[28] In Chapter III, McCulloch's views will be evaluated in conjunction with Marx's criticism of such views. Then, we will integrate the more refined neo-classical elements into McCulloch's argument. The following is a tentative summary of the fundamental aspects of this "automatic compensation" theory.

A possible displacement of labour through any type of technological change is offset in the long term through the effects of flexible wages and prices. This compensation theory is different from the Keynesian one. In this case, compensation is automatic whereas in the Keynesian case, discretionary public policy is required.

The main weakness of the neo-classical analysis is the lack of an

elaboration of the relationship between investment and technological change. The inward shifts in the production isoquants are taken to reflect technological change. Such change appears to be a costless exogenous phenomenon. Possible labour displacement is usually analyzed through the movements along a smooth isoquant which depicts infinite possibilities of substitution between labour and capital. The displacement of labour occurs when capital becomes cheaper relative to labour. The argument is that such a displacement cannot be permanent because the rise in the price of capital and the fall in the price of labour not only check the substitution process but, eventually, reverse it so that full compensation becomes possible. Clearly, the theory resolves the unemployment problem by limiting the issue to the movements along the isoquant when technology is given.

The theoretical difficulty in distinguishing the shifts from the movements along an isoquant has been pointed out by several economists.[29] When machines embody new technology over time, an analysis based on movements along an isoquant that assumes given technology lacks realism. Thus, adjustments following an initial substitution need not occur on the basis of the same technology. The assumptions such as infinite possibilities of substitution between capital and labour both before and after technological change have come under serious criticism in modern literature.[30] The role of time and the changes in the life span of machines due to technological progress are not part of this analysis. The relationship of the individual capitalist to technological change in a competitive system remains unexplained.

In summary, we will see that this theory based on long run adjustments

through reversible changes is not an adequate compensation theory. Once Marx's premise that capitalist development is characterized by the continuous introduction of sophisticated machinery is accepted to be realistic or possible, the compensation theory derived from the neo-classical school fails to refute the possibility of technological unemployment both in the short and long terms.

Structuralist Approach

Some economists associate technological unemployment with structural unemployment.[31] As we will later see, Marx's analysis, at times, contains an element of this argument. On the whole, however, his technological unemployment is not structural.

The structuralist approach explains technological unemployment in terms of a mismatch of the demand for and supply of labour in particular markets for labour when technological change takes place. Such change renders labour with certain obsolete skills unemployable while it creates a demand for labour with new skills. Any temporary unemployment is not due to a decrease in aggregate demand for labour. It is due to causes such as the immobility of labour, the obsolescence of skills, and inadequate channels of information concerning the new jobs. According to this approach, the increase in actual job vacancies is equal to or greater than the number of jobs eliminated. The standard solutions include retraining workers and increasing their mobility through public policies. The structural unemployment theory is studied comprehensively by Eleanor G. Gilpatrick. She says:

> Structural unemployment comes about in the long run and can arise regardless of the level of demand. As technology, the composition of final demand, and the location of industry change, these structural shifts affect the composition of labor skill requirements. There is no problem as long as the labor force is itself able to adapt to the new requirements

This approach has come under criticism by the orthodox Keynesians who argue that the problem is still one of aggregate demand and that such unemployment is not significant. The argument is that if the alleged structural unemployment is eliminated by increases in aggregate demand, then it could not have been structural unemployment in the first place. In other words, the Keynesian contention implies that there should be no serious concern about such unemployment. The specifics of this controversy are not relevant to our study. However, it should be noted that the structuralist argument is, in essence, a critique of the neo-classical assumption of homogeneous labour which is also shared by the Keynesians who ignore structural changes in the economy due to technological change.[33] In this sense, it has some similarity to Marx's analysis. The similarity, however, should not be exaggerated. It shares a common weakness with the neo-classical and Keynesian approaches because it does not explain the effects of technological change on the creation and destruction of jobs. It assumes, a priori, that technological change creates as much or more employment than that which is temporarily destroyed.

Summary.

Neither the Keynesian nor the structuralist approach offers a theoretical apparatus to analyze the question of technological unemployment. Both approaches emphasize the solutions to unemployment rather than considering the possibility that technological change may lead to a net contraction in aggregate employment even if total spending were sufficient to maintain full capacity utilization of the capital stock and mismatch of skills did not occur. The neo-classical approach, on the other hand, relies on a long run compensation mechanism. One can place these three approaches on a continuum. Technological change may cause unemployment

according to the structuralist view because of the slow adjustment of existing skills to those required by such change. If the public policies can overcome this lag, then the neo-classical mechanism takes care of the unemployment problem. If there is still unemployment, then it is the Keynesian aggregate demand manipulation that will eliminate the unemployment.

2. Concern Over Technological Unemployment

The foregoing discussion has underlined the present state of economic theory with respect to technological unemployment. This question has been a greater source of concern among the non-economists, for example, unions, other social and natural scientists, and government officials.

In the early 1960's, several government sponsored studies were undertaken in response to President Kennedy's concern over technological unemployment in the U.S.[34] The Luddite movement, which Marx also notes, is a historical case.[35] In more modern times, unions have frequently voiced their concern. The ILO has emphasized this concern in several studies.[36] Doubts have been expressed in the writings of many non-economists. Thurmon Arnold, during the 1930's, is one of them.[37] A contemporary example is Barry Commoner, a biologist, whose concerns over the energy and environment issues are gaining popularity. He states:

> The facts about the shortage of jobs are only too well known. Unemployment has been chronic in the United States, in the last few years rising to levels unprecedented since the Depression. Apparently there has been no economic force sufficiently strong to counteract completely the effects of the changes in production technology on the availability of jobs[38] .... Some economists have criticized these reports, denying that there is, or will be, a capital shortage. The critics usually do not deny that there

> is an increased demand for capital, but they contend that the economic system is capable of meeting that demand, and thereby of preventing a shortage. In effect they deny the question by claiming that it can be answered.[39]

This lengthy quote has been cited to indicate that this summary of the concern from a non-economist is, as we will see, a broad formulation of Marx's concern. It underlines the Marxian hypothesis that, due to an increase in constant capital per worker through technological change, a relative shortage in the supply of capital will lead to increasing unemployment levels.

We should, at this point, add that these remarks do not imply a total lack of concern among the economists. They imply only that the debate has taken place on the fringes of traditional economic theory and has been limited to a few economists. In particular, some German economists both prior to and after Keynes in the 20th century, have continued the debate. Some of these economists have attempted to explain the Great Depression by using models of technological unemployment.[40] Even the advent of the Keynesian thought did not lead to a complete dismissal of this analysis as witnessed in the case of Löwe who, without denying either the "principle of effective demand as a strategic determinant of the level of aggregate income and employment" or the overall effectiveness of the neo-classical mechanisms, shows the real possibility of technological unemployment based on the classical and Marxian arguments.[41] We will be referring to others such as Mitnitzky,[42] Lederer[43] and Neisser[44] throughout this study. In the English speaking group, Seligman[45] and Theobald[46] have taken more popular approaches and criticized what Heilbroner calls "belief in the benign social impact of technology."[47] Hansen criticized the compensation argument

that was based on demand created by the increased productivity due to technological change.[48] Nevertheless, he agreed that wage and price flexibility would solve the temporary unemployment problem.

It must also be noted that Joseph Schumpter, who is one of the very few economists besides Marx to have emphasized the role of technological change and innovation in capitalist development, also shared the belief in the benign effects of technological change. He excluded the question of technological unemployment from his analysis. He saw unemployment not as a direct result of technological progress but as a result of the periodic discontinuation of it. Schumpeter declared the Compensation Controversy "dead and buried" on the basis of Hicks' development of the elasticities of substitution which, ironically, were not developed to answer this question.[49] In fact, Hicks argued that the Ricardian technological unemployment was theoretically tenable.[50] His response to E. Beach's critique also stresses this.[51]

It is difficult to explain the apparent absence of emphasis on this question in modern economic theory as taught or as reflected in economic journals. Ignoring presently the serious difficulties with respect to measurements and definitions, for example, of capital, which may have contributed to discouragement, the real reason appears to be based on common sense observations. The historical experience indicates that there are more jobs today than there were fifty or a hundred years ago. One possible conclusion from this is that technological change has not and will not reduce total employment opportunities. Moreover, one can also argue that technological change is the source of this increase in employment. These two conclusions are frequent in literature.[52]

These conclusions based on a long term observation are difficult to maintain for two reasons:

(i) Increase in employment in the long term does not rule out the possibility of increasing unemployment in the short term, that is to say, an absolute diminution in the number of jobs during a short period. Moreover an increase in the absolute number of jobs over the long term is consistent with a simultaneous increase in the unemployment rate. It is often pointed out that, in the last few decades, the unemployment rate has climbed up and has been higher at the peak period of each successive cycle.[53]

The long term observation is not a relief to those who are unemployed in the short term, for example, for 6 months or a year. Marx's analysis treats both the short and the long term effects.

(ii) Observation of technological change and higher employment in the long term, even if we observe falling unemployment rates, does not in itself imply a causal relationship from technological change to employment. The long term argument poses serious obstacles to empirical testing. The role of the public sector, the relationships between the developed capitalist world and the underdeveloped countries, changes in markets, etc. make a meaningful empirical correlation difficult to undertake. Because of these theoretical and empirical problems, the long term argument is impossible to prove. Marx's long term argument also encounters these difficulties, and it is, as we will see, dependent on some very special conditions. The strength of his analysis is that it consistently relates technological change to a multitude of variables which often appear as exogenous variables in traditional theory.[54]

Our brief summary of the concerns demonstrates that the question of technological unemployment is alive.[55] It needs to be studied at a theoretical level before it can be tested meaningfully. It is our belief

that Marx's analysis, which has largely been ignored in studies on this question, can make a real contribution to the understanding of its theoretical aspects. The present study will be limited to the synthesis and the evaluation of Marx's ideas. An empirical verification is not within our scope.

3. Marx's Approach

The most important aspect of Marx's approach is that the question of technological unemployment is isolated and defined.

He poses the question at three levels:

Level One

This level includes the direct and indirect short term effects of technological change on employment. Specifically, these effects refer to labour displacement and labour absorption. They are the immediate (direct) results of the adoption and the construction of machinery which embodies new technology as well as the results of the indirect effects caused by technological change. The direct displacement effect is measured by the number of workers displaced when machinery is substituted for current (direct) labour in a firm (industry). The direct absorption effect is measured by the number of workers employed in the construction of machinery. Obviously, in the real world, the construction of machinery precedes its adoption. This is an important distinction for it, as we will see, has serious implications for any study of technological unemployment. It will also be seen that Marx is not fully aware of these implications.

The meaning of short term needs to be clarified because it does not correspond to the Marshallian "short run", and it is not a concept explicit in Marx. It is a concept that we will utilize in order to

clarify Marx's analysis. It is, in essence, a period during which the construction and adoption of the new machines take place and the indirect employment effects of technological change are observed through the changes in the wage rate, prices of commodities and the extra surplus derived from the particular technological change. The most important characteristic of this level of analysis is that technological change does not require net accumulation as a prerequisite.

There are both theoretical and realistic difficulties in our definition. The changes in the wage rate and prices may take a long time. This adjustment process and its magnitude depend on many conditions such as the magnitude of technological change, its rate of diffusion and the degree of competition. Thus, our definition cannot strictly be put in an actual time period and must be considered as an analytical concept. However, this difficulty is not very serious because Marx does not consider these indirect effects to be substantial. A more serious objection to our definition can be based on ruling out net accumulation as a prerequisite for technological change. As we will see, Marx's short term analysis as well as his long term accumulation model are very much dependent on this implicit assumption which is the major weakness of his argument. This weakness is independent of the possible neo-classical criticisms that can be directed against him.

Level Two

This level covers long term accumulation and technological employment.

The main characteristic of this analysis is that the question of technological unemployment is observed when accumulation is accompanied by technological change and when the labour force is also increasing.

It is an analysis of the long term evolution of the capitalist system. This long term analysis abstracts from crises (cycles).[56] Despite mixed evidence in Marx, it is our opinion that, even in this discussion, Marx does not see net accumulation as a prerequisite. In other words, the decrease in the rate of accumulation does not appear to check the high rate of technological change with a labour saving bias.

Level Three

This level of analysis integrates technological unemployment into Marxian crises. Even though Marx does not do so, such a synthesis is possible on the basis of his comments in different contexts.

As indicated earlier, it is not possible to locate in Marx such a division of the levels of discussion with respect to technological unemployment. Only the evaluation in the following chapters can justify our approach. It will, then, be demonstrated that the short term effects as we have specified constitute the fundamental logic of Marx's approach and of his criticism of the classical compensation theory. He applies the same logic to his long term and cyclical analyses. We will also demonstrate that the cyclical treatment of technological unemployment can be integrated into the crisis-free long term accumulation model and that such a synthesis reduces the seriousness of some objections that can be raised against his long term prediction. In short, the levels of discussion as specified here are but a method to arrive at the totality of Marx's analysis by extending its scope at each stage. They are organically interrelated and should not be considered as disconnected discussions.

After having specified the scope of this study in broad terms, we also wish to specify the areas which will not be covered. It is impossible

to avoid a certain degree of arbitrariness in doing so. Marx's analysis does not easily lend itself to being compartmentalized. However, not all of Marx's ideas on the effects of technological change are directly related to the analysis of unemployment. This does not mean that they may not support his analysis or may not add to its comprehensiveness. Our contention is that his analysis is not seriously weakened when some of these subsidiary arguments are excluded. Consequently, the following issues related to technological change will not be a part of this study:

(i) Social degradation, alienation and technological change[57]

(ii) Role of the state in creating employment and inducing technological change[58]

(iii) Labour theory of value[59]

(iv) Origins of capitalist accumulation and technological change[60]

The major objection may be to the exclusion of the labour theory of value. In our view, Marx's analysis of technological unemployment can be developed without establishing the validity of this theory. Marx himself often carries out his analysis only in prices without specifying the labour theory.[61] In this study, we will follow the same approach. This approach is meaningful for the question under study because the behaviour of the capitalists can be explained in terms of prices not values when they decide to introduce new machinery. Whenever we use the term "value", we will be referring to the market prices.

4. Underlying Elements of Marx's Thought

In this section, we will review the most important elements of the Marxian framework. Some parts of the following discussion may not appear to be directly related to our study. We believe that Marx's analysis

of technological unemployment is inevitably linked to his general philosophical approach. The consistency of his analysis should also be judged and evaluated within the inner logic of his general approach to historical change and capitalism.

Dialectics and Historical Materialism

Marx states: "[I]t is the ultimate aim of this work, to lay bare the economic law of motion of modern society...."[62] To achieve this aim, he analyzes the modes of production specific to each historical epoch. His main emphasis is on the evolution of the capitalist mode of production.

Marx's historical materialism is a scientific attempt to explain social organizations as well as changes in them on the basis of the material conditions underlying a specific period. Historical materialism has often been referred to as economic determinism. Even the quotation cited lends some credence to this interpretation. However, any serious student of Marx's works would disagree with such a narrow interpretation.[63]

Dialectics, the theory of change, is an integral part of Marx's materialism.[64] Understanding of it is important to grasp Marx's approach to technological change and its results.

Dialectics is a method to explain change as arising from the inevitable conflicts that exist in a relationship which, on the surface, appears to be a harmonious unity. In other words, this apparent unity contains the forces that lead to its disunity or to its rupture from within. In modern parlance Marx would have said that the disequilibriating forces are inherent in any equilibrium.

This approach does not only present a theory of change but also a

theory of the direction of the change. The entity, through the conflicts, develops its true essence in successive transformations. There is a continuous process of thesis-antithesis-synthesis.[65] The first stage corresponds to a unity and the second stage to the rupture of this unity through conflicts. Each process culminates at a level of synthesis which is not only different from the original thesis; it also represents a more developed state. The synthesis, in turn, serves as the thesis for further changes.

We need not fully develop the concept of dialectics for our purpose. Its meaning can be clarified by citing a concept that we will often refer to in our study. "Capital" in Marx does not merely refer to things but, even more essentially, to a relationship. At one level, it represents a relationship between a class of capitalists owning the means of production and a class of workers who are "freed" from such ownership and who have only their labour-power to sell.[66] It represents a personified relationship. At another level, which is but a reflection of the former relationship, capital consists of the relationship between the means of production; the relationship between machinery and labour-power in the production process. According to Marx, the capitalist's motivation is to expand his capital.[67] This can be done only by changing the relationship that exists in capital. It can only expand by exploiting more labour. This is where the contradiction exhibits itself.[68] There are limits to this exploitation, for example, the size of the population and the length of the working day. The alternative is to exploit fewer workers more intensively by introducing machinery. Capital starts a race between machinery and labour. "The instrument of labour, when it takes the form of a machine, immediately becomes a competitor of the workman

himself."[69]

What is logical from the perspective of an individual capitalist turns into its opposite when all capitalists adopt the same method of exploitation. The price of the product sinks, and the capitalists now have a much larger stock of equipment and fewer workers in employment. Marx argues that the capitalists cannot, on this basis, increase their profits because it is the living labour that gives rise to surplus.[70] By displacing labour, the system digs its own grave. (We will demonstrate later that Marx's concrete economic analysis is not adequate to support this view.)

In short, aggregate capital moves from one state of existence (thesis) when a larger number of workers are employed to another state (synthesis) when the number of workers has shrunk, and when the magnitude of fixed capital in terms of machinery and equipment has grown relative to current labour.

In this simple example, capital accumulation is a description of the race between machinery and labour. This race will be the topic of our study. Marx also applies the dialectical approach when he introduces the conflict between the limited purchasing power of the working class due to technological unemployment and the expanded capacity to produce due to technological change.[71] As we will see in Chapter V, technological unemployment can be related to the Marxian crises through this under-consumptionist version.

The foregoing cursory exposition on dialectics is, nevertheless, sufficient to indicate Marx's thought. This thought pattern underlies his major works. In the Grundrisse, the dialectical terminology is

explicit.[72] Even though Capital does not contain the specific use of such terminology, the underlying pattern of thought is still evident. It is this dialectical approach which is the foundation of Marx's dynamics where dynamics can be interpreted as revolutionary changes in the fundamental relationships. This concept of dynamics is very different from that which exists in traditional economic theory.[73] Not only are time and changes in datum allowed but, in addition, the changes are explained endogenously. On the other hand, in traditional theory, the fundamental contradictions are resolved when a new equilibrium is reached. The forces disturbing the equilibrium remain unexplained. In Marx's synthetic analysis, exogenous variables are difficult to identify. Technological change, competitive conditions, monopolies, the role of the state, scientific development, etc., all become endogenously determined by the relationships that are inherent in capital.

Understanding of dialectics can clarify Marx's statements that may appear contradictory to economists trained in static analysis. Capital needs more labour to expand itself, but it also displaces labour. Similarly, capital contains the preconditions of competition but also the preconditions of monopoly due to the inevitable destruction of individual capitals. The following quotation directly related to our topic should demonstrate Marx's dialectical thought: "Machinery always creates a relative surplus population, a reserve army of workers which greatly increases the power of capital."[74] The inevitability of periodic crises to overcome the temporary barriers created by capital is an extension of this thought.

Marx's Terminology

In this study, we will, as much as possible, adhere to Marx's own terminology in discussing his fundamental relationships. Such an approach is essential in order to avoid the distortion of his arguments. Pareto says: "Marx's words are like bats, both birds and mice can be seen in them."[75] As Marx's dialectical thought has illustrated, this ambiguity is often intentional, and it constitutes an integral part of Marx's analysis. Attempts to eliminate the multiple but related implications of Marx's concepts would inflict damage on his analysis. Bertell Ollman states: "Immersed as they are in capitalist assumptions, whose import is only indifferently grasped, no one is less qualified to understand the unique contribution of Marxian economics than the economists."[76] Even though the statement may be too harsh, it is a warning that must be heeded. Marx's economic variables must not only be seen as quantities but also as the embodiment of social relationships which are not only shaped by the former but which also act on the former.

Capital can again be used to illustrate the point. At one level of meaning, it is a quantity of money capital that will be divided into constant and variable capital. Constant capital stands for outlay on machinery, equipment and raw materials; variable capital, the wages paid to current labour. At another level, capital is a social-economic relationship. "The way of conceiving capital in its physical attribute only, as instrument of production, while entirely ignoring the economic form which makes the instrument of production into capital, entangles the economists in all manner of difficulties."[77] Capital is perceived as a relationship between: capitalists and workers, capitalists and other capitalists, past labour (constant capital) and current labour.

A serious difficulty in evaluating Marx's works is the differentiation of these levels of meaning. The best approach is to maintain both levels of interpretation in studying Marx. As it will become clear in this work, Marx sometimes works exclusively with one level. For example, he often cites the quantitative expansion of aggregate capital. However, concentration and centralization, the changing capital-labour ratios (constant to variable capital), etc. are implicit in this quantitative expansion. When he works only with a quantitative expansion without a change in relations, he specifies it, e.g. capital accumulation with a given technical base.[78]

Another serious problem is that Marx himself is not always consistent in the use of his terminology. In general, he uses the term, "capital", to indicate the sum of its constant and variable components. There are, however, instances where he seems to be using it only for the constant part. This inconsistency is probably due to the confusion over the variable capital. Marx is often ambiguous on whether the variable capital is advanced or paid out of the earnings at the end of the production period. He argues the latter in several instances.[79]

Most of his examples include the variable capital as part of the advanced capital. Practical examples can be given to illustrate the validity of both approaches. A production process which requires 6 months would require advances in the variable capital whereas one that requires a day or a week would not. In our context, this distinction is not significant. Once we assume continuous production which consists of many distinct periods of production and sales, the importance of this distinction becomes negligible. Consequently, we will use the sum of constant and variable capital as equal to advanced capital. Another

reason for not being concerned about this distinction is the following: According to Marx, the relative shortage of real capital caused by the increase in the organic composition of capital due to technological change is primarily a shortage of constant capital to be advanced. It is this shortage that gives rise to unemployment because the workers cannot be equipped by the increasing amounts of constant capital necessitated by technological change. The role of variable capital becomes less significant. This argument is particularly evident in Marx's long term accumulation model.

There is a further problem associated with Marx's usage of "constant capital". This problem derives from the fact that he does not always differentiate between constant capital used up and constant capital advanced. We will clarify this confusion when we define the "organic composition of advanced capital".

Time in Marx

Time is a very important element in Marx's works. The concept of short term that was previously discussed does not pose any serious difficulty as applied to the Marxian analysis. It can be taken as a time period during which changes in employment are measured as technological change without prior net accumulation having occurred. We can use it as a theoretical concept to isolate the effects of a particular technological change. The more problematic concept of time is the one that applies to Marx's long term view of capitalism in a historical context. This concept of time cannot be taken as an actual period which has a defined beginning or an end.

Actual historical time is used by Marx when he argues that the modes

of production are historically determined and that the laws of the "bourgeois mode of production" are not "natural laws of production."[80] However, in analyzing the secular development of capitalism, despite his specific case, England, he abstracts from actual history. He develops a model of pure capitalism.[81] His economic classes are only defined in terms of capitalists and workers. He disregards landlords and small owner-operated businesses.[82] In this sense, Marx's long term model of capitalism, which will be developed in this study, is a model founded on "tendencies" in pure capitalism.[83]

A serious problem arises in this context with respect to any empirical or theoretical evaluation of the Marxian argument. According to him, capital accumulation and technological change create a tendency to cause increasing unemployment levels in the long term. He also indicates the possible countertendencies that may temporarily offset this general tendency.[84] Given his model of pure capitalism, these movements are impossible to evaluate against an actual historical period. (We will evaluate the Marxian "tendencies" in Chapter IV when we discuss the falling rate of profit.)

Assumptions in Marx

In this section, we will specify and discuss some of the principal assumptions relevant to the Marxian analysis. The more particular assumptions will be stated later in the development of our discussion.

The following assumptions are not givens in his works. These are conclusions that he derives from his historical approach. Instead of repeating many of these arguments, we will consider them as assumptions in our study.

(i) Competition

"Unlimited competition is therefore not the presupposition for the truth of the economic laws, but rather the consequence - the form of appearance in which their necessity realizes itself."[85] He adds: "The predominance of capital is the presupposition of free competition...."[86] Competition is a result of capitalism.

Marx's concept of competition is, on the surface, very similar to the one prevalent in modern economic theory. It implies free competition among capitalists, among workers and perfect mobility of labour and capital. However, it also leads to forms of restricted competition due to "centralization" and "concentration".[87] Free competition is gradually replaced with monopolistic forms of enterprise. Marx does not analyze the significance of such changes with respect to employment. Our long term model on technological unemployment will include some of these changes. However, we will basically maintain a competitive model.

Another important difference from the neo-classical competitive model is that the capitalists (firms) in Marx are aggressive. They try to increase their surplus through capturing markets from each other.[88] The main tool of this aggressive behavior is technological change. The similarity with Schumpeter's approach is striking.

(ii) Profit Motivation

Marx's capitalist is also a profit maximizer. Profit maximization is not sought with a view to consume most of it at a later period. The main motivation is to accumulate. Only in this way can the capitalist maintain himself as a member of the social class that he belongs to. This social dimension is different from the subjective utility approach

where the expected future consumption is rationally weighed against the present consumption foregone. Marx criticizes such views for depicting capitalist motivation as one directed towards larger consumption in the future.[89]

(iii) Uncertainty and Risk

Marx's analysis does not assume perfect knowledge and absence of risk. "Capital undertakes only advantageous undertakings, advantageous in its sense. True, it also speculates unsoundly, and, as we shall see, must do so. It then undertakes investments which do not pay, and which pay only as soon as they have become to a certain degree devalued."[90] We will return to the role of uncertainty and risk in the discussion of crises in Chapter V.

(iv) Methodology and Sources

The present study will basically be a non-mathematical one. The term "model", as it will be used by us, should not be interpreted as a derivation of mathematical relationships. Rather, it is used to mean a critical presentation of the interrelations of Marx's ideas as they pertain to technological change and unemployment. Our main tool will be literary exposition. The partial mathematical relationships to be formulated are simple, and they will be utilized to complement our exposition. There are two major reasons for such a stylistic choice. The first one is that this student is not a mathematical economist. A more important reason is that the Marxian analysis does not easily lend itself to mathematical treatment. Continuous technological change, periodic crises, competitive struggle, etc. cannot be shown through mathematical relationships. The inner logic connecting these aspects must be explained. Mathematical tools have a way of introducing too many

simplifying assumptions and of having a life of their own. The dialectical approach of Marx must first be understood in conceptual terms. Given the concerns expressed by several economists such as Leontief [91] on the possible abuse of mathematical tools in modern economics, we believe that our approach minimizes the risk. Finally, since the question of technological unemployment has received so little attention, the first step should be to explain and evaluate all the different aspects of it on a grand scale without fearing that some of the explanations might be speculative.[92] Only then can some theoretical progress in this area be achieved. Unfortunately, mathematical expositions tend to eliminate this type of discussion. The fixation on Marx's reproduction models which lend themselves to mathematical model-building has had the effect that the role of the industrial reserve army, technological change, and the possible links between crises and technological change have largely been ignored by model builders.[93]

In this study, we will rely mainly on primary sources, namely, Capital, Volumes I, II, III, Theories of Surplus-Value, Parts I, II, III, and the Grundrisse. Other works of Marx will not be emphasized as much. The direct quotations and interpretations from the German economists such as Mitnitzky, Kruse and Kähler are based on our translations since their particular works on the question of technological unemployment have not appeared in English. The same applies to a number of French economists.

NOTES TO CHAPTER I

1. J. Robinson, Economic Philosophy (Middlesex: Penguin Books, 1970), p.102-3. "Marx on Employment", EJ 51 (June-Sept. 1941), p.234-48. For a more general discussion see also Robinson, An Essay on Marxian Economics (1942), 2nd ed. (New York: St. Martin's, 1966).

2. A. J. Jaffe and J. Froomkin, Technology and Jobs (New York: Frederick A. Praeger, 1968), p.38.

3. N. Belfer, "Technical Change and Technological Unemployment" (Ph.D. dissertation, Harvard University, 1946), p.1, 11, 63-4.

4. M. A. Stephenson, "The Role of Technological Change in the English Classical School of Economics" (Ph.D. dissertation, Tulane University, 1965).

5. S. S. Pu, "Technological Progress and Employment" (Ph.D. dissertation, Harvard University, 1949).

6. D. P. Levine, "Accumulation and Technical Change in Marxian Economics" (Ph.D. dissertation, Yale University, 1973).

7. D. Ricardo, Principles of Political Economy and Taxation, ed. R. M. Hartwell (Middlesex: Penguin Books, 1971), p.380.

8. Works dealing with Ricardo's model are numerous. The following is only a selective list. J. R. Hicks: "A Neo-Austrian Growth Theory", EJ 80 (June 1970), 257-81; "A Reply to Professor Beach", EJ 81 (Dec. 1971), 923-5; A Theory of Economic History (London: Oxford University Press, 1969); Value and Capital, 2nd ed. (London: Oxford University Press, 1968), p.286-92. Also see P. Sylos-Labini, Oligopoly and Technical Progress, trans. E. Henderson (Cambridge: Harvard University Press, 1962), p.112-22. A very succinct and informative summary of the Ricardian model is presented by D. P. O'Brien, The Classical Economists (London: Oxford University Press, 1975), p.224-9.

9. K. Marx, Theories of Surplus Value II (Moscow: Progress Publishers, 1968), 547-85. (hereafter cited as Marx, TSV II).

10. For some discussion on the topic see M. Bronfenbrenner, "Das Kapital for the Modern Man", Science and Society 29 (1965), 419-38; D. Furth, A. Heertje, and R. J. Van Der Veen, "On Marx's Theory of Unemployment", Oxford Economic Papers 30 (1978), 263-76; A. Balinky, Marx's Economics (Lexington, Mass.: D. C. Heath, 1970), p.147-50.

11. The neo-classical approach will be further developed particularly in the appendix to Chapter III in order to indicate the major differences between it and the Marxian approach.

12. For a critical discussion of the neo-classical paradigm see B.B. Seligman, "Philosophic Perceptions in Economic Thought", JEI (March 1971), 1-24; M. De Vroey, "The Transition from Classical to Neo-Classical Economics: A Scientific Revolution", JEI (Sept. 1975), 415-39.

13. A. Heertje, Economic and Technical Change (New York: John Wiley and Sons, 1977).

14. A. Gourvitch, Survey of Economic Theory on Technological Change and Employment, National Research Project (Philadelphia, 1940).

15. A. Kähler, Die Theorie der Arbeiterfreisetzung durch die Maschine (Kiel, 1933).

16. B. Ollman, Alienation - Marx's Conception of Man in Capitalist Society (London: Cambridge University Press, 1971), p.xv.

17. P.A. Samuelson and A. Scott, Economics, 3rd Canadian ed. (Toronto: McGraw-Hill, 1971), p.414.

18. See E. Mansfield, The Economics of Technological Change (New York: W.W. Norton, 1968). On p.136-7, he states: "Thus, rapid technological change need not result in increased aggregate unemployment. The important thing is that the government increase aggregate demand at the proper rate." How the resources to equip the workers become available is left unexplained. The same type of argument is advanced by W.W. Heller. He divides the causes of unemployment into two: (i) Unemployment due to deficient aggregate demand; (ii) Unemployment due to technological change. Yet, he sees the reasons for (ii) in the lack of training and skills for the jobs available, immobility of labour and imperfect flow of information. He concludes, however, that even if unemployment were of this type, "a sufficient autonomous expansion of demand brought about by monetary or fiscal measures should be capable of melting it away." "The Administration's Fiscal Policy", A.M. Ross, ed., Unemployment and the American Economy (New York: John Wiley and Sons, 1964), p.95-6. For other articles along the same lines see the same book and also J.T. Dunlop, ed., Automation and Technological Change (Englewood Cliffs: Prentice-Hall, 1962).

19. Mansfield, p.136.

20. A. Lowe, "Technological Unemployment Reexamined", Wirtschaft und Kultursystem (1955), p.229-54.

21. P. Mandy, Progrès Technique et Emploie (Belgium: Librairie Universitaire, 1967), p.6, 39, 45-50, 72-8. Also see C. Freeman, "Economics of Research and Development", in I. Spiegel-Rösing and D. de Solla Price, eds., Science, Technology and Society (Beverly Hills: Sage Publications, 1977), p.227.

22. J.M. Keynes, Essays in Persuasion (New York: W.W. Norton, 1963), p.364.

23. Ibid.

24. M. Bouniatian, "Technical Progress and Unemployment", ILR XXVII (March 1933), 327-48. N. Kaldor, "A Case Against Technical Progress", Economica XII (May 1932), 180-96.

25. E. Lederer, Technischer Fortschritt und Arbeitslosigkeit (Tübingen, 1931).

26. Gourvitch, p.47.

27. J. R. McCulloch, "The Opinions of Messrs. Say, Sismondi, and Malthus, on the Effects of Machinery and Accumulation, Stated and Examined", Edinburgh Review XXXV (March 1821), 102-23.

28. P. H. Douglas, "Technological Unemployment", American Federationist 37 (Aug. 1930), 923-50.

29. E. F. Beach, "Technological Unemployment: A Failure in Theorizing", Relations Industrielles/Industrial Relations 31 (1976), 125-6. The difficulty in distinguishing the shifts from movements is also indicated by N. Kaldor, "Capital Accumulation and Economic Growth", in F. A. Lutz and D. C. Hague, eds., The Theory of Capital (New York: St. Martin's, 1968).

30. For a critical evaluation, see M. Hollis and E. J. Nell, Rational Economic Man (London: Cambridge University Press, 1975), p.228-32. For a model which combines the neo-classical substitution with ex-post fixed coefficients see L. Johansen, "Substitution versus Fixed Production Coefficients in the Theory of Growth: A Synthesis", Econometrica 27 (April 1959), 157-8.

31. A comprehensive evaluation of the meaning of structural unemployment is presented by E. G. Gilpatrick, Structural Unemployment and Aggregate Demand (Baltimore: Johns Hopkins, 1966).

32. Ibid., p.4.

33. Ibid., p.9. Also see Mandy, p.39.

34. President Kennedy stated: "The major domestic challenge of the Sixties [is to] maintain full employment when automation is replacing men." Quoted in Dunlop, p.1. The U.S. Senate studies on this concern can be found in R. MacBride, The Automated State (Toronto: Ambassador Books, 1967).

35. D. Landes, The Unbound Prometheus (London: Cambridge University Press, 1969), p.294; Marx, Capital I (Moscow: Progress Publishers, n.d.), 403-4.

36. The ILO studies are too numerous to be listed here. It is important to note that this organization provided the forum for the debate between Bouniatian and Lederer. Also see the references in E. F. Beach, "Rezler on Automation and Employment", Relations Industrielles/ Industrial Relations 28 (Oct. 1973), 878.

37. In response to a New York Times editorial on May 27, 1936, which argued that technological change would absorb the displaced workers in the long-run, he says: "This is a beautiful example of the 'long-run' argument.... In this way an industrial economist could prove that a hundred particular individuals who had been discharged because of the introduction of machinery had not really been discharged at all because of the laissez-faire heaven which lay in the future." T. Arnold, The Folklore of Capitalism (1937) (New Haven: Yale University Press, 1968), p.97.

38. B. Commoner, The Poverty of Power (New York: Alfred A. Knopf, 1976), p.227.

39. Ibid., p.228. The author also makes several references to Marx. p.252-3.

40. L.V. Birck, "The Theories of Over-Production", EJ 37 (March 1927), 30. Other economists will be referred to in Chapter V on crises.

41. Löwe, p.229.

42. M. Mitnitzky, "Kapitalbildung und Arbeitslosigkeit", Archiv für Sozialwissenschaft und Sozialpolitik 66 (August 1931), 62-91.

43. E. Lederer, "Technical Progress and Unemployment", ILR XXVIII (July 1933), 1-25.

44. H. Neisser, "Permanent Technological Unemployment", AER XXXII (March 1942), 50-71.

45. B. Seligman, Most Notorious Victory (New York: MacMillan, 1966).

46. R. Theobald, Free Men and Free Markets (New York: Doubleday, 1963).

47. R. Heilbroner, "The Impact of Technology: The Historic Debate", in Dunlop, p.25.

48 A. Hansen, "The Theory of Technological Progress and the Dislocation of Employment", AER, Supplement, XXII (March 1932), 25-32. In Chapter III, we will return to Hansen's arguments.

49. J. Schumpeter, History of Economic Analysis, (New York: Oxford University Press, 1954), p.684. Also see footnote on p.679.

50. For Hicks' works on this see note 8.

51. In response to E. Beach's critical article, "Hicks on Ricardo on Machinery", EJ 81 (Dec. 1971), Hicks still maintained his position in "A Reply to Professor Beach". Even though our objective is not to clarify this controversy, our analysis in the following chapters will indirectly achieve this task. We will frequently refer to Beach's criticisms of Marx as well.

52. The long run view is expressed by Bouniatian. p.343. The long run beneficial effects are also expressed elsewhere in the following way: "In the long run and for the economy as a whole, changes in machine technology are no doubt a major source of growth of income as well as of employment." E. Mueller and others, Technological Advance in an Expanding Economy: Its Impact on a Cross-Section of the Labor Force, (Ann Arbor: Braun-Brumfeld, 1969), p.1.

53. MacBride, p.38.

54. For example, as we will later see, science becomes business. He also attempts to treat labour supply endogenously. Also see J. Steindl, Maturity and Stagnation in American Capitalism (Oxford: Basil Blackwell, 1952), p.192-3.

55. O'Brien, p.228. See his bibliography on the modern extensions of the controversy, p.239.

56. J. Schumpeter, Capitalism, Socialism and Democracy (New York: Harper and Row, 1950), p.40. He points out that Marx's model on accumulation is "prosperityless" and "depressionless."

57. Marx, Capital I, 604. Also see Marx, Grundrisse, trans. M. Nicolaus (Middlesex: Penguin Books, 1973), p.692, 750. For further discussion, see H. Braverman, "Labor and Monopoly", Monthly Review, Special issue, 26 (July-Aug. 1974).

58. Marx, Capital I, 419, 448.

59. Ollman points out that Marx, in his letters to Kugelmann, stated that any attempt to prove the value theory was "nonsense". p.176.

60. Marx, Capital I, 667-716.

61. One could, of course, say that he assumed the prices to be equal to labour values.

62. Marx, Capital I, 20.

63. S. Avineri, The Social and Political Thought of Karl Marx (London: Cambridge University Press, 1968). Also see P. A. Baran and E. Hobsbawm, "The Method of Historical Materialism", Kyklos 14 (1961).

64. Ollman quotes Lenin saying: "It is impossible completely to understand Marx's Capital, and especially its first chapters, without having thoroughly studied and understood the whole of Hegel's Logic." p.36.

65. This terminology is Hegelian. Marx rarely uses it in his works. However, the pattern of such thought is clear in his writings. For the explicit usage of this terminology by Marx see The Poverty of Philosophy (New York: International Publishers, 1963), p.107; Theories of Surplus-Value III (Moscow: Progress Publishers, 1971), 429. (hereafter cited as Marx, TSV III.)

66. Marx says: "Capitalist production, therefore, under its aspect of a continuous connected process, of a process of reproduction, produces not only commodities, not only surplus-value, but it also produces and reproduces the capitalist relation; on the one side the capitalist, on the other the wage-labourer." Capital I, 542. Also see Grundrisse, p.409, where he states: "Thus capital creates the bourgeois society, and the universal appropriation of nature as well as of the social bond itself by the members of society."

67. "To accumulate is to conquer the world of social wealth, to increase the mass of human beings exploited by him, and thus to extend both the direct and indirect sway of the capitalist." Marx, Capital I, 555.

68. For the contradictions and limits to exploitation see particularly chapter XV on "Machinery and Modern Industry." Marx, Capital I, 351-475.

69. Ibid., p.405. He also says: "The self-expansion of capital by means of machinery is thenceforward directly proportional to the number of the workpeople, whose means of livelihood have been destroyed by that machinery." Ibid.

70. Marx says: "As the use of machinery becomes more general in a particular industry, the social value of the product sinks down to its individual value, and the law that surplus-value does not arise from the labour-power that has been replaced by the machinery, but from the labour-power actually employed in working with the machinery, asserts itself." Ibid., p.383.

71. "The same with the productive force. On the one hand, the necessary tendency of capital to raise it to the utmost, in order to increase relative surplus time. On the other hand, thereby decreases necessary labour time, hence the worker's exchange capacity." Marx, Grundrisse, p.422.

72. Ibid., p.401, 415, 494, 546. On these pages one sees the Hegelian influence on Marx very clearly.

73. P. Leon, Structural Change and Growth in Capitalism (Baltimore: Johns Hopkins, 1967), p.140-41.

74. Marx, TSV II, p.554.

75. Quoted by Ollman, p.3.

76. Ibid., p.188.

77. Marx, Grundrisse, p.591.

78. Marx, Capital I, 590.

79. In Chapter II, we will show that this distinction is not important for our study.

80. Marx, TSV III, 429.

81. Abstraction from real history as a method to develop pure models is discussed by L. Althusser and E. Balibar, Reading Capital (London: Unwin Brothers, 1977).

82. Marx shows how the machines and the factory system eliminate "small masters ". Capital I, 448.

83. The significance of this will become clear when we specify the meaning of compensation in Chapter III.

84. Clearly, the most important countertendencies are those which may reduce capital intensity. Such countertendencies will be indicated in Chapters II and III. Also see Marx, Capital III, 77-104, 232-40.

85. Marx, Grundrisse, p. 552.

86. Ibid., p.651. He argues that he makes "no presupposition other than the previous historic development." Ibid., p. 488.

87. Marx, Capital III, 225, 238, 250, 262-3, 307, 313, 437-8. Also see Grundrisse, p.651.

88. Marx, TSV II, 484.

89. Marx, Capital I, 549, 555-7; Capital II (Moscow: Progress Publishers, 1971), 70-2; TSV II, 282-3. He says: "If it is finally said that the capitalists have only to exchange and consume their commodities among themselves, then the entire nature of the capitalist mode of production is lost sight of; and also forgotten is the fact that it is a matter of expanding the value of capital, not consuming it." Capital III (Moscow: Progress Publishers, 1971), 257.

90. Marx, Grundrisse, p.531.

91. For criticisms in this area and questions raised about the relevance of equilibrium models see E.H. Phelps Brown, "The Underdevelopment of Economics", EJ 82 (March 1972); G. Myrdal, "Response to Introduction", AER, Papers and Proceedings, LXII (May 1972); W. Leontief, "Theoretical Assumptions and Nonobserved Facts", AER LXI (March 1971). Althusser points out that, in Marx, mathematical formalization must be subordinate to conceptual formalization. p.183.

92. Heilbroner says: "Hence, while there is still time left, we must peer courageously ahead, take audacious triangulations on our course, seek to combine empiricism and speculation on the grand scale." p.25.

93. M. Desai, Marxian Economic Theory (London: Gray-Mills, 1974), p.83.

CHAPTER II

NATURE OF TECHNOLOGICAL CHANGE IN MARX AND THE DIRECT SHORT TERM EMPLOYMENT EFFECTS

1. Introduction

In this chapter, after we analyze the role of technological change and machinery in Marx and develop the concept of "organic composition of capital", we will study the direct short term effects of technological change on employment. The indirect short term effects through changes in the wage rate, prices of commodities produced by the firms undertaking technological change, and surplus will be considered in Chapter III when we study Marx's critique of the classical compensation theory. In one sense, the model at the end of this chapter is a definitional one, and it is static because it excludes accumulation and growth. However, this static model is an essential phase of Marx's arguments on technological unemployment. Marx uses it to demonstrate the net labour displacement effects of technological change as distinct from the net absorption effects of the accumulation process.

2. Nature of Technological Change in Marx

It is not our objective to analyze all of the causal mechanisms and diffusion patterns of technological change in Marx. We wish rather to

study its effects on unemployment. Therefore, we will only briefly discuss the nature of technological change in Marx. This discussion will indicate the types of technological change behind the Marxian unemployment.

Marx does not develop the links between science, inventions and technological change. However, there is sufficient material in his works to arrive at a tenable interpretation. He states that "capital accumulation is contingent on an increase of knowledge"[1] and that this increase costs the capitalist nothing.[2] This might imply that technological change is an exogenous variable randomly forthcoming. Such an interpretation is difficult to maintain given his many comments that, in capitalist development, scientific progress and inventions become endogenously determined by the capitalist motivations and the process of accumulation. "Invention then becomes a business, and the application of science to direct production itself becomes a prospect which determines and solicits it."[3] In reference to the "sporadic use of machinery in the 17th century", he argues that this use stimulated also the "creation of the science of mechanics" by "supplying the great mathematicians of that time with a practical basis."[4]

The foregoing comments indicate that Marx's concepts of technological change, i.e., the adoption of new techniques in the production process, scientific progress, and inventions are not distinctly separate. They interact and are determined by the capitalists' motivation to increase their surplus. Such an interpretation is consistent with Marx's dialectical perspective which allows little room to independent phenomena.[5] In this framework, the distinctions among science, inventions and technological change become irrelevant.[6] "Capitalist production leads to separation of science from labour and at the same time to the use of science in material

production."[7]

In modern literature, there are several types of classification of technological change. Some of these classifications emphasize the effects of technological change on the marginal productivity of capital and labour, and define technological change as capital saving, labour saving or neutral according to these effects.[8] It should be pointed out that these classifications are not designed to analyze the question of technological unemployment but to analyze the effects of technology on the distribution of income. Hence, they will not be utilized in our discussion. Whenever we use the terms such as capital using or labour saving (displacing), we will be using these terms in their popular sense to mean that actual labour is displaced by the introduction of new machines. Labour saving can also mean that labour input per unit of output has decreased. In fact, as A. Ross states: "[A]lmost every technological change is labor-saving in the sense of reducing labor requirements per unit."[9] Yet, this does not necessarily mean that workers have been displaced.[10] It will be seen that Marx's technological change fits this popular definition. Its meaning will become clear in the following sections of this chapter.

Other classifications also exist to specify the types of technological change not in terms of their effects on marginal productivities but in terms of the forms that technological change takes. One classification divides technological change into embodied and disembodied types, and another into product and process innovations.[11]

As for the first one, Marx discusses both types of technological change. However, he emphasizes the embodied change and shows the

disembodied change as a consequence of and as limited by the extent of embodied technological change. In other words, in Marx, these two forms are not independent of each other. Technological change exhibits itself in an increased quantity of constant capital both in physical units and money value. This embodied change makes further cooperation between workers and division of labour possible. These are a "technical necessity dictated by the instrument of labour."[12] What we observe as costless improvements in the production methods due to organization, division of labour and coordination are, according to Marx, the consequences of prior embodied technological change. In a sense, there is a complementarity between the two types of technological change. He points out that such complementarity also exists if the capitalists want to make use of "physical forces, like steam, water" because their exploitation "necessitates a costly and expensive apparatus."[13]

The distinction between process and product innovations is also present in Marx.[14] However, when he analyzes technological unemployment, he limits himself to the study of process innovations that are realized through new machines. But a process of innovation in some firms when embodied in new machines and equipment normally implies the production of these machines by other firms.[15] In other words, the Marxian technological change includes product innovations if only the production process is considered. If the classification is understood to be applicable to the distinction between the process innovations and the innovations in consumer goods, Marx focuses on the former. Unlike Schumpeter, he does not emphasize the significance of new consumer products even though he is cognizant of the introduction of new consumer products. He argues that the capitalists have to create new needs, expand them to wider circles, and

expand those needs that already exist.[16] But he, for the most part, stresses the quantitative expansion of the commodities that already exist when he is trying to prove the labour displacement effects of technological change. The introduction of new goods or the cultivation of new tastes on the part of consumers in addition to their present consumption levels may alleviate the Keynesian type of concern. But this is not the case in Marx. Marx's argument is, in general, not dependent on the lack of new markets or on demand but on capital scarcity. Consequently, the exclusion of new consumer products from his analysis is not a serious weakness. One could criticize him by arguing that modern capitalism does not face a problem of capital shortage but a problem of inadequate demand. However, one could not refute his analysis on the basis that he ignores the introduction of new consumer products. Such a criticism is untenable given his capital shortage model.
In the analysis of the compensation controversy in Chapter III, we will show that the Marxian analysis can be maintained even if capital is used to introduce new consumer products.

Finally, Marx sees technological change as a revolutionary phenomenon. It acts "on the new capital and on that already in action."[17] It is the most important tool for the capitalist class to exploit the workers and to capture markets from others. He does not allow the possibility of several alternate forms of techniques available at a given time; the possibilities in choosing alternate techniques are limited. As it was previously pointed out, this view contrasts sharply with the neo-classical production isoquants which reflect an infinite range of techniques. Moreover, in Marx's long term analysis, technological change results in increasing amounts of constant capital per worker. Reverse substitution in favour of labour becomes more and more difficult as the magnitude and

the life span of constant capital increase. Even though Marx does not deal with the substitution process over time adequately, one cannot but get the impression that the new machines make any possible reverse substitution uneconomical. In this sense, even new "capitals" seeking outlets adopt the mechanized technology. Hence, ex-ante substitution in favour of labour also becomes difficult. Whether such a view is tenable will be a part of our study in the appendix to Chapter IV.

3. Technological Change and Machinery

In Marx, technological change is synonymous with the use of new machinery which embodies it. Machinery is associated with the factory system, and it symbolizes the dissolution of manufactures based on simple cooperation among workers. The manufactures are, according to him, only an extension of handicrafts on a large scale.[18]

He defines machinery as "a mechanism that, after being set in motion, performs with its tools the same operations that were formerly done by the workman with similar tools."[19] Moreover, machinery substitutes "natural forces for human force," and it necessitates "the conscious application of science, instead of rule of thumb."[20] Machinery leads to further rationalization of the production process in a cumulative manner.

He says: "...[M]achinery is intended to cheapen commodities, and, by shortening that portion of the working-day in which the labourer works for himself, to lengthen the other portion that gives, without an equivalent, to the capitalist. In short, it is a means for producing surplus-value."[21] This indicates the rationale for the introduction of new machinery embodying new techniques from the perspective of an individual capitalist.

The cheapening of the commodities should, then, be interpreted to mean a decrease, in the average cost per unit of commodity in a firm below the average cost in the industry.[22] Given the market price, extra surplus is temporarily received by the initial innovators before the price sinks when the widespread adoption of the new machines takes place.[23]

The important difference between this approach to profit maximization and the traditional one is that the Marxian capitalist is compelled by the objective laws of competition to be aggressive, and that he reduces his costs of production by displacing labour. Economizing in other costs is also emphasized[24] but is not as significant in his analysis. The share of wages in advanced capitalism falls absolutely in the short term and relatively in the long term due to the introduction of machines.

The productivity of machinery is measured by the amount of living labour that it replaces.[25] Given a level of output,[26] the new machine makes it possible to reduce the number of workers employed and increases output per worker. The capital cost of the machine is less than the sum of the wages of the displaced workers. He states: "It is evident that whenever it costs as much labour to produce a machine as is saved by the employment of that machine, there is nothing but a transposition of labour; consequently the total labour required is not lessened or the productiveness of labour is not increased."[27] Marx uses this statement to show that the machine construction cannot absorb the displaced workers. It is inherent in this logic that no net accumulation accompanies the introduction of the new machine. We will see in the following chapters that Marx's statement is not a proof of an actual displacement of workers when accumulation is allowed. He also points out that the capitalist's aim is to reduce costs.[28] The displacement of labour is a result of this

economic motivation. This is the dominant motivation rather than the intent to repress strikes which Marx also mentions.[29]

The new machine is gradually introduced by the other capitalists in the industry. The competitive conditions, i.e., the loss of markets to the innovative firms and the desire of the other capitalists to remain in their social class, lie behind the diffusion of new technology. Similar technological changes occur in other industries;[30] that which initially appears to be temporary technological unemployment becomes a permanent one. "...[S]ince machinery is continually seizing upon new fields of production, its temporary effect is really permanent."[31]

We have briefly outlined the motivations behind and the process of the introduction of machinery as they relate to technological displacement of labour.

This is a partial picture of the process described by Marx. The specific displacement and absorption processes will be developed at the end of this chapter.

4. Forms of Capital

According to Marx, advanced money capital is the monetary value of capital before it enters the production process. The "productive capital" exhibits itself in the production process as the means of production and living "labour-power", i.e., the labour directly employed with other means of production to produce the finished product. The "commodity capital" is the finished product before it is sold. Marx clearly distinguishes these three forms of capital.[32] The circuit representing these three forms is M-C-C'. The circuit, in this form, is not yet completed because C', the commodity capital, has not been converted into

M'. Without this conversion, capitalism cannot survive because "realisation" will not have taken place. M-C-C'-M' represents the full circuit.

To facilitate our initial model on the short term effects of technological change on unemployment, we will not deal with that part of the circuit which represents C'-M'. We will assume that the product is produced and sold at the expected prices. There is no obstacle in the realisation process. We will utilize the advanced money capital and the productive capital to derive our measures of the Marxian technological change.

5. Measurements of Technological Change

Marx divides the advanced capital, henceforth indicated as AC, into two components, namely, constant and variable capital.[33] Then, AC will be equal to C plus v.[34] We will denote the constant capital advanced with a capital letter and the variable capital advanced with a small letter. This notation is necessary because the variable capital advanced is smaller than the variable capital employed when the variable capital advanced turns over several times during the total period for which C is advanced. Similarly, the constant capital advanced is greater than the constant capital consumed during a single production period if the machines bought last over several production periods, during which commodities are produced and sold. The output of each period would be equal to the value of c + v + s. However, c is much less than C.[35] This distinction between capital advanced and capital "employed" or "consumed"[36] is made by Marx even though he is not consistent with the terms when he analyzes technological unemployment. Yet it is an essential

distinction for the discussion of technological unemployment because the capitalist needs AC to start his operation. How much current or living labour will be set into motion depends on the division of this capital or of the real commodities corresponding to it into C and V. Obviously, technology will determine this division. We will return to this issue shortly.

Marx defines the constant capital as the value of the machinery, equipment, buildings, raw materials, semi-finished goods, and other auxiliary substances that enter the productive process.[37] The variable capital, v, is the sum of the wages paid to the workers.[38] He also makes a distinction in terms of fixed and circulating capital.[39] Whereas the distinction between the constant and the variable capital is largely based on the theory of value -- the constant capital only yields its own value to the commodity and the labour-power adds more than its exchange value -- the distinction between fixed and circulating capital is based on the difference in time periods that each component of the advanced capital requires to turn over.[40] This double classification is unique to Marx.[41] It is not observed among the classical economists who only saw the division between the fixed and circulating components. Since we are not concerned with the value theory, the classification in terms of fixed and circulating capital may appear to be more suitable for our analysis. One difficulty with it is that Marx includes wages as well as raw materials in the circulating capital whereas in v he includes only the wages to current labour. Clearly, v is the better concept for an index of direct labour. Hence, we prefer to use the classification in terms of C and v. Also, we will, for the most part, equate C with machines. One must, however, note that Marx is aware of the role of raw materials in C; he often argues that the use of raw materials will increase rapidly

as the introduction of superior machines expands the scale of output.[42]

The constant and variable components of AC have different turnover periods. The constant capital advanced yields only a part of its value to the output during a single production period whereas the variable capital advanced yields all of its value. Since we are concerned with the advanced capital in a non-accumulation model, the surplus arising from the subsequent production process is not relevant at this stage.

If the production period of output is equal to the turnover period of the total constant capital, the distinction due to the different turnover times disappears. However, in most lines of production the constant capital turns over more slowly than the variable capital. The period for which the constant capital is advanced consists of several production periods. At the end of each one the finished output is sold. The variable capital recovered can be readvanced from these sales. When the production process is initially started, i.e., when machines are bought and labour is employed, wages need not be advanced for all these periods. It is sufficient for the capitalists to have at hand only the funds for one period of production. Obviously, if the production period is short enough, they do not even need to advance any wages initially. Workers, after all, are not paid on the first day. For simplicity, we can assume that the period of production is long enough so that the workers need to be paid before the output is ready for sale. We have already pointed out that the possible ambiguity is not very significant to Marx's argument due to the fact that the real bottleneck is C.

Technological change results in the change of the composition of

capital. Marx measures technological change through the changes in the "technical" and "value-composition" of the advanced capital.[43]

The technical composition indicates the division of the productive capital between the physical means of production and living labour-power.[44] This can be considered as the ratio of the physical units of the means of production to the number of workers at any given time in the production process. Given the heterogeneous and ever-changing nature of the means of production, it is impossible to compute an actual coefficient. This is possible only where the constant capital is reduced to one commodity, for example, tractors per worker in agriculture. Even then, qualitative changes in the tractors due to technological change would render comparison over time difficult. Consequently, the technical composition of capital (TCC) is not an operationally useful index of technological change. Moreover, the capitalist motivations cannot be explained on the basis of this real relationship. As a result, Marx adopts the concept of value-composition of capital. Nevertheless, he refers constantly to TCC as a conceptual tool. Its significance will become clear shortly.

The value-composition of capital is "determined by the proportion in which it [capital] is divided into constant capital or value of the means of production, and variable capital or value of labour-power, the sum total of wages."[45] This measure, as we will see, is not an unambiguous measure of technological change either. Marx attempts to reduce its ambiguity by imposing the condition that changes in the value-composition must reflect also the changes in TCC, i.e., an increase in constant capital to variable capital must also mean an increase in the means of production for the workers employed. He says: "The value-composition of

capital, inasmuch as it is determined by, and reflects its technical composition, is called the organic composition of capital."[46]

TCC may differ from OCC. Marx discusses the possible sources of divergences between the two in Theories of Surplus-Value.[47] The following discussion is based mainly on his comments. However, he does not formulate the mathematical relationships that we present. The physical volume of the means of production may remain the same whereas OCC may increase. Yet this increase in OCC does not indicate a technological change. Before we discuss the cases where changes in OCC may differ from those in TCC and may not reflect a technological change, we need explicit definitions for these two measures of technological change.

Based on Marx's statements, we will use $\frac{C}{V}$ as the organic composition of capital[48] and let it be equal to q.

To derive a notation for TCC, let:

K: Quantity of means of production advanced, i.e., machines and equipment

N: Number of workers employed

k: Means of production per worker, i.e., $\frac{K}{N} = k$.

The q may differ from k for the following reasons:

(i) Changes in the prices of the means of production advanced.

(ii) Changes in the wages of labour.

(iii) Changes in both.

The money value of the means of production advanced and labour employed can be derived from the information above when:

P_k: Price per unit of the means of production

W: Wage per worker during one production period

then: $K \cdot P_k = C$, $N \cdot W = v$ and $\frac{K \cdot P_k}{N \cdot W} = \frac{C}{v} = q$. Given a constant k, if $\frac{P_k}{W} \neq k$, then q will be different from k. We can trace some of the reasons for this by discussing the cases listed above.

(i) A decrease in P_k will reduce the organic composition of capital. This means that the capitalist can now purchase the same means of production with a smaller outlay. The scale of production and employment can increase once this released capital is also advanced.

On the surface, this appears as a constant capital saving improvement. Yet, this decrease in q at the level of a firm or industry may be the result of an increase in q at the level of another industry producing these means of production more cheaply, i.e., embodied technological change may have taken place there. Marx does not think that the decrease in q at the aggregate level will be a dominant characteristic in capitalism. The reasons for this will be discussed when we analyze the possible countertendencies.

An increase in P_k increases q. At a given level of k, such a possibility exists if the means of production become more expensive. This may be due to a shortage of some inputs in the production of the means of production. Once again, this does not reflect a technological change for the firms buying the means of production even though their q has increased. In fact, more of their capital may be tied up in C. Given fixed coefficients in production, they may even have to reduce their scale of production and cause unemployment if they do not have much capital at their disposal. Such displacement is not due to technological change, but due to its absence.

(ii) If W decreases, q will increase even though k is constant. The

reduction in the wage rate will enable the capitalist to employ the same number of workers with a smaller advance in v to produce the same level of output. Such a decrease in W can, for example, be due to cheaper wage goods imported or to increased productivity in the production of means of subsistence elsewhere. However, this increase in q, according to Marx, does not reflect technological change that displaces labour. On the contrary, such an increase in q releases a part of the variable capital without a fall in the number of workers employed. A part of v that is released can be used to employ additional workers. On the other hand, an increase in W will reduce q. However, this is different from the case when P_k has decreased. No capital will be released. In fact, the scale of production may have to be reduced. At best, the increase in v will represent the same number of workers. It will not be an index for an increased employment.

(iii) The effects of changes in both P_k and W can easily be deduced from the examples above.

In all these cases, we have held the technical composition of capital constant at the level of the industry and allowed the relative prices of the inputs to change. This, in turn, led to changes in q. The possible changes in q which are due purely to changes in the relative price structure do not reflect a technological change at the level of the industry buying the inputs even though they may reflect technological change elsewhere, particularly when the prices decrease. Such changes in q will be called relative changes (increases or decreases) in the organic composition of capital.[49] The increase in q which Marx uses as an index of technological change involves not only an increase in q but also an increase in the mass of means of production for a given number of workers.

We will call this an absolute increase in q. This absolute increase in q means that the ratio of past labour to current labour increases in man-hours and is reflected through the changes in the money outlays on C and v. In this way, we can eliminate the changes in q due to relative price changes only. Then the increase in k will reflect also this increase in the ratio of past to current labour as well even though it may increase faster than q.

As indicated earlier, the use of k in relation to q is problematic as new types of equipment are introduced. Marx does not appear to be aware of this. Consequently, we will refer to k only as a conceptual tool to indicate that each worker is equipped with a larger mass of means of production that embodies larger quantities of primary raw materials.

It is impossible to eliminate the ambiguity in OCC as a measure of technological change over time. This is true, of course, even in modern theory which does not provide an unambiguous measure of technological change because both the changes in the nature of capital goods and the changes in relative prices must be considered. Rather than resolving the difficulties associated with Marx's index of technological change at this point, we intend to clarify its meaning as we apply it to his analysis throughout this work.

In summary, according to Marx, q increases in absolute terms in capitalist development. Also, both k and q tend to move in the same direction.[50] According to Marx, k grows faster than q because technological change reduces the price of the individual units of the means of production but also makes it necessary to equip the workers with increasing amounts of the means of production.[51] In the ratio, $\frac{K \cdot P_K}{N \cdot W}$, the relative decrease

in Pk or W is offset by a greater percentage of increase in K. This points out a very important aspect of Marx's thought; technological change will reduce the prices of the individual components of the means of production but it necessitates an absolute increase in C per worker. In other words, labour embodied in each unit of means of production may decrease, but the mass of machinery necessary to equip each worker will embody more labour than the previous one.

6. Organic Composition of Capital and Organic Composition of Output in Relation to Employment

In the previous section, we have defined the organic composition of capital and have discussed its relation to k. However, we have not explicitly discussed the reasons for defining q as $\frac{C}{v}$.

Traditionally, q has been calculated from the value of output produced in one period when: $O = c + v + s$. Here, c stands for the part of the advanced constant capital that enters the value of the product, i.e., depreciation, v for the part of the output corresponding to wages paid to workers, and, finally, s for the part of the product that is received by the capitalist as surplus.

The ratio, $\frac{c}{v}$, calculated from above will be smaller than $\frac{C}{v}$ as long as the period for which constant capital is advanced consists of several production periods. At the end of each period, a certain amount of output is sold. Then, c only stands for the part of the constant capital used up or employed in one period. We will call $\frac{c}{v}$, the organic composition of output in order to distinguish it from q.[52] It will be indicated as o.

This coefficient measures the ratio of constant capital employed to the variable capital in order to produce a certain level of output.

However, it does not give us information on the magnitude of the capital that is necessary in order to start the production process at the beginning. It does not tell us how much employment will be created when the capitalists advance their capital in terms of constant and variable components initially. It does not indicate the initially required capital to absorb a given amount of workers. In real terms; it does not indicate the amount of commodities that must be at the disposal of the capitalist so that he can use one part of them as means of production and the other part as an advance in terms of means of subsistence. To state differently; o is a coefficient that measures the ratio of constant capital and variable capital used up per unit of output whereas q measures the ratio of constant and variable capital necessary to start the production process. Marx's concept of technological change implies that the share of the advanced constant capital will increase over time and that the creation of employment will get more and more difficult due to the necessity for increased amounts of constant capital that are needed to equip the workers. The organic composition of output is not directly relevant to the employment question.

To further clarify the distinction between the two coefficients, one must employ the concept of turnover in Marx. We have previously referred to this concept without defining it. Marx says: "From the point of view of the capitalist, the time of turnover of his capital is the time for which he must advance his capital in order to create surplus-value with it and receive it back in its original shape."[53] This time is "the sum of its time of circulation and its time of production."[54] We will assume that the circulation time is negligible.

Assuming that the production period, i.e., the period necessary to

produce a given level of output ready for sale, is one year, the variable capital advanced will have to be equal to the sum of the wages to be paid to the workers during the year. The variable capital will turn over once during the year. Unless all of the machinery is also used up during the same period, the turnover time of C will be longer than 1 year. Then, c will be less than C.

$\frac{C}{v}$ tells us how much constant capital per worker must be advanced, assuming that v is an index for the number of workers, to start production initially or how much constant capital per worker must exist if production is to be maintained. In the latter definition, there is a minor problem because C is used up over time. If constant capital is replaced at the end of its total turnover period, the value of constant capital per worker, if it is measured in successive periods, will be decreasing because the machine is losing its value over time. However, this does not change the fact that a much larger C per worker must be advanced at the beginning. The gradual reduction in the value of machinery does not show the technical relationship that must exist. Hence, it is the ratio of C to v at the beginning of the total production process which is relevant for the question of employment.

The following formulations show the difference between q and o and why q is the more meaningful measure of technological change in the analysis of employment. A similar presentation is done by Geoffrey Kay who also stresses the importance of this distinction.[55]

tv: Turnover time of v measured in years

tc: Turnover time of constant capital advanced measured in years

Turnover time of v = one production period

v: Total variable capital employed during the time when C is

recovered in total

(i) $c = C \cdot \frac{tv}{tc}$

(ii) $V = v \cdot \frac{tc}{tv}$

Organic composition of output, $o, = \frac{c}{v} = \frac{C \cdot \frac{tv}{tc}}{V \cdot \frac{tv}{tc}} = \frac{C}{V}$

The organic composition of output, whether calculated on the basis of a single production period (single output) as $\frac{c}{v}$ or on the basis of the total turnover period of C (total output over several periods) does not change. The numerator and the denominator are multiplied by the same number of turnovers.

Organic composition of capital, $q, = \frac{C}{v} = \frac{c \cdot \frac{tc}{tv}}{V \cdot \frac{tv}{tc}} = \frac{C}{V \cdot \frac{tv}{tc}}$

The difference between $\frac{C}{V}$ $\left(\text{or } \frac{c}{v}\right)$ and $\frac{C}{V \cdot \frac{tv}{tc}}$ can best be shown by assigning certain arbitrary values:

Let: C = \$80,000

V = \$100,000

tc = 5 years

tv = 1 year

Then, o will be $\frac{80,000}{100,000}$ over 5 years or $\frac{6,000}{20,000}$ over one year. In either case,

$o = \frac{4}{5}$.

However, q will be: $\frac{C}{V \cdot \frac{tv}{tc}} = \frac{80,000}{100,000 \cdot \frac{1}{5}} = \frac{80,000}{20,000} = 4.$

It is the latter coefficient that is meaningful in assessing the effect of technological change in employment in the short term. It indicates that the constant capital advanced must be 4 times the variable capital advanced in order to employ a given number of workers. If a single production period is one year and the annual wage rate is $10,000 per worker, then only 2 workers can be employed or set into motion with an advanced capital of $100,000. This capital is but the sum of C and v. However, o does not provide us with this information. It indicates only that, to produce a certain annual output, the capitalist will have to use up $16,000 of equipment while employing two workers during a year. But each worker will have to be provided with more equipment than $16,000 worth of equipment if the production process is to be maintained.

The foregoing discussion illustrates that the organic composition of output is not a meaningful measure for our purpose. Although Marx does not explicitly make a distinction between the two measures, his discussion of turnover time and his emphasis on the amount of capital to be advanced imply this. Moreover, in reference to the labour absorption process, he often states that capital must grow to a certain size before it can be advanced. This view is consistent with the use of q instead of o to measure technological change and its impact on employment.

This distinction has not been made very clear in Marxist literature. Part of the blame rests with Marx who does not clearly integrate the turnover time into his analysis of employment even though he discusses it separately. When he derives the reproduction models, he leaves out the concept of turnover to simplify his analysis. Other economists have based the organic composition of capital on the notations that are explicit in these reproduction models. As long as one is interested in o, this

procedure is valid. However, if one is interested in the employment effects of technological change, it is inadequate. Obviously, one can eliminate the confusion by assuming that the turnover times of v and C are the same, i.e., tv = tc. Then, o will be equal to q. Even though this assumption eliminates any possible confusion, it, at the same time, limits the scope of the analysis of technological unemployment. In fact, Marx often states that the new machines will not be replaced for a long time. He wants to indicate that the labour absorption in the machine construction cannot be permanent. In the rest of this study, we will also maintain the assumption, tv = tc, when we derive certain mathematical relationships. However, in our literary discussion, we will relax this assumption and consider the implications for Marx's analysis.

An important point to note before leaving this topic is that the organic composition of capital poses another problem due to the changes in the turnover time. For example, a decrease in tv, i.e., a faster turnover of variable capital, means that a single production period is shortened. This will result in an increase in q because the capitalists need to advance a smaller v for the same number of workers. If the tv is six months instead of one year, then one-half of the previous variable capital will suffice. But q will increase. However, this increase in q does not imply an absolute increase in C at the expense of the advanced variable capital. A smaller amount of variable capital will, by turning over twice during the year, employ the same 2 workers even though variable capital advanced is sufficient to employ them only for 6 months. Such an increase in q will increase employment because a part of the variable capital that is released will become available to employ additional workers. It must, however, be noted that the released v should be large enough to

finance also C that is necessary. When one considers the conditions that can reduce the turnover time of v, one realizes that the possibility cannot be too great during short periods. To increase the intensity of the production process such that the same output can be produced during one-half of the previous period of production with a given stock of capital goods is not realistic. If such increases in turnover of the variable capital were easy to undertake, then there would be little rationale for technological change. As we will see in the next section, Marx is explicit in arguing that there are limits to the increase in intensity of labour with a given technique. With a given technology, the increase in q due to a decrease in tv cannot be exaggerated. In fact, the decrease in tv must, ultimately, be linked to a change in the technological base of the production process, i.e., to a prior increase in C in the Marxian context. Yet, according to Marx, this change occurs at the expense of v in the short term when no prior net accumulation occurs. One, then, has to evaluate the offsetting effects of the decreases in tv of v as opposed to the conversion of v to C. Nevertheless, the decrease in the turnover period of v can serve as a countertendency to the rise in q and should not be ignored.

The foregoing problem leads us to reiterate a point that was previously made. In order to reduce ambiguity, Marx's measurements must be conceived not only in money terms but also simultaneously in physical terms even though the latter is conceptually difficult. The technical composition of capital, k, does not change if tv decreases through an increase in the intensity of work independent of technological change. The workers must still be equipped with the same amount of machinery and equipment. If tv decreases while C increases, for example, when technological change occurs, then each worker must be equipped with a larger amount of

constant capital which also embodies a qualitative change in the physical means of production. Since we will be dealing with the changes caused by technological progress, it is this case that concerns us most. Then, there is an absolute increase in q due to technological change which is further accentuated by a decrease in tv. However, the latter effect is an expansionary one as it frees v. Its effect is equivalent to the effect of a decrease in the real wage rate. On the other hand, the increase in C, as we will see, has a contractionary effect on employment. But since both of these changes can cause an increase in q, the increase in q can reflect both the contractionary and expansionary effects on employment.

An increase in q due to the decrease in tv must also be called a relative increase. It works as a countertendency to the displacement effects of the absolute increase in q. In the rest of our analysis, we will, for the most part, ignore the decreases in tv. We will integrate the decreases in the real wage into our discussion of compensation. However, our main emphasis will be on the increase in q that is caused by the conversion of v to C in the short term and by the increase in C relative to v in the long term as both C and v increase.

7. Direct Short Term Effects of Technological Change on Unemployment

The direct short term effects of technological change on unemployment can be illustrated at the level of an individual "capital" (firm) or among a few "capitals" in an industry. Marx demonstrates his short term argument initially at a micro level. This approach is preferable for the following reasons:

(i) Technological change does not occur simultaneously in all the firms comprising an industry or an economy.

(ii) The motivation to introduce the new machine that embodies technological change can best be explained at a micro level even though Marx's capitalist always operates in a social-political setting. The individual capitalist's aim is to reduce his average cost per unit of a commodity below the market price and, hence, to capture an extra surplus.

We will assume, analogous to Marx's two-sector model, two firms where Firm 1 produces the new machines and Firm 2 produces the wage goods. (We can assume that the capitalists obtain their luxury goods through imports or from other firms.) There is no problem of realization, and the wage rate is uniform in the economy.

Firm 2 emerges from Period 0 with its advanced capital intact and with a surplus which, according to our definition of short term, is not used to bring about technological changes. This period refers to the total period for which C is advanced. In Period 1, the capitalist can advance the same C and v on the basis of prior technology, and a simple reproduction on the basis of a given technology can occur. But the capitalist is interested in increasing the surplus in the next period. He can increase his surplus either by increasing the "absolute surplus-value" or the "relative-surplus value."[56] The absolute surplus-value can be increased without an increase in C or v through "the prolongation of the working-day beyond the point at which the labourer would have produced just an equivalent for the value of his labour-power, and the appropriation of that surplus-labour by capital."[57] Such surplus creation by increasing the length of the working-day has limits. He points out that, with factory legislations and struggles on the part of the workers, this form of surplus

extraction becomes more difficult.[58] The capitalist may also try to speed up the existing machinery and, hence, intensify labour. However, this method also has limitations, for example, "the capability of the workman to follow the motion without a greater exertion than he can sustain for a constancy."[59] He also indicates that it is in the interest of the capitalist to preserve the machinery "from too rapid deterioration" and to preserve "the quality of the article manufactured."[60]

Marx also points out that the use of more of the same type of machinery may intensify labour. However, the same type of limitations apply here as well. This method to increase the intensity of labour indicates that Marx's capital-labour ratios are not absolutely fixed with a given technology. It appears that there is a minimum ratio that must exist. Yet, it can be increased "by giving the workman more machinery to tent."[61] But he does not see such a change as very significant: "Improved construction of machinery is necessary [for this]...because without it greater pressure cannot be put on the workman...."[62]

Given all these limitations, the major method to increase surplus is to increase the relative surplus-value through process innovations that are embodied in new machines. "...[T]he production of relative surplus-value revolutionises out and out the technical processes of labour and the composition of society."[63]

We will assume that the capitalist finances the new machine out of the previously advanced capital which he has recovered in full at the end of Period 0. The important point behind this assumption is that the present firm is not compelled to scrap its previous machine before C is recovered. There is no capital destruction which would add another source of labour displacement. We will analyze this aspect fully in the context of crises.

The following is a presentation of the employment effects of technological change at the level of two firms.

Let: AC: Capital advanced

C: Constant capital advanced

v: Variable capital advanced

Subscripts: The first subscript refers to the firm and the second to the time period -- 1 and 2 to capital and wage-good producing firms respectively -- 0 and 1 to the consecutive time periods.

Changes in the Organic Composition of Capital at the Level of Firm 2

$AC_{20} = C_{20} + v_{20}$ (Before the machine is adopted)

$AC_{21} = C_{21} + v_{21}$ (After the machine is adopted)

Savings for the capitalist arise directly from the decrease in the capital advanced at a given level of output, i.e., $AC_{21} < AC_{20}$

$\therefore\ C_{21} + v_{21} < C_{20} + v_{20}$

Before we proceed to specify the magnitude of C_{21} relative to C_{20} or the magnitude of v_{21} to v_{20}, we must note, as indicated earlier, that it is a more correct interpretation of Marx if we consider C_{21} as a new machine instead of the replacement of the old machine plus a new machine. In other words, the new machine is not financed only through the conversion of v to C. The recovered C also undergoes a qualitative change. This is an important point because technological change which is financed only through the conversion of the recovered v would, ultimately, encounter an upper limit determined by the size of v. If, on the other hand, the recovered C can also be used, the limit is much less significant; Marx could, then, argue that technological change need not require prior net

accumulation. Marx does not perceive new technology in divisible units of equipment that the capitalist buys but as an interdependent complex system of machines and equipment. Consequently, the part of v converted to C and the readvancement of recovered C constitute the "complex" or "collective" machine[64] that is adopted. He distinguishes the "co-operation of a number of machines of one type from a complex system of machinery."[65] It is clearly the latter he has in mind in analyzing technological change. Yet, Marx never indicates whether the past C is totally recovered and readvanced for the new machines. If this is not the case, the obvious question arises: Is what has been recovered as C and a part of v sufficient to bring about significant technological change by financing the construction of the new machines? This is a serious question that we will return to frequently throughout the thesis. Our assumption that C is recovered totally can help the Marxian argument with respect to the speed of technological change. However, it is doubtful that he based his argument on it. In fact, his criticism of Ricardo indicates a great deal of capital destruction when the new machines are introduced.[66] More on this later.

Returning to the relationship specified earlier, we will show that this relationship, i.e., $AC_{21} < AC_{20}$, will hold in the following cases which may or may not involve the conversion of v to C. These cases are important to study in order to specify the limited nature of the Marxian change.

(i) If C_{21} is greater than C_{20}, then the savings or the increase in surplus will be due to a reduction in v advanced in Period 1 relative to that advanced in Period 0. This reduction in v will be greater than the increase in C between Periods 0 and 1. This can be expressed as:

$C_{21} - C_{20} < v_{20} - v_{21}$, where $C_{21} - C_{20} > 0$

Such technological change involves the conversion of a part of v to C.

(ii) C_{21} can be equal to C_{20}, i.e., $C_{21} - C_{20} = 0$. The new machine costs as much as the old one. In this case too, v_{21} will be less than v_{20} but no conversion takes place.

(iii) C_{21} can be less than C_{20}. The new machine costs less than the old one. There are, then, 2 possibilities:

(a) If $v_{21} > v_{20}$, the savings from the constant capital will be greater than the increase in the total wage bill, i.e.,

$v_{21} - v_{20} < C_{20} - C_{21}$

(b) If $v_{21} = v_{20}$, the increase in surplus, Δs, will originate totally from a reduction in the constant capital advanced, i.e., $C_{20} - C_{21} = \Delta s$. Here, as in (a), no conversion from v to C takes place.

(iv) A final case is when not only $C_{21} < C_{20}$ but also $v_{21} < v_{20}$. Technological change reduces both the required constant capital and the required variable for a given level of output. The increase in s will be a sum of the reductions in both C and v.

Marx does not discuss these cases specifically. We will see that he is very much aware of the possibility of constant capital saving innovations. Hence, the cases listed above are deducible from his arguments. However, given our previous discussion, the case emphasized by Marx is (i). In that case, q increases absolutely. Obviously in (ii) and (iv) when v decreases faster than C, q will also increase. Yet, these increases in q are relative changes. We have already discussed them in detail. They reflect an increase in embodied or past labour per current

worker without requiring an absolute increase in C or a conversion of v to C. These increases in q release capital that can be used to employ the workers even if they are initially displaced. However, no such initial displacement is necessary because the capitalists need not utilize v to finance the purchase of the new machines. The case (i) fulfills the Marxian condition because the new machine costs more than the old one. This is why v has to be converted to C given our initial assumption that the short term Marxian analysis rules out new additional capital, i.e., the exclusion of prior surplus in the introduction of the new machine. Then, the only motivation behind the adoption of the new machine is that it releases a part of the previously advanced v as additional surplus. This, we believe, is essential to the Marxian analysis which relies on a conversion of the part of the wages into constant capital in order to illustrate direct short term net labour displacement.

This part of Marx's analysis is essentially Ricardian. In his evaluation of Ricardo and Barton, he says that for the capitalist the machinery "merely provides a new type of investment for his capital, its immediate results, according to the assumption, is the dismissal of workers and the conversion of part of the variable capital into constant capital."[67] This is clearly an expression of the short term in Marx.

He states that the chapter "On Machinery" in Ricardo "bears witness to his honesty which so essentially distinguishes him from the vulgar economists."[68] He criticizes Ricardo, however, for equating the conversion of v to C with the wages paid in the construction of the machines. He says: "The conception that accumulation of capital is identical with conversion of revenue into wages, in other words, that is synonymous with accumulation of variable capital -- is one-sided, that is

incorrect."[69] One must note that there is a confusion in terminology in this quotation. Marx could not have been criticizing Ricardo in a context when net accumulation takes place. Ricardo's model, as we will see, is definitely without accumulation. It is a conversion of the previously advanced wage fund into constant capital. Marx argues that part of the v that is directed to the purchase of the machines also includes constant capital that is advanced in the construction of the new machines, and that it does not represent a fund for the employment of workers.[70] This will be illustrated in the following presentation of the absorption and displacement processes that can be inferred from his analysis.

The labour displacement at the level of Firm 2 can be shown in the following manner:

U_d: Number of workers displaced at the level of Firm 2

N: Number of workers employed at the level of Firm 2

Subscripts: As indicated earlier

Employment in Period 0

$$AC_{20} = C_{20} + v_{20}$$

$$N_{20} = \frac{v_{20}}{W}$$

Employment in Period 1

$$AC_{21} = C_{21} + v_{21}, \quad (AC_{20} > AC_{21})$$

$$N_{21} = \frac{v_{21}}{W}$$

(Since $C_{21} > C_{20}$ and $v_{21} < v_{20}$, q_{21} will be greater than q_{20}.)

Labour Displacement

(i) $N_{20} - N_{21} = U_d$

(ii) $\frac{v_{20}}{W} - \frac{v_{21}}{W} = U_d$

(iii) $\frac{\Delta v_2}{W} = U_d$ where $U_d > 0$. ($U_d > 0$ signifies displacement)

Similarly, labour absorption can be shown at the level of Firm 1 that has produced the machine. We let labour absorption at the level of Firm 1 be denoted as Ua. The level of employment will be indicated by N as before.

Employment in Period 0

$AC_{10} = C_{10} + v_{10}$

$N_{10} = \frac{v_{10}}{W}$

Employment in Period 1

$AC_{11} = C_{11} + v_{11}$, $(AC_{11} > AC_{10})$

$N_{11} = \frac{v_1}{W}$

Let us assume that q does not change in this firm. No technological change in the production of capital occurs. The construction of new machines may require a change in the methods of production at the level of Firm 2. We would, then, have to consider the possible labour displacement and absorption processes due to the restructuring of capital also at this level. To avoid further complication, we ignore this possibility. Presently, it should, however, be noted that even though Marx is aware of technological change at this level as well, he does not analyze it fully. Its significance must be important. If changes in the methods of production at this level are substantial, and if they require

net investment in large amounts, the initial increase in employment may be very large in the construction of the machine. Whether such an increase in employment can be compared with the possible displacements to take place in the future is a theoretical difficulty to which we will return at the end of this chapter.

A further complication arises from our notations. Realistically, the construction of the machine precedes its adoption. In other words, Period 1 cannot be characterized by the simultaneous construction and adoption of the machines. This difficulty can be overcome by specifying three time periods, for example, 0 for when no new machines are constructed, 1 for when the machines are constructed, and 2 for when the machines are adopted. In that case, Period 2 would be applied only to Firm 2. As long as we keep this time sequence in mind, we can avoid the difficulty by assuming implicitly that Period 1 is split into two parts of which the earlier signifies the construction of the machine.

If q is constant in the machine construction, the obvious result is that both C and v will increase proportionately. The labour absorption due to the construction of the machine will be:

$$U_a = N_{11} - N_{10} = \frac{v_{11} - v_{10}}{w}$$

In this absorption process, there is a point emphasized by Marx that is not in our formulation. We have already alluded to it in reference to Ricardo who sees the part of v spent on the machines as a wage fund for the workers to be employed in their construction. Marx frequently uses this as a criticism against the classical economists in general. This criticism can be shown by considering the changes in variables between the periods instead of using the levels in the two periods. The increase in constant capital advanced by Firm 2 which purchases the new machine

does not totally represent wages in the firm producing the machine, i.e., Firm 1. In fact, ΔC_2, the increase in the constant capital advanced by Firm 2, will be equal to $\Delta C + \Delta v + \Delta s$ as received by Firm 1. In other words, it will have to cover the additional constant capital advanced, additional wages advanced and also a certain amount of surplus in Firm 1. This is explicitly stated by Marx in his critique on compensation.[71] The increase in variable capital in Firm 1 will be equal to $\Delta C_2 - \Delta C_1 - \Delta s_1$. The implicit assumptions are that Firm 2 purchases the total output of Firm 1 and that, upon the purchase of the machines, Firm 1 recovers all of its advanced capital. Marx is not explicit on this. We will take up Beach's criticism of Marx over this point at the end of the chapter.

If we follow the Marxian logic, the change in employment at the level of Firm 1 will be: $U_a = N_{11} - N_{10} = \frac{v_{11} - v_{10}}{W} = \frac{\Delta C_2 - \Delta C_1 - \Delta s_1}{W}$. This formulation is explicit in Marx's criticism of the classical compensation theory.[72]

Given this formulation, Marx's criticism of Ricardo can be expressed verbally. According to Marx, capital must be seen as a mass of machines and equipment as well as wage goods to be advanced. Such commodities are produced in one period and are advanced in the next period. Hence, a part of v, i.e., a part of the subsistence goods, that was previously advanced to workers by Firm 2 is now paid to the firm producing the machine. However, not all of this amount represents the wages paid to the additional workers employed in the construction of the new machine. Unless Firm 1 uses no constant capital and extracts no surplus, the sum of these wages will be less than the value of the machine. In other words, one part of v paid by Firm 2 will serve as means of production, and it will

not set into motion any additional workers. It can only keep in employment the workers elsewhere who were previously producing the wage goods for the workers who are now displaced.

Finally, after having formulated the displacement and absorption processes separately, we can formulate the net labour displacement (absorption) by combining the changes in Firms 1 and 2.

Und: Net labour displacement

$$Und. = \frac{|\Delta v_2|}{W} - \frac{\Delta v_1}{W}$$

If:

(i) $U_{nd} > 0$: Net displacement occurs

(ii) $U_{nd} < 0$: Net absorption occurs

(iii) $U_{nd} = 0$: No change in employment takes place

The relationship above can be restated by substituting $\Delta C_2 - \Delta C_1 - \Delta s_1$ for Δv_1. Also $\Delta C_2 + \Delta s_2$ can be substituted for Δv_2 because the decrease in the wage bill at the level of Firm 2 is equal to the sum of the increase in its constant capital and surplus. (We are still assuming that surplus in this case is originating from a diminution in v.) Then, we have:

$\Delta v_1 = \Delta C_2 - \Delta C_1 - \Delta s_1$ and $|\Delta v_2| = \Delta C_2 + \Delta s_2$

From the latter case, we get: $\Delta C_2 = |\Delta v_2| - \Delta s_2$.

The last formulation indicates that the increase in the advanced constant capital of Firm 2 is equal to only a part of the variable capital which has been displaced at this level. Substituting this for ΔC_2 in $\Delta v_1 = \Delta C_2 - \Delta C_1 - \Delta s_1$, we get: $\Delta v_1 = |\Delta v_2| - \Delta s_2 - \Delta C_1 - \Delta s_1$.

This last formulation captures Marx's argument most explicitly. The increase in the variable capital of Firm 1 will be much less than the

reduction in the variable capital at the level of Firm 2. The composition of capital has changed at the expense of existing v. The net labour displacement (absorption) can be restated as follows:

$$U_{nd} = \left(\frac{|\Delta v_2|}{W}\right) - \left(\frac{|\Delta v_2| - \Delta s_2 - \Delta C_1 - \Delta s_1}{W}\right) = \frac{\Delta s_2 + \Delta C_1 + \Delta s_1}{W}$$

Evaluation and Summary.

We believe that the foregoing analysis and formulations represent Marx's short term analysis at a micro level even though he does not perform this task as we have. Our formulations separate the displacement and absorption effects when only the previously advanced capital is readvanced in order to purchase the new machine. In the process, one part of v is converted into C. This analysis abstracts from accumulation through the use of prior surplus. It is our contention that Marx's net displacement argument is basically founded on this even though there are other elements such as destruction of capital in a dynamic economy and cyclical results of technological change. This static framework according to which the restructuring of capital without a need for accumulation is a phase in the Marxian accumulation process. It is this phase that causes net displacement whereas accumulation, as we will see in Chapter IV, increases the absolute level of employment. (Obviously, the use of the increase in surplus in the subsequent periods is a form of accumulation that we will consider shortly.)

At this point, we must underline a source of possible inconsistency in Marx. This may throw some doubt on our abstraction from accumulation. According to the short term analysis, the total v advanced by Firms 1 and 2 decreases absolutely as the machine is adopted. The immediate effect is one of net displacement of labour. This view, as indicated earlier, is

much more explicit in Marx's chapter on "Machinery and Modern Industry", particularly in the section on "The Theory of Compensation as Regards the Workpeople Displaced by Machinery".[73] He says: "Some of the capital that was previously devoted to production of necessary means of subsistence, has become reproduced in another form."[74] His numerical examples indicate a given amount of capital that was advanced "in a carpet factory" and that is now restructured. In this analysis, he uses a conceptual model in which the changes are compared in terms of "before" and "after."[75] An absolute diminution in total takes place after the technological change. On the other hand, in his evaluation of Ricardo in Theories of Surplus-Value, the evidence is mixed. He appears to emphasize a relative decrease in v with respect to C.[76] His use of the term "accumulation" also implies this. This approach, however, is compatible with an increase in both C and v. Moreover, it could also mean that accumulation is required in the introduction of the new machine. In this case, the "immediate result" of the machine on employment need not be an absolute decrease in v. The actual net displacement of labour need not follow. Even though particular individuals may lose their jobs temporarily, the total employment may increase due the absolute increase in v. In Chapter III, we will see that he makes some other comments that may also imply that what he has in mind is not the Ricardian conversion process with a given capital. In fact, his criticism of the "so-called labour-fund" may strengthen the view that he does not consider a given amount of variable capital.[77] Yet in his chapter on machinery as well as in other parts of Theories of Surplus-Value, our interpretation finds explicit support. We will refer to some of these instances in the next chapter.

It appears that, in order to criticize the Ricardian case -- according to which the new machine displaces labour only when the wage fund decreases

absolutely and -- which does not consider technological unemployment in the long term when both C and v may increase while $\frac{C}{v}$ also increases, he seems to be basing his criticisms of Ricardo on this actual conversion of previously advanced v into C. However, if this interpretation is accepted, the implication would be that Marx himself is considering the accumulation case only. Then the introduction of the new machine will involve net accumulation. Prior surplus will be divided into C and v. Normally, the absolute level of employment will increase even though per unit cost of output may decrease because of the relative labour saving nature of the machines. Stated differently, accumulation will not increase the demand for labour proportionately since q will also increase, but it will increase the absolute number of workers employed. Then, one cannot talk about an immediate net displacement effect in employment. Whether such accumulation leads to increasing levels of unemployment as well as to increases in the absolute level of employment will depend on a host of factors among which the rate of growth in population is a primary one. The Chapter IV is a detailed analysis of this argument and need not be summarized here.

Despite his criticism of Ricardo, the conversion of prior v to C is an essential part of Marx's analysis: We will maintain that this model also underlies his accumulation process. Hence, the de-emphasis on this conversion at some places in his writings should not be seen as a refutation of Ricardo but as an implicit criticism of his approach which perceives the possibility of technological unemployment only when v decreases in absolute terms. This criticism is independent of Marx's other criticism that Ricardo does not see the necessity for constant capital in the construction of the new machine.

Marx's criticisms should indicate that Marx's view of technological unemployment goes beyond Ricardo's. It includes the possibility of unemployment in the long term when accumulation, technological change and population growth occur simultaneously. Finally, we will also see that his analysis also includes the relationship of technological unemployment to crises.

We can summarize the previous formulations in the following manner. Once it is assumed that the new machine is financed completely out of the accumulated depreciation funds, i.e., the funds recovered from C, plus a part of v and that the firm building the machine does not have to make additional investment besides that which is financed out of the receipts from the sale of the machine, the Marxian result is guaranteed from the outset. Net labour displacement will occur. The assumption of a uniform wage rate is not a very important element in this outcome. Only significantly different wage rates, i.e., much lower wage rates in the capital goods sector can offset the displacement effects. Marx's argument cannot be refuted on the basis of such a hypothetical case. This is particularly unlikely in the developed capitalistic sectors where competitive conditions do not allow wide differentials. If an offsetting labour absorption takes place in other firms which are very labour intensive, for example, handicrafts,[78] this has nothing to do with the direct effects of technological change at the level of the two firms that produce and adopt the machinery. Such offsetting effects will fall under the possible forms of general compensation which must be distinguished from the direct effects of technological change. Then, it appears that the fundamental assumption which assures the Marxian result in its short term context is the one that rules out the initial net accumulation. A critical evaluation of this assumption as well as other real problems with the foregoing analysis

will be presented at the end of this chapter. In the next section, we will generalize the previous micro analysis to two sectors (departments).

8. Direct Short Term Effects of Technological Change on Unemployment in a Two Sector Model

Given our previous discussion on the role of technological change in Marx's competitive system, other firms must gradually adopt the new machinery in order to survive. The rate of diffusion depends mainly on the savings to be achieved through the adoption of the new machines in relation to the loss incurred in the capital value of the machines to be scrapped. The larger the difference, the faster the rate of diffusion. The more technical aspects of the economic considerations do not concern us and are not discussed by Marx. Salter has a thorough analysis of the important considerations in such a switch in technology.[79]

We can depict the Marxian diffusion in more general terms. The pressure on the price level due to the more efficient machines that increase the productivity of labour will tend to reduce the profitability of the ventures using the old types of machines. The likely result is that the firms that adopt the new machines will initially attempt not to reduce the prices in proportion to the decrease in the cost of production.[80] When adoption becomes more widespread, the pressure on the price to sink to its new social average cost will be greater because the quasi-monopolistic powers of the initial firms are eliminated.[81] The new machines threaten the existence of the firms that are slow in adopting the machines. The implicit assumption in Marx must be that the new machines yield such a competitive edge that their adoption has to be undertaken rapidly by others.

Before we develop the two sector model, we will underline some

technical problems. Going from two firms to two sectors obviously raises the problem of aggregation. Moreover, if the total economy is seen in terms of these two sectors, each sector consists of different industries and produces very different types of commodities. The problem of the aggregation of different amounts of advanced capitals with different turnover periods is problematic in reality. The concept of an average q in the two sectors or in the economy as a whole raises measurement problems as well as conceptual difficulties. Marx clearly has an average of the "individual compositions" in each "branch of production". Then, he arrives at an "average of these averages" which gives "the composition of the total social capital of a country".[82] We do not intend to get hopelessly tangled in the precision of such measurements or concepts at aggregate levels. Since the fundamental theoretical questions and logic behind Marx's analysis are still to be uncovered, it is doubtful that starting from more technical aspects would contribute to our analysis. These aspects of aggregation and measurement will be ighored in our study. Our emphasis will be on the general thrust and logic of Marx's analysis. Only when such technical aspects are directly related to our analysis, will we discuss them. This was already illustrated in our elaboration of the measurements of technological change in Marx.

A more intuitive approach is sufficient in our case: We can interpret the average composition of advanced capital in the two sectors as that which characterizes the median of the firms in those sectors. If the firms are not significantly different from each other in size, an increase in the average composition of q should then imply that technological change is not concentrated in a few firms but that it portrays a dominant trend. This is important to stress. Otherwise, only a few firms will be under-

going substantial technological change and will be raising the average q. Then, the absorption of the workers displaced in those firms adopting the new machines can occur in other firms with much lower q's even if the average q increases. Technological unemployment may cease to be of concern if such significant differences in q are maintained among the two sectors or among the firms or industries in each sector. Obviously, this is a realistic situation which cannot be ignored. The general thrust of Marx's argument is that such differentials will decrease once capitalistic relationships dominate the economy and once the industries based on primitive modes of production are eliminated. Marx states:

> It is further assumed that this gradual change in the composition of capital is not only confined to individual spheres of production, but that it occurs more or less in all, or at least in the key spheres of production, so that it involves changes in the average organic composition of the total capital of a certain society....[83]

A more important question is whether such possible absorption can in fact be considered as an automatic compensation guaranteed by the particular technological change that displaces labour. As we will argue in Chapter III, an interpretation can be given to Marx's analysis by relying on Kruse's invaluable theoretical approach to the definition of compensation.[84] We will show that even if workers are absorbed because of these differentials, such absorption should not theoretically be considered as compensation in its narrow sense. It can be considered as compensation only if absorption is directly necessitated by the particular technological changes occurring. In other words, the low q's in other firms must then have to be explained as a consequence of the increase in q's in those firms displacing the workers. Otherwise, there is no theoretical reason to expect that such differentials will exist in order to offset the displacement.

Assuming, as in our two firm model, that there is no accumulation out of prior surplus so that we can separate the effects of technological change from the effects of accumulation, we can demonstrate the displacement and absorption processes in a two-sector model consisting of capital goods and wage goods sectors.

Subscripts: I and II refer to capital and wage good sectors respectively and 0 and 1 to time periods as before.

Labour Displacement in Sector II (Wage Goods Sector)

$$U_d = \frac{v_{II_0} - v_{II_1}}{W}$$

We can now use an alternate formulation which includes the change in q explicitly. Since: $AC_{II_0} = C_{II_0} + v_{II_0}$ and $AC_{II_1} = C_{II_1} + v_{II_1}$, then:

(i) $\frac{C_{II_0}}{v_{II_0}} = q_{II_0}$ (ii) $\frac{C_{II_1}}{v_{II_1}} = q_{II_1}$

From (i): $v_{II_0} = \frac{C_{II_0}}{q_{II_0}}$ From (ii): $v_{II_1} = \frac{C_{II_1}}{q_{II_1}}$

Substituting these organic compositions in the formula for labour displacement:

$$U_d = \frac{\frac{C_{II_0}}{q_{II_0}} - \frac{C_{II_1}}{q_{II_1}}}{W}$$

This formulation is preferable to the earlier formulations which depict only the changes in v where the technological process and the changes in q are only implicit in the background. Another distinct advantage of this formulation is that it can be used more meaningfully to analyze the effects of changes in q when accumulation takes place. A slightly modified version of it will be used in the chapters on compensation and

long term accumulation. It will enable us to maintain the distinction between the employment effects of a rise in q and the employment effects of accumulation when v also increases in absolute terms. This formulation will demonstrate the Marxian race between machines and employment in the long term.

Labour Absorption in Sector I (Capital Goods Sector)

$$U_a = \frac{v_{I_1} - v_{I_0}}{W} = \frac{\frac{C_{I_1}}{q_{I_1}} - \frac{C_{I_0}}{q_{I_0}}}{W}$$

The net labour displacement is the sum of the sectorial changes in employment.

$$U_{nd} = \frac{\frac{C_{II_0}}{q_{II_0}} - \frac{C_{II_1}}{q_{II_1}}}{W} - \frac{\frac{C_{I_1}}{q_{I_1}} - \frac{C_{I_0}}{q_{I_0}}}{W}$$

The left side of the equation shows the displacement effect which, given the wage rate, indicates that the displacement effect will be greater as q increases in successive periods. The right side of the equation shows the absorption process. It should be noted that surplus arising from the displacement process is not in this equation and will be integrated into it in the next chapter.

9. A Critical Evaluation of the Short Term Model

We have formulated Marx's direct displacement and absorption processes in the adoption and construction phases of the machines. We have not considered the possible forms of absorption due to the "freed" 85
variable capital upon the adoption of the new machines. Possible labour absorption through the effects of a decrease in the wage rate as a consequence of unemployment and the effects of increased purchasing power

as a consequence of a decrease in the prices of commodities constitute the bulk of the following chapter. We have called these effects following the construction and adoption phases indirect short term effects.

We have indicated some of the conceptual problems in our formulations, for example, in aggregation and averaging as well as in the different measures of technological change. Any meaningful critical evaluation of the short term model must be based on more fundamental questions and implicit assumptions that lie hidden in Marx's analysis. We will indicate the most important ones at this point. We will be referring to them throughout the study, and we will develop them further in more relevant contexts. Therefore, the following should be treated only as suggestions which are neither exhaustive nor complete.

Bias in Technological Change

The most obvious assumption in Marx is that technological change will increase q in absolute terms. In other words, technological change is embodied in machines, and it increases the required constant capital to be advanced as well as the ratio of C to v.

Whether such technological change has characterized capitalist development is debatable. It has been argued that the period observed by Marx was characterized by such a pattern and that, in the twentieth century, the pattern appears to have been reversed or at least checked.[86] Moreover, it has been claimed that as constant capital grows relative to variable capital, the firms try to economize constant capital and that, in the phase of capitalism characterized by monopolistic or oligopolistic firms, the firms, not driven by competitive pressures as much, may not undertake as many labour displacing innovations.[87] They slow down the

rate of technological change in order to preserve the value of their previously advanced capital by not introducing technology that may force their real capital to premature obsolescence. It is also pointed out that inflationary policies of the government satisfy the capitalists' drive for larger surpluses without the creation of an industrial reserve army that checks the growth in the wage rate.[88] The controversy in this area is widespread, and it is not part of our analysis since it has no explicit counterpart in Marx's competitive models. Marx indicates that the increase in constant capital may be a countertendency to fast technological change. Yet, he still sees the competitive pressures strong enough to offset this.

The Marxian bias cannot be defended on theoretical grounds.[89] There is no theoretical necessity for a dominant bias favouring an increase in q. We will return to this point throughout this study and make further observations. However, our objective is not to prove or disprove the validity of the Marxian bias. The Marxian analysis remains valuable independent of the validity of the bias. The issue can be narrowed to a practical one. It cannot be denied that technological change of the Marxian type does occur. The workers are displaced through the adoption of more expensive machines. This can occur with a constant or even decreasing output at the level of the firms or industries adopting such machines. The coal industry in the twentieth century is an example of it.[90] Marx's examples in agriculture are valid during his time[91] and still are. Landes points out that early capitalism was very much characterized by substitution of machines for labour due to rising costs of labour.[92] If the possibility of the Marxian technological change is accepted, then the theoretical question is the following: Does the introduction of such machines create automatic compensation either through

absorption in machine construction or through the indirect effects earlier listed? More broadly stated, does the market system set into motion forces that counteract the displacement of workers? These questions will occupy our attention in the next chapter insofar as they can be answered on the basis of Marx's arguments.

In summary, to argue that technological change of the Marxian type is not the only type would be an evasion of the question. It is not necessary to prove that the Marxian technological change is the dominant bias. The theoretical as well as practical question remains as long as any such technological change occurs. Obviously, if it is not dominant, the problem may cease to be a source of major concern in the real world. Nevertheless, the theoretical question will have been left unanswered. As we will see, the familiar compensation arguments fail to answer the question.

Conversion from v to C and Separation of Technological Change from Accumulation

We have stated that the short term Marxian analysis rules out the necessity of new capital accumulation in introducing the machines. We believe that this implicit assumption is the most fundamental one in Marx's analysis. The short term employment effects are due to the conversion of the previously advanced variable capital to constant capital. A part of the previously advanced variable capital is freed and becomes surplus when the new machines reduce the number of workers employed. Before we deal with the realism of the assumption that no new capital is required in the introduction of the new machines, a more obvious weakness must be indicated in relation to the conversion process.

In Ricardo, the workers producing the new machines do not require any

constant capital. The machines are constructed mainly by current labour.[93] One-half of the workers are transferred from the production of subsistence goods to the production of the machine. Hence, while the machine is produced, there is no unemployment. Once the machine is produced and adopted, unemployment will result. Ricardo's explanation is that while the machine is produced, "only one-half of the usual quantity of food and necessaries" would be produced. Thus, when the machine is adopted, the capitalist will have a much smaller wage fund (circulating capital) to advance. One-half of the workers will be unemployed. Ricardo points out that, as long as the capitalist can make the same or a larger amount of "net revenue" (profit), it is irrelevant to him that "gross revenue" (net revenue plus wage fund) has decreased.[94]

In Marx, the process is more complicated. Since a substantial amount of constant capital is used in the construction of the machines, the number of workers absorbed in the production of machines is not equal to the reduction of workers in the wage goods sector. It is less. Hence, unemployment would be immediate. Yet, Marx does not deal with this process as rigorously as Ricardo. Even though some constant capital is also to be used in the production of the machine and must be made available, he does not show how some of the wage goods freed by the displacement of the workers will be converted into means of production to produce the new machines. If one looks at the conversion process only in terms of money while ignoring the real flows and the physical characteristics of the composition of the commodities available, this difficulty will disappear. But, in reality, it cannot be ignored. It would appear that, in Marx, the resources embodied in the wage goods can, without much friction or

delay, be converted into resources that can be used for the machine construction. We will consider the role of constant capital more extensively in Chapter III.

Given the fact that Marx was very much aware of the different forms in which capital appeared, i.e., money, productive and commodity capitals, one would have expected a more clear explanation of this conversion process in the case of technological change. He sees that "some of the capital that was previously devoted to production of necessary means of subsistence, has to become reproduced in other form,"[95] i.e., in the form of means of production. In reference to the use of surplus as represented by commodities, he often indicates that these commodities must be of the type suitable for further expansion.[96] He also asks himself whether these commodities can be used as constant capital without first being converted to wages.[97] However, in his short term analysis, he appears to ignore these questions. He seems to be assuming that one part of the wage goods freed can, without friction, be used as constant capital and cease to be a wage fund to absorb additional labour in the production of the machine. This certainly seems to be his view in his short term analysis. The following lengthy quotations where he criticizes Ricardo for ignoring the constant capital illustrates our point.

> Ricardo's view (derived from Smith) that all accumulation can be reduced to expenditure on wages, would be incorrect even if no accumulation in kind took place -- which is the case, for example, when the farmer sows more seed, the stock-breeder, increases his stock of cattle for breeding or fattening, the owner of engineering works uses part of his surplus-value in the form of machine tools -- and even if all producers who produce the elements of some part of capital did not over-produce regularly, counting on the fact of annual accumulation, i.e., the expansion of the general scale of production. Moreover, the peasant can exchange part of his surplus

> corn with the stock-breeder, who may convert this corn into variable capital while the peasant converts his corn into constant capital.... The flax-grower...sells part of his surplus product to the spinner, who converts it into constant capital. With this money the flax-grower can buy tools and the tool-maker can then buy iron, etc., so that all these elements are turned directly into constant capital.[98]

This quotation shows the complexity that Marx is dealing with. However, ultimately, he sees v being converted to C whereby its advance does not set into motion any additional workers. The view that this conversion process can be much faster and smoother is expressed more clearly in the following quotation. We must, however, note that this criticism is not with respect to Ricardo's labour displacement process but to his classification of "fixed" and "circulating" capital.

> Ricardo forgets to mention the house in which the labourer lives, his furniture, his tools of consumption, such as knives, forks, dishes, etc., all of which have the same quality of durability as the instruments of labour. The same things, the same kinds of things, appear in one place as articles of consumption and in other as instruments of labour.[99]

The quotations cited above are significant not only for the Marxian short term analysis but also for the long term accumulation model. He does not appear to see the conversion of one type of goods into another use as a serious difficulty. Yet, it must be pointed out that his analysis is not seriously weakened by this. Even if a part of the wages of the workers displaced is totally used as wages for the workers who will be employed to construct the machines, labour absorption will still be less than the displacement as we have shown in our formulations.

It is, however, realistic to assume that the economy will gradually adjust so that not only direct but also past labour will be used in the

construction of the machines. Hence, the conversion of wage goods into constant capital is not unrealistic in a changing economy. Then, this part of v will not set into motion any new labour. It can only keep those producing the constant capital necessary in the construction of the machine still in employment. When perceived in distinct time periods, the commodities produced in one period are advanced for the second period with a change in their organic composition, i.e., a larger part is used to equip fewer workers than before.

A more fundamental problem with the Marxian analysis is that net accumulation may be a necessity in the introduction of the new machines. In other words, the new machines may represent such a break from the old machines that their construction and adoption may require net accumulation in the economy. If this is the case, the initial increase in employment even in the machine construction alone may be large enough to offset the subsequent displacement effects. It can, of course, be argued that the firms buying the new machines are doing so mainly to reduce the labour costs in their advanced capital and are not utilizing their surplus to buy the machines, i.e., the initial accumulation in the department constructing the machines is not being followed by a later accumulation in the department buying the machines but by an absolute decrease in their v. In that case, it is conceivable that, sometime in the future, the initial splash of employment in machine construction will be offset by gradual elimination of jobs. Yet, this is a static analysis. It compares two points in time and rules out further change in between. If subsequent technological changes are also accompanied by large amounts of net accumulation in the construction of the new machines, the level of employment will continuously increase and no immediate or long term net

displacement will occur. Such an approach would give the opposite result of the Marxian short term analysis. In fact, if technological change normally necessitates net accumulation, the Marxian long term analysis is also seriously damaged for even though it treats technological change and accumulation simultaneously, rapid technological change that increases q appears to be occurring even when accumulation slows down. In other words, the labour displacing machines do not appear to necessitate accumulation in their construction. Marx's long term prediction on unemployment is very much dependent on the separation of technological change from accumulation in this sense, i.e., accumulation will normally involve technological change, but the rate of change in the latter is not seriously limited by the former.

This alternative approach is a very important challenge to Marx's argument. If technological change normally requires large amounts of initial net capital investment, the Marxian case would only be a special one. The importance of this approach is that it does not seek compensation in the wage and price adjustments of the neo-classical model. In one sense, more than full compensation is inherent in the investments associated with technological change. The most clear expression of this approach is to be found in Earl Beach's articles. In an article on Marx he states:

> Consider a change in q, the organic composition of capital, which is a ratio of c to the total c and v. An increase in q is another name for mechanisation. When the baking industry is mechanized, the industry which makes baking machinery has its output increased. To ignore this relation in a 'ceteris paribus' assumption is to use long run analytical method of comparing two equilibrium points. It is to compare two conditions of mechanisation, and not to analyse the effects of the process of mechanisation.[100]

He adds that the evaluation of the introduction of machinery requires a

"form of analysis" to specify the "year-to-year changes" and not "a long run assumption that all adjustments have been completed."[101] In other words, the increase in employment in the machine construction industry cannot be measured against the possible displacements in the long run under the assumption that no further change will take place. This, Beach argues, is a static analysis. Presently, we can say that the Beach approach is one that challenges not only the Marxian view but also the classical and neo-classical views. It is explicit in his analysis that the absorption effects of technological change should not be sought in the long run adjustments of coefficients of inputs, prices, wages, etc., but in the growth process stimulated by the increases in investment necessary for technological change. Hence, it is not only a critique of the pessimistic Marxian conclusion but also a critique of the optimistic compensationists who implicitly assume that the immediate effects will be of a labour displacing nature but that the long run market forces will reverse these effects. The Beach conclusion is also an optimistic one but it is not based on such long run mechanisms.

Beach also points out that Marx uses small c's in his analysis. "An increase of c in the baking industry implies a much greater increase in output of the machine making industry. c is but the annual depreciation or cost of using machinery; the total cost of the machine is several times as great. The change in employment in the machine making industry is, therefore, something to be considered."[102]

This is a valid criticism since Marx does not make this distinction clear. However, in our formulations, we have eliminated this difficulty by using C instead of c and switched the analysis to the advanced capital from the constant capital used up in a single period of production. Even

though our formulation answers this criticism that can be posed against Marx, it does not answer the one when machine construction requires net investment. We will return to Beach's criticism in the following chapters.

NOTES TO CHAPTER II

1. Marx, TSV III, 440.

2. Marx, Capital I, 365. Even though "scientific power" costs nothing, its utilization requires machines. Grundrisse, p.765. He also emphasizes the benefits of the accumulation of skills "from one generation to another." Capital I, 538. Such accumulation of skills "give[s] capital a power of expansion independent of the given magnitude of capital actually functioning." Ibid., p.567.

3. Marx, Grundrisse, p.704.

4. Marx, Capital I, 329. Such non-linear thinking is pervasive in Marx. It is clearly a reflection of his dialectical approach.

5. The dialectical approach treats social change as a whole from a historical perspective.

6. N. Rosenberg argues that in Marx, science progresses because of economic activities. "Karl Marx on the Economic Role of Science", JPE 82 (July-Aug. 1974), 715.

7. Marx, TSV III, 443.

8. See A. Asimakopulos and J.C. Weldon, "The Classification of Technical Progress in Models of Economic Growth", Economica XXX (1963); C. Kennedy and A.P. Thirlwall, "Technical Progress: A Survey", EJ 82 (March 1972); T. Ihlau and L. Rall, Die Messung des technischen Fortschritts (Tübingen: J.C.B. Mohr [Paul Siebeck], 1970).

9. A.M. Ross, ed., Unemployment and the American Economy (New York: John Wiley and Sons, 1964), p.13.

10. H. Jerome, Mechanization in Industry (New York: National Bureau of Research, 1934), pp.27-31. Also see Jerome, "The Measurement of Productivity Changes and the Displacement of Labor", AER, Supplement, XXII (March 1932).

11. The literature in this area is extensive. See M. Blaug, "A Survey of the Theory of Process Innovations", Economica 30 (Feb. 1963); Kennedy and Thirwall.

12. Marx, Capital I, 365. Also see Poverty of Philosophy, p.39.

13. Marx. Capital I, 365.

14. Ibid., p.332. Also see TSV III, 440.

15. Blaug, "A Survey", p.109.

16. Marx, TSV III, 440; Grundrisse, pp.348, 408.

17. Marx, Capital I, 567.

18. Marx says: "Modern industry was crippled in its complete development, so long as its characteristic instrument, the machine, owed its existence to personal strength and personal skill, and depended on the muscular development, the keenness of sight, and the cunning of hand...." Capital I, 361.

19. Ibid., p.353.

20. Ibid., p.364.

21. Ibid., p.351.

22. Marx, Capital III, 264-5.

23. Marx points out that the individual capitalist introduces the new machines in order to acquire short term profits. Capital III, 264. "During this transition period, when the use of machinery is a sort of monopoly, the profits are therefore exceptional...." Capital I, 383. "As the use of machinery becomes more general in a particular industry, the social value of the product sinks down to its individual value...." Ibid.

24. Marx says: "Just as the capitalist mode of production promotes the development of the productive powers of social labour, on the one hand, so does it whip on to economy in the employment of constant capital on the other." Capital III, 86.

25. Marx, Capital I, 369.

26. It must be pointed out that Marx does not specify a level of output in discussing the employment effects of technological change. It is the magnitude of capital to set labour in motion that he stresses. The resulting output may be the same, smaller or larger. What he emphasizes is that the machinery diminishes "the number of workmen employed by a given amount of capital." Ibid., p.383. Levine argues, on the other hand, that Marx assumes a given output in order to demonstrate technological unemployment. p.6. We will show that even if the output expands, Marx's technological unemployment is possible.

27. Marx, Capital I, 369.

28. Marx states: "The economy realised by a certain capital within its own line of production is first and foremost an economy in labour, i.e., a reduction of the paid labour of its labourers." Capital III, 82.

29. Marx, Capital I, 410-12. Landes also says: "For the British employers the best remedy for insubordination was technological unemployment." p.190.

30. Marx, Capital III, 212.

31. Marx, Capital I, 407.

32. Marx, Capital II, Part I, Chapters I-III.

33. Marx, Capital I, 202.

34. Ibid., p.204.

35. Marx, Capital II, 404.

36. Ibid.,pp.352, 382-3, 400. He often refers to the capital advanced. TSV II, 104; Capital II, 257, 260, 267.

37. Marx, Capital III, 111; Capital I, 202.

38. Marx, Capital I, 574.

39. Marx, Capital II, Part II, Chapters IX, XI.

40. Ibid.,pp.188, 219.

41. See footnote in Capital I, 572.

42. Ibid.,pp.203, 417. He assumes C to be equal to machines in order to simplify his argument. Ibid., p.413.

43. Ibid., p.574. Also see Capital III, 145-6; TSV III, 383-5.

44. Technical composition, according to Marx, is the "growth in the mass of means of production, as compared with the mass of the labour-power that vivifies them." Capital II, 583. He also uses the term, "organic composition of productive capital" or "technological composition" to indicate the same relationship. TSV III, 382.

45. Marx, Capital I, 574.

46. Marx. Capital III, 145-6.

47. Marx, TSV III, 381-9.

48. Marx, Capital II, 20; TSV III, 388. He defines the organic composition as "different ratios in which it is necessary to expend constant capital in the different spheres of production in order to absorb the same amount of labour." TSV III, 387.

49. The terms "relative" and "absolute" are also used by G. Kay, Development and Underdevelopment (New York: St. Martin's, 1975), p.142.

50. According to Marx, "the material growth of the constant capital implies also a growth - albeit not in the same proportion - in its value, and consequently in that of total capital." Capital III, 212. "The mass of employed constant capital would have increased in relation to variable, but its value could have fallen." Ibid.,p.255.

51. Ibid.,pp.81, 84; TSV III, 442.

52. A similar distinction is made by Kay, pp.135-6.

53. Marx, Capital II, 159.

54. Ibid., p.156.

55. Kay, pp.136-48.

56. Marx refers to this distinction continuously. He says: "... [T]he production of absolute and relative surplus-value determines 1) the duration of the daily-labour process and 2) the entire social and technical configuration of the capitalist process of production." Capital II, 389. Also see his criticism of Rodbertus. TSV II, 16.

57. Marx, Capital I, 477. Also see p.299 for a similar definition.

58. Ibid.,pp.385-6.

59. Ibid., p.390.

60. Ibid.

61. Ibid., p.388.

62. Ibid.

63. Ibid., p.477. Also see pp.296-304.

64. Ibid., p.359.

65. Ibid., p.357. He perceives the most adequate form of machines as "an automatic system of machinery" which "moves itself." Grundrisse, p.692. "....[I]n organised system of machinery ... one detail machine is constantly kept employed by another, a fixed relationship is established between numbers, their size, and their speed." Capital I, 359. Also see pp357-61, 607-8.

66. Marx, TSV II, 556.

67. Ibid., p.558.

68. Ibid., p.555.

69. Ibid., p.470.

70. Marx, Capital II, 227-8.

71. Marx, Capital I, 413.

72. Ibid.,pp.412-21.

73. Ibid.

74. Ibid., p.414. Also see TSV II, 557.

75. Marx, Capital I, 412-3.

76. Marx, TSV II, 566.

77. Marx, Capital I, 570-73.

78. Ibid., p.406.

79. W.E.G. Salter, Productivity and Technical Change (London: Cambridge University Press, 1966), pp.48-65. Also see Jerome, Mechanization, pp.333-46.

80. Marx, Capital III, 264-5.

81. Ibid.

82. Marx, Capital I, 574-5.

83. Marx, Capital III, 212.

84. A. Kruse, Technischer Fortschritt und Arbeitslosigkeit (Munich, 1936), p.9-15. Also see Heertje, Technical Change, p.36.

85. Marx often uses the term "freeing" when he refers to variable capital saved upon the introduction of machines. TSV III, 441. He also uses the term to refer to the increase in the purchasing power of consumers and the displacement of workers. TSV II, 557-8.

86. P.M. Sweezy, The Theory of Capitalist Development (New York: Monthly Review, 1942), p.103. Also see J. Christiansen, "Marx and the Falling Rate of Profit", AER, Papers and Proceedings, 66 (May 1976), 21; J.M. Gillman, "Welfare Capitalism in the Capitalist Crisis", Science and Society 22 (1958), 97, 105; M. Dobb, "The Falling Rate of Profit", Science and Society 23 (Summer 1959).

87. E.O. Wright, "Alternative Perspectives in Marxist Theory of Accumulation and Crisis", in J. Schwartz, ed., The Subtle Anatomy of Capitalism (Santa Monica: Goodyear Publishing, 1977), p.214.

88. J. Morris, "Spurious Capital and the Rate of Profit", Science and Society 31 (1967), 304.

89. See B. Schefold, "Different Forms of Technical Progress", EJ 86 (Dec. 1976), 817; M. Blaug, "Technical Change and Marxian Economics", in D. Horowitz, ed., Marx and Modern Economics (New York: Monthly Review, 1968), pp.240-41. Reprinted from Kyklos III (1960).

90. E. Clague and L. Greenberg, "Employment", in Dunlop, p.119.

91. Marx, Capital I, 418, 632-3. Marx discusses the response of the farmers to the wage increase in the English agricultural districts between 1849-1859 and says: "What did the farmers do now? Did they wait until, in consequence of this brilliant renumeration, the agricultural labourers had so increased and multiplied that their wages must fall again, as prescribed by the dogmatic economic brain? They introduced more machinery, and in a moment the labourers were redundant again in proportion satisfactory even to farmers. There was now 'more capital' laid out in agriculture than before, and in a more productive form. With this the demand for labour fell not only relatively, but absolutely." Ibid., pp.597-8.

92. Landes, pp.60, 115-6, 190. Also see Schefold, p.815.

93. Ricardo, pp.380-81.

94. Ibid.

95. Marx, Capital I, 414.

96. Marx, TSV II, 137, 488.

97. Ibid., p.490.

98. Marx, TSV III, 379-80.

99. Marx, Capital II, 227.

100. E. F. Beach, "Marxian Analysis", Relations Industrielles/ Industrial Relations 30 (1975), 772.

101. Ibid., p.773.

102. Ibid.

CHAPTER III

THE COMPENSATION CONTROVERSY AND MARX

1. Introduction

In the present chapter, we will develop further and modify some of the key theoretical concepts and formulations introduced in the previous chapters. We will also present and analyze Marx's criticisms of the classical compensation mechanisms as they relate to technological unemployment. Even though Marx's own writings will still be the main sources of reference, the views of some other economists will be utilized in order to clarify Marx's theoretical apparatus. Kruse's work in a non-Marxist tradition will be a major source in clarifying the meaning of compensation.[1]

It is our belief that the following analysis incorporates the essence of Marx on the question of technological unemployment and compensation even though the specific arguments or formulations that will be developed in this chapter cannot, admittedly, be located as such in Marx. Rather, they are the synthesis and, to a degree, an interpretation of Marx's arguments carried to their logical extension.

The main thrust of the present chapter is to develop Marx's theoretical framework in which the compensation controversy can be analyzed. The

classical arguments and Marx's critique of them will be studied with a view to evaluate this theoretical apparatus. The survey of the classical compensation mechanisms will be a limited one. More comprehensive surveys have already been done by a number of economists such as Gourvitch,[2] Kähler,[3] and Neisser.[4]

It is our contention that the theoretical approach to be developed in this chapter is consistent with Marx's claim that no automatic full compensation for the technologically displaced labour is guaranteed through the direct and indirect short term effects.

We will, in our presentation, integrate some of the neo-classical views on compensation with the classical views. However, since our objective is not to undertake an exhaustive survey of these arguments but to clarify Marx's critique of compensation, we will not attempt to present all the different aspects of the neo-classical arguments. In the appendix to this chapter, some of these arguments will be presented. In particular, the role of interest rate in reversing the bias in capital using Marxian technological change will not be emphasized. This has no place either in Marx's or in the classical economists' treatment of the question of technological unemployment. Stated differently, the question of compensation for the displaced workers through the creation of employment will be discussed on the assumption that the machines do displace labour. Whether a reversal in techniques in the future can serve as compensation will not be presently discussed. In the appendices to this chapter and Chapter IV, this possibility is evaluated with respect to the influence of the changes in the relative prices resulting from an initially labour displacing technology. This is done in order to see whether Marx ignores the role of relative prices in choosing a certain type of technology.

2. Definition of Compensation

In Chapter II, we have already seen that, according to Marx, technological change displaces labour upon the adoption of the new machine. The new machine, in this context, does not refer to a newly produced machine of the same kind replacing an old machine which has been worn out. It refers to a machine which embodies new technology, i.e., it is qualitatively different from the old one.

Since, according to Marx, the construction of this new machine absorbs less labour than the quantity displaced, there is net labour displacement when the effects of the stages of construction and adoption are combined. In the following analysis, we will choose the displacement of labour upon the adoption of the machine as our reference point. This is done because we wish to elaborate on the compensatory influence of the machine construction. Certain theoretical questions were deliberately overlooked in Chapter II in order to reproduce Marx's model. That part of the Marxian model concerning the machine production is, as we shall see, incomplete. The theory of compensation cannot be discussed by assuming that the machine construction can only be a source of partial compensation. Further elaboration is required.

However, the choice for the actual adoption of the new machine as a reference point poses a problem in terms of the time sequence of the events associated with technological change. The construction of the machine precedes its adoption. It has been argued by Kruse that because of this the machine construction should not be considered as a compensation.[3] As we will see, such a contention cannot be maintained once compensation is fully defined.

The central question to answer within the analysis of compensation is whether the market system provides any automatic mechanisms to compensate for the workers who are displaced upon the adoption of the new machine by creating additional employment. The optimistic view is that, barring temporary inconveniences involved in the movement of labour from one occupation to another, there will be full or more than full compensation. In other words, the displaced workers or even a larger number will find employment as a consequence of the particular technological change. The pessimistic view as exemplified by Marx holds that, at best, a partial compensation can take place. This means that only a part of the displaced workers will find employment. Yet, this question cannot be answered without defining what we mean by "compensation." A remarkable degree of confusion has been generated in economic literature due to the absence of a clear theoretical definition. As a result, the question itself remains unclear, and so do the attempts to answer it.

The most common answer to this question, as we have indicated in Chapter I, is in terms of historical observations. Mentor Bouniatian, an economist who has discussed the question of technological unemployment in a theoretical context and criticized Lederer's pessimistic diagnosis, ultimately relies on a historical observation to support his conclusions. He states: "The facts are there to prove this assertion: For a century and a half the rapid progress of the technique of production has not reduced the number of workers."[6] As we will see by the end of this chapter, the theoretical reasons given by Bouniatian and earlier by McCulloch are not sufficient for this assertion. If the capitalist system creates increasing levels of employment due to the general process of economic growth independently of labour displacing technological change,

such an expansion in employment cannot be considered as compensation for technological unemployment.

For compensation to have a clear theoretical meaning, it must be related to the specific changes associated with technological change. Compensation, whether partial or full, can be said to have taken place only if the changes directly or indirectly caused by the initial technological change are sufficient to create employment. In other words, one must show that the mechanisms which bring about compensation are the direct or indirect results of the changes associated with the new machine that displaces labour upon its adoption. Other types of technological change or government policies that occur independently cannot be used to prove compensation. Compensation can be shown if these changes are shown to be necessarily or normally linked to the technological change that displaces labour upon the adoption of the new machine.

This general definition of compensation must be the only relevant one to the analysis of technological unemployment upon the assumption that the new machine displaces labour upon its adoption. If the new machine does not displace labour but serves as a substitute for the old machine without an outlay of additional constant capital, or if it represents a saving in constant capital advanced, then the controversy over compensation becomes irrelevant. Even though the latter may still displace labour, this type of technological change will, for the most part, free both constant and variable capital. Then, the creation of an equal amount of employment will depend on the demand for labour by the capitalists, i.e., on profitable investment opportunities and not on the relative scarcity of capital caused by the change in the composition of capital.. It is this latter concept that underlies the Marxian technological unemployment. In this

sense, compensation will be analyzed by assuming that the capitalists utilize all their capital and that investment opportunities are not a barrier. As we will see, the classical compensation argument is also treated within a context when Say's Law holds.

A definition of compensation exists in a less developed form in Kruse.[7] Heertje states:

> According to Kruse's view with which I agree, compensation in the strict sense exists only if capital needed is formed as a result of the introduction of new technology. This view does not exclude, of course, the possibility that in reality the disappearance of technological unemployment is to a large extent due to capital formation occurring independently of technological change, so that compensation in the broad sense takes place.[8]

This view is very similar to that of Marx's. He states:

> ...[I]t must be shown that machinery does not deprive the labourers of bread. And how is this to be shown? By the fact that after a shock (to which perhaps the section of the population which is directly affected cannot offer any resistance) machinery once again employs more people than were employed before it was introduced - and therefore once again increases the number of productive labourers and restores the former disproportion.[9]
>
> The labourers that are thrown out of work in any branch of industry, can no doubt seek for employment in some other branch. If they find it, and thus renew the bond between them and the means of subsistence, this takes place only by the intermediary of a new and additional capital that is seeking investment; not at all by the intermediary of the capital that formerly employed them and was afterwards converted into machinery.[10]

Presently ignoring concepts such as "productive labourers" and "disproportionality", it is clear that Marx is relating any possible compensation to the particular technological change and not to a general growth process independent of it. In his discussion of profits as a source of compensation, this theoretical approach becomes more explicit. It is only the accumulation out of profits which arise directly or indirectly

from the reduction in the labour costs of production upon the displacement of labour that can be considered as a source of compensation. Any additional surplus originating from sources independent of the particular technological change cannot, in Marx, be legitimately discussed in the context of compensation. It is interesting to note that neither Heertje nor Kruse makes a reference to Marx with respect to this similarity in their views on compensation.

The definition of compensation in Marx remains ambiguous at this point. There are further theoretical difficulties that need clarification with respect to both Marx's approach and compensation in general. The following discussion will perform this task. Yet, we must indicate that Marx never gives a precise definition of compensation outside the quotations cited. In fact, one can even trace contradictory statements in his discussions. Consequently, our attempt to arrive at a tenable interpretation is based on the general thrust of his arguments. We will, however, underline many of the ambiguities and contradictory statements in Marx throughout the following discussion.

(i) The analysis of technological unemployment and compensation must be undertaken at an aggregate level. The impossibility of full compensation cannot be defended on the grounds that the particular workers displaced may remain so for extended periods even though an equal or a larger number of other workers is absorbed. Such a definition of compensation is a limited one which does not belong to an analysis of the effects of machinery on the aggregate levels of employment. It is relevant only in studying the effects of technological change on certain skills or groups of workers. At times, Marx uses this argument to criticize the compensation theory. He often refers to the "same identical workmen" displaced.[11]

This concern for the particular workers who may remain unemployed is a recurrent theme in Marx. Yet, such a narrow definition of compensation is not behind Marx's theoretical criticism of the compensation theory. His use of the concept of the industrial reserve army in conjunction with technological change is evidence that he is considering the effects of technological change on aggregate employment. This apparent inconsistency in Marx's works disappears once we recall from Chapter I that his theoretical model is an abstraction from the actual differential effects of technological change on, for example, the composition of the labour force and skills required. These effects must always be considered in the real world. But these are not the basis of the model Marx uses to refute the classical arguments on full compensation.

A further advantage of the aggregate analysis is that the effects on employment may not be observed in the particular firms adopting the new machines. The displacement may occur elsewhere if the adoption process is simultaneously accompanied by a flow of capital from other firms where it was previously advanced. The labour displacement will, then, be shifted to these firms. The micro and sectorial models that were developed in Chapter II abstracted from this aspect.

(ii) The meaning of compensation requires further clarification. Should it refer only to jobs created or should it also satisfy a further condition, i.e., an unchanging wage rate? In other words, if there is a creation of jobs through the changes associated with the introduction of the new machine and the real wage rate sinks below the level which existed before the change, should we consider the additional employment as compensation? There might be a compensation of jobs but not of wages. Nathan Belfer limits the meaning of compensation by specifying the additional condition that the displaced workers are not absorbed at lower

wages.[12] In this sense, employment at lower wages would not be a source of compensation.

We will not add this additional condition in defining compensation. Belfer's specification has merit in analyzing technological unemployment in an economy characterized by wide wage differentials. Its relevance to underdeveloped countries where the displaced workers may be driven to labour in intensive low paying jobs is obvious. Then, compensation only in terms of employment may not be an interesting question to deal with. The direct and indirect effects of technological change on income distribution will have to be studied together with the employment effects.

It can even be argued that the condition on the wage rate should also be fulfilled if compensation is to be defined in a Marxian context. Marx gives some support to this when he criticizes the classical compensation mechanisms by pointing out that the displaced workers may, at best, be driven to handicrafts. "And even should they find employment, what a poor look-out is theirs! Crippled as they are by division of labour, these poor devils are worth so little outside their old trade, that they cannot find admission into any industries, except a few of inferior kind, that are supplied with underpaid workmen."[13] The clear implication is that he does not consider this as compensation. Moreover, he argues that the industrial reserve army "exists in every possible form. Every labourer belongs to it during the time when he is only partially employed or wholly unemployed."[14] Hence, underemployment also appears to be part of the industrial reserve army.

This source of difficulty can, once again, be resolved when one turns to Marx's pure model which ignores these wage differentials at a given

time. In fact, in this model these distinctions between handicraft and more capitalistic branches have disappeared. The economy reflects a similar organic composition of capital in all or most branches. Wages fluctuate over time, and these fluctuations do affect the rate of technological change of the Marxian type. He also shows, as we will later analyze, that wage flexibility is a source of compensation. Thus, in Marx's model, there is no justification to limit the concept of compensation by requiring that it should occur at the same wage. The best way to interpret this is to assume that, in the advanced capitalism depicted by Marx's theoretical model, the lower wage rate resulting from unemployment does not imply underemployment. In this way, we will limit compensation to employment only, without being concerned about the differentials in the wage rate caused by technological change at any given time.

In the previous chapter, we have held the wage rate constant and uniform during the machine construction and upon its adoption. In the present chapter, the subsequent change in the wage rate as an indirect effect will be part of the compensation process. In our simple formulations, an unchanging wage rate will still be maintained for mathematical convenience. The modifications will be clarified in our literary exposition. In the classical arguments, compensation through changes in the wage rate was rarely considered. Moreover, it was often not clear whether they were discussing the effects of technological change on employment or on the living standard of the workers.[15] In the discussion of price flexibility, it will become clear that McCulloch's analysis is often in terms of compensation of wages rather than of employment. He tends to associate the increase in the real wages of the workers due to

increased productivity with a simultaneous compensation in employment. On the other hand, Marx's critique is based on employment effects even though he also points out the effects on the income distribution and wage rate. His definition of compensation, however, is basically in terms of employment.

(iii) A final definitional difficulty arises due to Marx's distinction between "productive" and "unproductive" labour.[16] Marx's distinction is very similar to that advanced by A. Smith. It is obvious in Marx's criticisms of Ricardo that he does not consider employment in unproductive services as a source of compensation for the displaced workers.[17] He defines productive labour as labour which produces a surplus. Unproductive labour, on the other hand, provides services for the capitalists or productive workers but does not produce a surplus that can be used to employ other workers.

We need not go through the controversy centered on the validity of such a distinction.[18] In our case, the relevant question is whether this distinction is important for the study of technological unemployment and compensation. We will maintain that it is not important for a study that emphasizes the supply of capital. As long as the capital that is freed upon the introduction of the new machine is large enough to absorb the displaced workers, it is irrelevant whether such absorption takes place in personal services consumed by the capitalists or in further accumulation leading to the production of commodities for sale. The only significant difference between the two types of employment lie in the amounts of constant capital required. Spending on services may require much less constant capital per worker and, thus, lead to a greater degree of labour

absorption than it would in the case of the production of material commodities requiring a large amount of constant capital. It can, however, be argued that compensation in the service sector can be a misleading indicator since the service sector is slower in adopting labour saving technology. The distinction may be an important one if one attempts to analyze compensation by observing the real world. Then, the slow rate of mechanization in the service sector relative to the sectors producing tangible commodities will appear to be a source of compensation. Yet, given the theoretical definition of compensation in its narrow sense, such a differential in the organic composition of capitals cannot legitimately be called compensation unless it can be shown that this differential is due to the high rate of growth in q in other sectors of the economy, i.e., this growth in q in some sectors causes a reduction in the rate of growth in q in the service sector. It is possible to advance such an argument by indicating that the downward pressure on the wage rate due to technological displacement and the availability of a larger reserve army enable the expansion of the service sector at much lower wage rates without introducing labour displacing machines. This sector, then, would absorb the labour displaced, and it would be characterized by labour intensive techniques. Such an analysis in terms of dual sectors does not exist in Marx but often has been advanced by later economists following the Marxian tradition. H. Braverman underlines the importance of this mechanism in capitalism.[19] But we also observe that the modern economy has started to experience the introduction of labour displacing machines in the service sector as well, for example, in banks.

We will continue to assume that there is a tendency towards uniform q's across the economy.[20] Whether the capitalist system will develop in

such a way so as to maintain large differentials in q among different sectors is a larger question which cannot be answered on the basis of Marx's writings. The more clear impression from Marx's writings is that the system in its pure form will be composed of sectors which are more or less alike in the types of technology they use and in the compositions of capital advanced. Whether this is a realistic assumption or not is something we will not deal with in any detail. We will, however, often refer to the possibility of differences in q that may exist at any given time without establishing a causal relationship among them.

In view of the clarifications made up until now, we can formulate a more complete definition of compensation to study Marx. Compensation exists if and only if the changes directly or indirectly associated with a particular technological change that displaces labour upon its adoption lead to a creation of employment under the condition of a uniform q at a given time.

This definition is more restrictive than the one given by Kruse which was indicated earlier. The specification of q establishes the difference. However, this specification need not be interpreted too strictly. Abstracting from the damage that different q's at a given time do to Marx's labour theory of value, the possibility of different q's in the economy does not seriously damage Marx's refutation of the compensation argument. As long as these differences are not very large, Marx's analysis holds. If large differences in q are used to prove a significant degree of compensation, it must be shown that the differences in q are caused by the particular forms of technological change displacing labour. Otherwise, the mere existence of these differences cannot be taken as a theoretical

necessity. Since Marx assumes that in a developed capitalist system q's will tend to be similar because of pervasive technological change, we will maintain the assumption of a uniform q at a given time which, however, tends to increase over time.

The general outline of the theoretical approach to compensation has been specified. The rest of the chapter will show that Marx's arguments are within this framework even though he never explicitly develops it. His criticisms of the classical compensation mechanisms can only be understood by applying this theoretical apparatus. It may be said that the limitations placed on the meaning of compensation are arbitrary. However, on the basis of our previous analysis, it is the contention of this student that the effects of labour displacing technology cannot be treated in a theoretical framework which does not specify the necessary assumptions and the linkages. Assertions based on observations fail to do so. They come close to being tautological statements of this kind: No technological unemployment occurs because we see increasing levels of employment in the long run. In the Marxian model, compensation takes a very specific meaning which cannot be challenged through observations alone. If one is to defend the case for full compensation, one must base this defence on a rigorous theoretical foundation which specifies the assumptions and the associated direct and indirect changes that can be considered as legitimate sources of compensation.

Before we proceed with the following sections in the present chapter, we will list the changes which are directly or indirectly associated with the labour displacing technological change.

Direct Changes:

(i) Construction of the new machine

(ii) Adoption of the new machine

Indirect Changes:

(iii) Changes in the price of the product produced and changes in the level of output upon the adoption of the machine

(iv) Changes in the wage rate due to displacement of labour upon the adoption of machines

(v) Changes in the surplus (profits)

We will use the terms "direct" and "indirect" in order to refer to the effects of these changes on employment. They correspond to our definition of short term in which initial accumulation is ruled out. The direct changes have an immediate impact on employment. They are the most visible effects. The indirect changes will normally take a longer time to be felt. In each of these changes, we are interested mainly in the employment effects and not in a thorough analysis of the complex relationships among all the changes.

It is difficult to specify a real time sequence for the indirect effects. In a realistic context, extra surplus will be realized before (iii) or (iv) occur. Once the technological change is diffused, the subsequent price decrease will reduce and eliminate the surplus. Given some working class resistance, the wage flexibility may not become effective or it may do so much later. The indirect changes are also interrelated. The changes in prices of commodities affect the real wage rate and, consequently, the surplus. Several of these key relationships will be developed in the Marxian scheme of thought in order to trace their compensatory influence on employment. We do not need to attach a specific

time sequence to the indirect effects given the complex relationships among them. On the other hand, the direct effects, i.e., (i) and (ii), have a clearer time sequence. We will use 1 and 2 to refer to time periods corresponding to (i) and (ii) respectively, and 3 will be used in general for the time period when the indirect effects are felt on employment. It should be noted that these numbers refer to specific moments when the changes have been completed instead of to actual lengths of time in those periods. Abstracting from the problems associated with the turnover which we have already discussed, the levels of employment will be conceptualized as the number of workers employed at any of these moments.

We can now specify the notations corresponding to the aggregate levels of employment in 0, 1, 2, and 3 where 0 refers to the period before the construction of the machine, i.e., the period preceding the changes. Since we have used the notation N to indicate levels of employment at the level of two firms or two sectors, we will now use the notation L to refer to aggregate levels of employment and, thus, avoid a possible source of confusion.

L_0: Aggregate level of employment before technological change, i.e., before the direct and indirect changes

L_1: Aggregate level of employment during the construction of the new machines

L_2: Aggregate level of employment upon the adoption of the new machines

L_3: Aggregate level of employment once the indirect changes have occurred

These notations and the subscripts will be maintained and frequently referred to in the rest of this chapter. It should also be noted that the

direct and indirect changes listed and their employment effects correspond to Level I analysis which was outlined in Chapter I.

This list does not exhaust all the possible changes that can be associated with the Marxian type of technological change. Other changes such as capital destruction, centralization and concentration will be a part of the long term accumulation model and also a part of the analysis of crises. This restricted list of changes corresponds to the compensation mechanism advanced by the classical economists. It is an appropriate framework for our short term analysis. The neo-classical factor-substitution mechanism is not listed here mainly because it does not exist either in Marx or in the classical thought explicitly. Some aspects of this mechanism will be briefly referred to in this chapter and its appendix without developing it in a comprehensive fashion.

In the next section, a brief review of the classical compensation mechanisms will be undertaken. The thrust of this presentation will not be to review the ideas of all the classical economists on the question of machinery. Our approach is to review and evaluate the main ideas among the classical economists from Marx's perspective and on the basis of his critique. The direct references to McCulloch's work are not from Marx. In our opinion, they constitute the compensation theory criticized by Marx. They are not exhaustive and must be considered as a vehicle to clarify Marx's critique.

3. Classical Compensation Mechanism and Marx

The classical economists, with a few exceptions, maintained a theory of full automatic compensation, i.e., the jobs lost because of technological change which displaces labour will be fully compensated for through the

market mechanisms. In fact, these mechanisms may even lead to an increase in total employment, i.e., $L_3 \geq L_0$. Marx, in his critique of the classical arguments, states: "James Mill, MacCulloch, Torrens, Senior, John Stuart Mill, and a whole series besides, of bourgeois political economists insist that all machinery that displaces workmen, simultaneously and necessarily sets free an amount of capital adequate to employ the same identical workmen."[21]

What is not explicit in this quotation is as significant as what is. The list does not include Ricardo and Barton. Neither does it include Sismondi or Malthus. Yet, it is significant to note that Schumpeter calls Ricardo "the father of what Marx called the Theory of Compensation - the theory that the working class is being compensated for initial sufferings, incident to the introduction of a labor-saving machine, by favorable ulterior effects."[22] Schumpeter believes that Marx was wrong in "constructing an entirely unrealistic contrast between these men [J. Mill, McCulloch, Torrens, Senior and J.S. Mill] and Ricardo."[23] We believe that Schumpeter's observation is correct. When one reads Ricardo's chapter in its entirety, one sees that he did not think that labour displacement would be permanent. Moreover, it occurred only when the gross revenue fell during the construction of the machines. Ricardo says:

> The statements which I have made will not, I hope, lead to the inference that machinery should not be encouraged. To elucidate the principle, I have been supposing, that improved machinery is suddenly discovered, and extensively used; but the truth is, that these discoveries are gradual, and rather operate in determining the employment of the capital which is saved and accumulated, than in diverting capital from its actual employment.[24]

Obviously, Ricardo links the problem of unemployment to suddenness

in the introduction of the machines as well as to the temporary reduction in the wage fund. Yet, he believes that, once the new machines begin to operate and the output is expanded, labour displacement will be compensated for. We will see that Marx's analysis differs on both grounds. He does not link the problem to suddenness. Neither does he think that the expanded output generated through the use of the machines will be sufficient to absorb the displaced workers. Even if the expanded output is large enough, he does not think that there is a necessary relationship between this output and the displaced workers. Hence, one could say that Ricardo should also have been on his list. His references to Barton, on the other hand, indicate that Barton saw the nature of the problem more clearly.[25] We will cite Ricardo again to underline our evaluation and that of Schumpeter:

> I have before observed, too, that the increase of net incomes, estimated in commodities, which is always the consequence of improved machinery, will lead to new savings and accumulations. These savings, it must be remembered are annual, and must soon create a fund, much greater than the gross revenue, originally lost by the discovery of the machine, when the demand for labour will be as great as before, and the situation of the people will be still further improved by the increased savings which the increased net revenue will still enable them to make.[26]

Using the notations specified earlier, in Ricardo, L_0 would be equal to L_1. When the machines are adopted, L_2 would be less than L_0 and L_1. However, when the output expands due to the new machines, L_3 will be equal to or greater than L_0. Hence, more than full compensation can occur. We must note that McCulloch's views are very close to this explanation. Ironically, McCulloch was disturbed by Ricardo's doubts. In fact, given the evidence, he should not have been. We have also shown that Marx was critical of Ricardo. Some of the fundamental differences have already

been indicated. We will refer to others throughout the study. Consequently, we cannot agree with Schumpeter who states that Marx's analysis added nothing to that advanced by Ricardo. He states: "Ricardo's teaching is indeed being swallowed hook, line and sinker."[27]

The earliest compensation theory in its most complete form has been formulated by McCulloch. Since Marx does not review the argument in a systematic manner, we will summarize it on the basis of McCulloch's response to Sismondi and Malthus who had expressed certain reservations about the compensation theory. However, before we summarize McCulloch's argument, it is important to underline the basis of his response to Malthus and Sismondi. Even though this will sidetrack us from the present task, its importance is substantial because it will not only show how different Sismondi's and Malthus' doubts are from Marx's critique, but also reveal the central point that Marx's critique holds even when Say's Law is maintained.

Sismondi's and Malthus' doubts are based on the underconsumptionist view.[28] Their criticism is directed against Say's Law. To summarize briefly: if technological change changes the distribution of income in favour of the rich, the total income may not be spent on the produced commodities, given, in modern parlance, a decreasing MPC for this group. Hence, Say's Law may fail and unemployment may result.

However, in this form, unemployment is not really due to technological displacement per se but to an unfavourable distribution of income that may result from it. Once the propensity to consume is increased, for example, through the luxury consumption by landlords in the case of Malthus, unemployment will be eliminated.[29] The compensation mechanism will be

fully effective.

It is significant to note that McCulloch's response is directed towards this challenge to Say's Law. He argues that since Say's Law will still operate, full or more than full compensation must take place. As we will elaborate later in this study, Marx's criticism of the compensation mechanism is not dependent on the failure of Say's Law. In this sense, it has little in common with the doubts of Malthus and Sismondi. These two should also have been included in Marx's list. He often refers to Sismondi's and Malthus' doubts with respect to consumption demand without including them in the controversy on machinery.[30] In the chapter on crises, we will see that Marx also has a version of unemployment based on underconsumption. This might have something to do with his failure to include them in his list.

McCulloch's theory of compensation is based on Say's Law. According to him, if the productivity of labour increases tenfold due to technological change which initially required less labour in production, then the "wealth and enjoyments of every individual" will also increase tenfold.[31] If England "were able to furnish the same supply of cottons as at present, with a tenth part of the capital and labour, is it not plain that her means of producing all other commodities would be prodigiously augmented?"[32] "There would be general augmentation of the wealth of the society; but there would be no excess of commodities in the market; the increased equivalents on the one side being precisely balanced by the increased equivalents on the other."[33]

On the basis of these references, it is not even possible to say that McCulloch is dealing with compensation of employment. He seems to be saying that technological change will increase the output and the living

standards in a country. How this becomes a compensation for the displaced workers is unclear. This also confirms our earlier point that a lack of clear distinction between employment and material benefits of technological change makes the classical compensation theory often difficult to follow.

McCulloch, then, becomes more specific and gives detailed reasons to illustrate the compensation for the initial displacement of labour. One mechanism that he advances is the price flexibility.[34] As technological change reduces the per unit cost of production, the price decreases and the increased demand for the output will expand both output and employment. In modern context, McCulloch's argument can be improved by using the concept of elasticity which is implicit in a crude fashion in the classical compensation mechanism. If $E_D > 1$, the increased revenues will be sufficient to absorb the displaced workers. McCulloch also shows that, even if the demand for this particular product manufactured in the technologically progressive firms does not increase sufficiently, i.e., $E_D < 1$, the real increase in the consumers' incomes will be partly shifted to other commodities where production and employment will increase.[35] He states: "The means by which the purchasers formerly paid for the high-priced cottons could not possibly be diminished by this increased facility of production."[36] Since the purchasing power is indestructible, increased production will but increase the real purchasing power and employment. This view is clearly a part of the classical quantity theory of demand for money. The nominal purchasing power cannot decrease. With a given money supply, the decrease in the price level due to an increased output makes it possible for the same amount of money income to purchase the expanded output. The real purchasing power increases.

It is obvious at this point that the relationships of purchasing

power and output to the absorption of additional workers is not clear in McCulloch's argument. What is clear in his statements is that there will be sufficient demand to buy the increased output, i.e., Say's Law holds. How the displaced workers get reabsorbed is yet to be explained. As A. Löwe points out, the displaced workers also appear to be obeying Say's Law.[37] Not only the increased output creates the demand for itself but also the displaced labour creates the demand for itself. This view has also been stated by Douglas who formulates the compensation theory in terms of freed purchasing power and elasticities of demand.[38]

We must note that in the argument advanced by McCulloch, there are two implicit propositions that are assumed to follow from Say's Law. We will briefly present them because they are fundamental in understanding technological unemployment and Marx's critique of the compensation theory. A very clear exposition of the two propositions has been given by A.S. Skinner. Much of the following discussion is based on his article.[39]

The two propositions are: (i) supply creates its own demand, (ii) there is a tendency towards full employment. Yet (ii) cannot follow automatically from (i). The proposition (i) establishes two equalities: one between production and purchasing power, and another between purchasing power and effective demand. The first equality basically means that incomes will be equal to the value of the output. The second one means that purchasing power or incomes will be spent on the output. Obviously, McCulloch is defending the latter relationship since the first one, being always true, cannot be challenged. However, even if this is true, i.e., all of the output is purchased, it does not follow from it that all available labour will be employed. As Skinner points out, it is misleading to associate the proposition (ii) with Say's Law.

In our study, we will be referring to the two propositions taken together as the extended version of Say's Law. On the other hand, the proposition (i) will be referred to as Say's Law in its narrow or limited sense.

Marx does not make a clear distinction between these two propositions. Yet, we will see that his comments indicate that he is aware of them. In the chapter on crises, it will become clear that in an economy using money, he sees the possibility that the first proposition may not hold.[40] However, his analysis of technological unemployment is not based on the refutation of this proposition. Even when Say's Law in its narrow sense holds, there will be technological unemployment. The introduction of the new machines displaces labour. Even if the output expands as a consequence of the introduction of the machines, the fact that it is purchased through higher real incomes is no compensation for the workers who have been left outside the circuit. We will return to this argument later and cite other economists voicing the same view. It should suffice presently to quote Marx who, in this instance, clearly is attacking the second proposition which perceives the unemployed workers as obeying Say's Law as well. According to this classical compensation mechanism, "anyone who through some bad luck ceased to have money would inevitably set free sufficient capital for his own employment."[41]

After this brief detour, let us return to McCulloch's arguments. He also considers the criticism that the decline in the price of the product may not be equal to the decrease in the per unit cost of production, i.e. the price may be sticky. In that case, the result will be increased profits which will in turn be used to reabsorb the displaced workers.[42]

This analysis, either in terms of the increased consumer demand due to lower prices or in terms of the profits accruing to the capitalists when the cost reductions are not fully passed on in terms of lower prices, can be restated in an alternative form. Let:

Δa: Savings of consumers due to lower prices

Δb: Savings of producers, i.e., increase in profits

Δd: Decrease in the total cost of production due to technological change

Then, $\Delta a + \Delta b = \Delta d$. McCulloch's argument implies that if all the savings go to the consumers, i.e., $\Delta b = 0$ or if the savings represent only profits, i.e., $\Delta a = 0$, then there will be full compensation. The implication is that Δd is equal to the wages of the displaced workers. Then, the purchasing power whether as Δa or Δb will be equal to the wages of the displaced workers and will be sufficient to reabsorb them. There is no difference in their effects. The purchasing power cannot be destroyed.

We have earlier shown that in Marx, Δd cannot be equal to the wages of the workers displaced when the net displacement is the sum of the labour absorption in machine construction and labour displacement upon the adoption of the machines. This does not mean that the goods which previously represented the wages of the workers now displaced have disappeared. They still exist. But one part of them is now in the form of constant capital in machine construction. It does not create additional demand for labour. Hence, Δd is much less than the total wages corresponding to net displacement. Δd is only equal to the decrease in the total advanced capital whereas the wages of the displaced workers will be equal to Δd plus the increase in constant capital. If and only if technological change requires no constant capital in the production of the machine, Δd will

be equal to the sum of the wages of the workers displaced. Even then, a distinction must be made between the differential employment effects of Δa and Δb. Compensation cannot be guaranteed. As Marx implies, Δa cannot be a source of automatic compensation. It only represents an increased purchasing power for consumption. The corresponding goods have already been produced by fewer workers. Their purchase does not create any additional demand for the workers that have been displaced. This transaction keeps those who have produced these commodities still in employment without attracting additional workers. It is significant to note that the argument based on the purchasing power was also criticized by J.S. Mill who argued that demand for commodities did not constitute demand for labour.[43]

On the other hand, Δb can be a source of compensation subject to the limitations set by q. It constitutes a fund for further accumulation. We will return to this aspect later in this chapter.

The role of wage flexibility is not clear in McCulloch's compensation mechanism. Neisser argues that it does not exist at all in the classical discussion of the employment effects of machinery.[44] McCulloch, in fact, argues that technological change "cannot, in any case, diminish the wages of the labourer, while it must raise their value relatively to commodities and improve his condition."[45] In the long run, it is the Malthusian mechanism that checks the growth in the wage rate.[46] He does not link the displacement of labour to its effects on the wage rate and to a possible compensation due to reduced wage rates. Since the argument on the indestructibility of the purchasing power assures full employment, no further compensation is sought. The workers are not only compensated in terms of employment but also in living standards. Whatever unemployment

may initially occur, it is only temporary. Automatic compensation is ensured. In this way, one of the few possible compensation mechanisms, i.e., the wage rate, does not even appear in the classical analysis. Given the critique in this section, this should have been a major mechanism in their analysis. In fact, wage flexibility could have bolstered the second proposition associated with Say's Law.

McCulloch mentions the construction of machinery as a source of compensation.[47] However, given that there is agreement between the classical economists and Marx that the machine produced will not embody as much labour as the labour displaced upon its adoption, this line of argument is not emphasized. The agreement on this is still widespread in modern thought, and the attempt to locate full compensation in machine construction has been called the "naive argument."[48] As previously indicated, Beach's argument is a major exception to this, since it links the increase in employment to substantial net investment in machine construction.

Given the agreement on the inadequacy of labour absorption in machine construction, the classical economists sought compensation for the net displacement of labour in Say's Law.[49] McCulloch sums up the compensation theory by stating that "the introduction of machinery into one employment; necessarily occasions an equal or greater demand for the disengaged labourers in some other employment."[50] The word "necessarily" should be underlined. Within the theoretical framework developed earlier, this should mean that, in the classical context, price flexibility, consumer demand and profits arising from the technological change that displaced labour should necessarily lead to full or more than full compensation of the displaced workers. This is in contrast to Marx's view: "But by no means

does a necessary connection exist between the revenue that has been set free and the workers that have been set free of revenue."[51] In our later discussions, this concept of "necessary connection" must be recalled. It is, as we have already seen, central to Marx's definition of compensation. Finally, we should note that McCulloch's compensation mechanism is based, for the most part, on the indirect effects or changes that we have listed.

4. Forms of Compensation in Marx

Now, we turn to Marx's evaluation of the compensation theory. Our objective is threefold:

(i) To present Marx's criticisms in their entirety

(ii) To indicate other differences between the classical and the Marxian approaches

(iii) To further develop Marx's own approach while indicating certain theoretical difficulties with it. This analysis will include a formulation in which all of the possible compensation effects can be accounted for. To carry out the analysis, we will make use of the explicit arguments in Marx as well as their logical extensions. We will also see that these arguments find support among the more modern Marxist and non-Marxist economists.

Machine Construction, Adoption and Compensation

Marx's argument, as depicted in Chapter II, encountered some difficulties which were briefly indicated. The construction of the machine and its adoption cannot take place simultaneously. The machine must be produced in advance. Since labour absorption precedes displacement, in what sense can the construction of the machine be considered a source of compensation? To answer this, we need to explore how the construction is financed. Marx does not explicitly treat this aspect. In the following

analysis, we will present an interpretation which is consistent with the results of his simultaneous absorption and displacement processes.

In period 1, the construction of machine requires both additional C and v. This is so in Marx because the new machine requires more labour input and constant capital than the old one. There are two possible sources to raise this additional capital. One source would be a prior surplus from period 0. A second source would be the reallocation of the already advanced capital in period 0 to the firms manufacturing the machine in period 1.

These two possibilities do not include borrowing financed by monetary expansion. The best way to interpret capital in our context is to think of it as real capital, that is, as wage goods and as means of production or as a money flow corresponding to these. Surplus from period 0 is, using non-Marxian terminology, the savings of the capitalists. Money may circulate, and financial institutions may be involved. However, the transfer of these savings is not accompanied by monetary expansion and its inflationary effects.

Let us now study the two cases or the sources of funds in order to show their theoretical significance in the analysis of compensation. It must be noted at this point that when previous surplus is used in machine construction, we are no more in a short term analysis. In the following discussion, we will not be developing the long term model with accumulation. The case where initial surplus is used will be studied only to indicate why it may theoretically be justified to rule out this surplus as a legitimate source of compensation.

Use of Surplus from Period 0 to Construct the Machine in Period 1

In aggregate analysis, the use of surplus from period 0 in order to finance an expansion in the machine construction sector in period 1 is a realistic possibility. The specific source of this surplus is irrelevant. It may originate from the particular firms which will be producing the new machine or it may be a flow of surplus from the other branches of production in the economy. The important point is that, in period 1, accumulation at an aggregate level will have taken place. Thus, $\Delta s_0 = \Delta C_1 + \Delta v_1$ where Δs_0 stands for the surplus originating from period 0 (or prior periods) to be advanced as ΔC_1 and Δv_1 in period 1 in order to produce the technologically superior machinery. Consequently, using the earlier notations on aggregate employment, L_1 will be greater than L_0. Accumulation out of surplus to produce the machines increases the level of employment. An alternative way of stating this is that if, in period 0, the capitalists consume all the available surplus, i.e., simple reproduction takes place, no increase in employment will occur in period 1. The sum of capitalist consumption, the workers' consumption and the reproduction of the previous constant capital will maintain the same level of employment. In other words, L_0 will be equal to L_1.

If the machine construction involves accumulation, it must still be determined how much effect this will have on aggregate employment. In this context, we need to recall the distinction made earlier between constant and variable capital. Since the construction of the new machine requires both current labour and past labour embodied in equipment and tools, the initial surplus from period 0 must be divided into ΔC_1 and Δv_1. However, ΔC_1 does not set into motion additional labour. It is past labour as far as the machine construction is concerned. The advance of ΔC_1

only maintains those who have produced it in period 0 still in employment. It does not by itself increase L_1. Thus, the advanced C embodies labour but does not create additional employment. If the advanced constant capital were alternately imagined as representing commodities to be consumed by the capitalists, such consumption would add nothing to employment. The main difference, of course, is that the constant capital can be used to equip additional workers whereas the consumption of the goods corresponding to the surplus does not serve this task even though it would still keep in employment those workers who have produced them.

It should be emphasized that the analysis above, which is consistent with Marx's approach, should not be interpreted to mean that the production of constant capital in general does not create employment. It only means that its advance in the subsequent period does not add to employment. Otherwise, we would be double counting. We would be adding the workers who produced the constant capital to the workers who are equipped with the constant capital. Yet, it is only the second group that is the net addition to employment. The first group is already accounted for in the production of the constant capital. This is why the distinction between ΔC and Δv is essential in Marx to study the employment effects of technological change. Unless we assume that an expansion in machine production can be undertaken with current labour only without using constant capital, we cannot equate Δs_0 with Δv_1. Marx argues not only that developed capitalism cannot be understood in this way, but also that technological progress increases the ratio of ΔC to Δv.[52] To employ more workers at the aggregate level, the capitalists must advance not only wage goods but also constant capital. The ratio is specified by the requirements of technology, and, over time, that part of initial surplus allocated to C will grow relative to the part allocated to v. Hence, the demand for

labour will grow at a slower rate than the rate of accumulation. More on this in Chapter IV.

Given the discussion above, the increase in the aggregate level of employment between period 0 and 1 must be measured by $\frac{\Delta v_1}{W}$ and not by $\frac{\Delta s_0}{W}$ or $\frac{\Delta C_1 + \Delta v_1}{W}$. Since the machine construction is a necessary change associated with technological change under consideration, $\frac{\Delta v_1}{W}$ may be considered as a source of compensation. On the other hand, a theoretical difficulty exists when an initial surplus is included. This surplus originates from a period preceding the changes associated with the technological change. It has not been generated by the particular technological change occurring. It only facilitates the introduction of the change. It may be argued, on theoretical grounds, that such an intermediary of new capital independent of the consequences of the technological change should not be shown as a source of compensation. This view, as we have seen, is explicit in Marx. He excludes the use of a new intermediary capital as a source of compensation. The same contention is made by Kruse who, in addition, rules out compensation in the construction of new machines totally.[53] He limits the compensation effects only to the changes following the displacement of labour upon the adoption of the machines.

We believe that Kruse's objection to considering the use of the initial independent source of surplus to produce the machine as compensation is valid. Yet, the machine construction itself cannot be ruled out as a source of compensation on these grounds. It is a necessary process that must be considered as compensation. Marx, clearly, sees it as a source of

partial compensation as outlined in Chapter II. However, his model avoids the realistic difficulty posed by an initial surplus. The simultaneous displacement and absorption processes enable him to portray a case when the firm purchasing the new machine is also financing its construction out of the wages of the displaced workers. One cannot conceive of such a case unless the firms that will be buying the new machine cease production and wait for the construction of the new machine while readvancing their previously advanced v to the machine construction. Moreover, one would have to assume that this v is sufficient to finance the machine construction. Clearly, this micro analysis is plagued with serious difficulties. Yet, the clear advantage of this approach is that it limits the boundaries of the theoretical discussion of compensation and technological unemployment. Prior capital accumulation is disallowed.

Marx's theoretical model can be made more meaningful without excluding the use of initial surplus. The use of surplus in the machine construction can be allowed without altering his conclusions. Then, unlike in Kruse's case, machine construction will also appear as a source of partial compensation.

Let us assume that, in period 1, the construction of the new machine involves net accumulation in the economy due to an additional surplus from period 0. If we also assume that no accumulation takes place from period 0 to period 2, Marx's analysis will still hold. We can illustrate this in the following manner:

AAC: Aggregate advanced capital

Δs_0: Surplus arising from period 0 and to be advanced as ΔC_1 and Δv_1 in period 1

Δv_2: Reduction in the aggregate wage bill due to the displacement of workers in period 2 upon the adoption of the machines

Subscripts 0, 1 and 2 refer to the periods specified earlier in this chapter.

Then, we can illustrate the assumptions indicated above in the following manner:

(i) $AAC_1 = AAC_0 + \Delta s_0$, $(AAC_1 > AAC_0)$

(ii) $AAC_2 = AAC_0 + \Delta s_0 - \Delta v_2$

The aggregate advanced capital increases between periods 0 and 1. In theory, this prior surplus can be offset by assuming that $|-\Delta v_2|$ is greater than Δs_0. This satisfies the condition that the machine construction embodies less labour than the amount it displaces. Consequently, $\Delta s_0 - \Delta v_2 < 0$. Given this, $AAC_0 + \Delta s_0 - \Delta v_2 < AAC_0 < AAC_0 + \Delta s_0$.

Thus, even though there is accumulation from period 0 to period 1, we can, theoretically, eliminate the net accumulation over the three periods by reducing the advanced capital in period 2 by Δv_2. Then the advanced capital in period 2 will be less than that which is advanced in period 0. This is due to the freeing of wages by the displacement of labour. $|\Delta s_0 - \Delta v_2|$ will yield the surplus arising from the displacement process. In fact, it will be shared by the capitalists adopting the machines as well as those constructing the machines. The capitalists producing the machines will have recovered their surplus originating from period 0 when they sell the machines at the beginning of period 2. In addition, they will have earned a surplus. The capitalists purchasing the machines reduce their total outlay by displacing workers. In fact, it appears that they realize a surplus at the beginning of period 2 before even producing an output

during that period.

In short, the initial surplus can be assumed to be a temporary source of finance which does not lead to a net accumulation in the economy between periods 0 and 2. This analysis can be simplified by applying it to a case when the capitalists initially borrow a surplus to produce the new machines that they themselves will adopt. Upon the adoption of the machines, they displace some of their workers and pay back the loan. This means that the capitalists are not adopting the machines to increase their scale of production or to undertake accumulation but to reduce their labour costs at a more or less constant level of output. Then, the new machines embodying a greater quantity of labour than the old ones will have been purchased through an ultimate conversion of v to C, i.e., through the displacement of workers. The foregoing analysis overcomes the difficulty created in the Marxian analysis where the importance of the time sequence of construction and adoption is not underlined. It also shows that even when initial surplus is allowed in the construction of the new machines, the short term analysis can be made meaningful under special assumptions. Yet, when such surplus is involved, the foregoing analysis, which is essentially static, becomes difficult to maintain. Later, we will consider some of the objections that one can raise against it.

The employment effects of the foregoing analysis can be illustrated as follows:

L_0: Aggregate level of employment before the construction of the new machines

L_1: Aggregate level of employment during the construction of the new machines

L_2: Aggregate level of employment upon the adoption of the new machines

ΔL: $L_0 - L_2$

W: Given wage rate in the economy

q: Organic composition of the aggregate advanced capital where $q_2 > q_0$ and $q_0 = q_1$.

We can restate the relationships derived in Chapter II in aggregate context:

(i) $AAC = C + v$

(ii) $\frac{C}{v} = q$

(iii) $AAC = v(1 + q)$ (Substituting $v \cdot q$ for C in (i).)

or $v = \frac{AAC}{1 + q}$

The level of employment will be:

(iv) $L = \frac{\frac{AAC}{1 + q}}{W}$

Then:

$$L_0 = \frac{\frac{AAC_0}{1 + q_0}}{W} \qquad L_1 = \frac{\frac{AAC_1}{1 + q_1}}{W} \qquad L_2 = \frac{\frac{AAC_2}{1 + q_2}}{W}$$

When the machines are being built by using a prior surplus, L_1 will be greater than L_0 given our assumption that the organic composition of capital does not change between periods 0 and 1. (This assumption eliminates technological change in the construction of the machines.) However, L_2 will be less than L_0. The difference between L_0 and L_1 measures the compensation due to the construction of the machines.

If, as already explained, we reduce the aggregate advanced capital in period 2 by an amount of v that is greater than the initial surplus from period 0, there will be a net displacement of labour compared to L_0. For

example, an increase in employment by 50 in period 1 will be offset by a displacement of 60 in period 2. However, compared to period 0, there will be a net displacement of 10 workers. It should be noted that 60 workers will be displaced in period 2 even though aggregate employment falls by 10 compared to base period 0. Since we are comparing aggregate levels of employment, this is the only form in which technological unemployment or net displacement can be illustrated. The machine displaces 60 workers but it has absorbed 50 in its construction in the previous period. The difference, ΔL, between L_1 and L_0 measures compensation owing to the construction of the machines whereas the difference between L_0 and L_2 measures the net displacement in the economy. This case can be shown in the following manner:

$$\Delta L = \frac{\frac{AAC_0}{q_0 + 1}}{W} - \frac{\frac{AAC_2}{q_2 + 1}}{W}$$

On the basis of this relationship, general conclusions can be stated:

(i) Full compensation exists if $\Delta L = 0$.

(ii) Partial compensation exists if $\Delta L > 0$.

(iii) More than full compensation exists if $\Delta L < 0$.

Given our prior analysis of the initial surplus, AAC_2 will have to be smaller than AAC_0. Then, only a partial compensation due to machine construction is possible. Full compensation is possible if q_2 has decreased sufficiently compared to q_0. However, such a possibility is not strong in Marx's view of technological change in capitalism.

It may be said that Marx's view of technological change, even disregarding the problems associated with the movements in q, is too limited. One could argue that such technological change embodied in more expensive

machines would involve net accumulation in the economy in a permanent fashion and not as a temporary source of financing for the construction of the machine in period 1. This would mean that the firms purchasing the new machines finance the machines partly out of their surplus. It would also mean that the part of the variable capital to be converted to C may not be sufficient to purchase the machines. If such a contention is valid, we cannot, then, exclude the effects of surplus on employment by withdrawing it at the end for purely theoretical reasons in order to defend Marx's model in which financing of the machines ultimately comes out of the wages of the workers to be displaced. In this case, accumulation and technological change would have to be treated together. This is a valid objection.

It can, however, be answered in two ways: firstly, even if technological change is necessarily associated with permanent accumulation in the economy, a theoretical case for technological unemployment can still be made. Since the employment effects of accumulation cannot be arbitrarily eliminated in this case as it was when prior surplus was used only as a temporary financing method, aggregate employment will increase between periods 0 and 2. The total output will have increased in both machine construction and where it is adopted. This also presumes the existence of expanded markets.

Yet, even such accumulation may be consistent with technological unemployment. The new machines may enable the producers to produce the larger output with fewer workers than the case would be if the larger output were produced on the basis of an unchanging q. Stated differently, one can say that the increased AAC would have employed a larger number of workers if it were advanced on the basis of a constant q. The difference

between this level of employment which would have existed and that which is reached on the basis of an increasing q is a theoretical measurement of technological unemployment. Clearly, one can assert that, in this case the concern is an academic one, for no unemployment occurs in the short term. L_2 would be greater than L_0. Yet, in the long term when the labour force also increases, technological change which increases q in absolute terms can be observed through increasing levels of unemployment as well as simultaneous increases in the absolute level of employment. This interpretation of technological change is explicit in Marx's long term accumulation model. We shall analyze this and the implicit assumptions behind it in Chapter IV. We will, then, see that the theoretical measure of unemployment need not, in reality, correspond to actual unemployment. The latter will depend on factors such as the growth in the labour force, the rate of change in q and the rate of accumulation.

Secondly, even in the short term, the theoretical model can be applied to show an absolute decrease in the level of employment. As long as the firms which are purchasing the new machines are converting some of the variable capital employed to C in addition to their surplus, the level of employment upon the adoption will be less than the level of employment in period 1 when the machines were constructed. Thus, L_2 will be greater than L_0 but less than L_1 in period 1 when the organic composition of advanced capital is lower. The short term concern will reappear once the base period is shifted from 0 to 1 because $L_0 < L_2 < L_1$. In this case, the compensation controversy, in strict terms, should start from period 1. One should, then, consider whether sufficient surplus will be generated in the subsequent periods to offset this decrease in the level of employment. The surplus arising from technological change and the other compensation

mechanisms following the net displacement, i.e., $L_1 - L_2$, need to be studied. The increase in employment from period 0 to period 2 cannot be shown as a compensation for the decrease between periods 1 and 2. In this way, the effect of a permanent increase in AAC on employment can be separated from the subsequent effects of technological change on employment. In one sense, the discussion of machine construction and its compensatory effects become irrelevant when accumulation is a permanent characteristic of technological change.

In our static model depicting Marx's short term analysis, accumulation is disallowed not only for theoretical reasons but also because a temporary form of financing in the construction of the machine is a real possibility. Such financing may not lead to permanent accumulation. Clearly, once this prior surplus is withdrawn, it may be used elsewhere to increase employment. However, this employment has not been caused by the particular technological change and, hence, cannot be considered as a form of compensation. Its temporary use highlights the partial compensation or employment in the machine construction. This level of employment is, then, maintained ultimately by a portion of the variable capital used to purchase the machines. In other words, the role which is initially assumed by prior surplus is taken over by v upon the adoption of the machines.

Reallocation of Capital from its Employment in Other Branches to Machine Construction

A second source of capital to finance the machine construction lies in the capital already advanced in the economy. This means that the capital in use elsewhere is reallocated from certain lines of production to the firms that will be producing the new machines. In this case, there is no need for an initial surplus on a temporary basis. The level of employment

between periods 0 and 1 will not change. Labour and constant capital will be reallocated in the economy. When the machines are sold in period 2, the level of employment falls because the machines are bought with a view to reduce the labour costs. The workers in the machine construction will still be employed since they have to produce the replacements for these machines for the subsequent periods.

This case is also a realistic possibility. It can also be seen as a situation when the depreciation funds in the economy from period 0 are allocated to the construction of the new machines in period 1. Since there will be reduction in employment in the firms which are not readvancing the capital equivalent to the depreciation funds, the increase in the advanced capital in the machine construction draws the labour which was employed elsewhere or the equivalent of this labour from the industrial reserve army. The aggregate level of employment does not change. The same amount of capital is simply reallocated, and labour is moved from one type of employment to another. Simple reproduction takes place.

It should be noted that in this case, if the machine construction sector has a higher q in relation to the firms from which capital is released, there might be an actual decrease in the level of employment between periods 0 and 1. The differences in q were, however, assumed away by making $q_0 = q_1$, that is, by assuming that machine construction does not yet experience the Marxian technological change. If q increases from period 0 to period 1 due to mechanization of the Marxian type, the construction of the new machines will absorb fewer workers than what the same amount of capital employed in period 0. The employment effects of such a change will compound the displacement effects upon the adoption of

these machines since the adoption of the machines will further increase average q by increasing the individual q's in those firms buying the new machines. Marx implies this when he says that labour displacing technology will gradually be introduced in all lines of production.[54]

This form of financing captures the spirit of Marx's argument more correctly in the short term because Marx does not discuss the use of a prior surplus in predicting immediate technological unemployment. The conversion from v to C is more consistent with the view that technological change is brought about by the diversion of capital in its other uses to the particular firms or industries where such change is taking place. Since Marx does not explicitly deal with how the construction of the machines is financed initially, our conclusion is an inference based on his argument that the intermediary of new capital cannot be considered as compensation. Even though the use of a temporary surplus in machine construction alone can be made consistent with his analysis, permanent accumulation between periods 0 and 2, i.e., the use of surplus in the purchase of machines as well is not consistent with his short term analysis. This may occur in the real world. Marx, however, does not see it as being necessarily or normally associated with technological change. His short term analysis which is based on the conversion of v in use to C supports our interpretation. We have been able to locate only one explicit comment by Marx which throws some doubt on our interpretation. He says that the capitalist "must accumulate capital in order to extend his production and build technical progress into his productive organism."[55] We believe that our analysis in Chapter IV will confirm our interpretation that he does not see accumulation as being necessary to bring about technological change even though he argues that accumulation will involve technological change.

Assuming presently that our interpretation of Marx's view is valid, one still has to question whether Marx's view does explain, in reality, the capital requirements necessary for the introduction of new machines. Is technological change brought about through the reallocation of the previously used funds and resources or does it require, in general, accumulation at the aggregate level? Salter, for example, points out that technological change can be financed through a "high rate of replacement investment"[56] when net investment is zero.

It is not our concern to evaluate the validity of Marx's contentions in empirical terms. The Marxian model is applicable to either case. Nevertheless, if technological change is usually associated with accumulation, the levels of output and employment increase permanently as opposed to the case involving only temporary financing. Immediate displacement will not materialize.

Returning to the case when the machine construction does not require a prior surplus, one could illustrate the employment effects by using the same notations and formulations as before. We need not repeat the analysis. The only difference would be that $AAC_0 - AAC_2$ would now be sufficient for the analysis because AAC would not have increased between periods 0 and 1. Since no initial surplus would have been advanced, it would not be necessary to remove it in order to isolate the effects of technological change on employment. Hence, the decrease in AAC between periods 0 and 2 would be the same as $|\Delta s_0 - \Delta v_2|$ when a prior surplus was temporarily used in the construction of the new machines. The decrease in AAC would represent the additional surplus for the capitalists involved in the construction and adoption of the machines. We must, however, recall that the decrease in the advanced variable capital would be greater than

the decrease in AAC because a part of v would have been converted to C.

Our formulations in the rest of this chapter can be interpreted either according to the case when a prior surplus is temporarily used or according to the present case when no such prior surplus is allowed. Given our explanations, the Marxian results are identical. In both cases, an increase in AAC between periods 0 and 2 is ruled out.

We will make two final observations before we proceed with the other compensation mechanisms. Firstly, even though Marx does not explicitly discuss the sources of difficulty in his simultaneous absorption and displacement model, his analysis can be maintained on the basis of our interpretations which overcome this difficulty. Secondly, the case where surplus is initially used to introduce technological change is an interesting one, regardless of whether it also implies permanent accumulation in the economy or whether it is only a temporary source. In either case, the level of aggregate employment when machines are constructed will increase, i.e., $L_1 > L_0$. Given that Marx never assumes full employment of labour, such a change is possible. On the other hand, within the classical context, this is not possible because the classical economists implicitly assume full employment of labour. They start out with full employment. This approach cannot explain the case in which the construction of the new machines uses a prior surplus. There will be no idle labour to employ. One cannot argue that the workers to be displaced by the adoption of the machines can serve this purpose. The time sequence makes this impossible. The displacement, if any, is to come in the future. The machine construction requires workers now. In fact, given the assumption of full employment, it is not clear how such technological change can be explained in the classical model once accumulation is allowed, aside

from the Malthusian population growth. The classical model would have to limit the analysis to the case when no prior surplus is involved. This, in fact, is the Ricardian case; the workers are taken away from one employment during a certain period and are employed to construct the new machine. This process is a necessity once full employment becomes the starting point. However, the Marxian analysis is compatible with both cases because unemployment appears to be a permanent feature of capitalism in Marx. A further implication of Marx's analysis is that even when no prior surplus is involved, the workers employed in the construction of the machines may be different from those that are displaced in those industries from which capital has been withdrawn.[57] Even though in an aggregate analysis this is not a criterion to measure employment, it underlies an important difference between the Marxian and classical approaches.

Price Flexibility and Compensation

We have already seen that price flexibility resulting from technological change was pointed out by McCulloch as a compensation mechanism. In this section, we will elaborate upon our earlier brief discussion. Hence a certain degree of repetitiveness is unavoidable.

The modern version of this compensation mechanism is not essentially different from McCulloch's presentation except that the concept of elasticity is an important part of it.[58] We will assume that the cost decrease due to displacement of labour is completely passed on to consumers through lower prices, i.e., no immediate extra surplus is reaped by the capitalists.

To review briefly; technological change reduces the cost per unit of production at a given level of output, and, under competitive pressures, the price decreases by the equivalent of the decrease in the unit cost.

The implicit assumption here is that technological change is diffused rapidly in the economy. Hence, no extra surplus arises from it. It should, however, be noted that even in this case, there will still be some surplus as a normal return. In our example, this is ignored because the capitalist will realize such surplus even without technological change. Then, surplus in this section refers to the extra profits, or to quasi-rents in modern parlance. According to those economists who believe that full compensation will occur, at lower prices, if $E_D > 1$, the increased revenues of the firms which have adopted the new machines will be sufficient or more than sufficient to compensate for the technologically unemployed. Steuart and Malthus held this view as well. They believed that the displaced workers would be reabsorbed mostly in the same industry.[59] Designating the period following the adoption of the new machines as period 3 when the other compensation mechanisms become effective, this implies that $L_3 \geq L_0$ or $L_3 - L_2 \geq L_0 - L_2$.

On the other hand, if $E_D < 1$, then the consumers will not use all the increase in their real purchasing power to purchase this particular product. Given that the purchasing power will find other outlets for spending under Say's Law, this fund will be used to purchase more commodities from the other firms where output and employment will expand.[60]

The weaknesses of this analysis are indicated by Marx who shows that the consumer demand cannot be a source of compensation.[61] Let us initially continue to assume that output is constant.[62] According to Marx, when the cost reduction is passed on to consumers who may comprise workers and capitalists, a part of society's money income is freed. If it were not passed on to the consumers, it would have represented a second "freed fund", i.e., the surplus of the capitalists.[63] In the former case, the

consumers will be able to purchase more of the particular product produced by the innovative firms or other commodities. Those who are still employed enjoy more commodities relative to the previous period even though the output of the commodities is the same. Ignoring presently the role of the capitalist consumption, the increase in the consumption of the workers who are still employed cannot be a compensation for the decrease in employment. When the workers are displaced, Marx says, they are also cut off from the commodities that they were previously buying.[64] The increased purchasing power of those who are still working can only maintain the real demand for commodities at its previous level. Fewer workers are purchasing the same amount of commodities that were earlier bought by a larger number of workers. Marx states:

> The same quantity of commodities and even more of them - including those consumed by the workers - can be produced although less capital, a smaller portion of the total product, is transformed into variable capital, that is laid out in wages.[65]
>
> Thus, so far as his capitalist's own product is concerned, in the first place, even if it enters into the consumption of the workers, its increased production in no way contradicts the fact that a part of it ceased to exist as capital for workers.[66]

If the capitalist consumption is also added, the result does not differ. In fact, according to Marx, if the drop in consumption due to the displacement of some workers is not offset by an increased consumption on the part of the remaining workers and/or capitalists, there would be further unemployment in other branches of the economy.[67] Löwe also points out that since the purchasing power of the displaced workers has been lost, "the best the buying increment of entrepreneurs and consumers can achieve is to balance this loss.... In this way the production consumption circuit will again be closed, but it is a circuit from which the displaced workers have been eliminated."[68] Total demand for goods and services is equal to

the total supply of goods and services, but labour is also unemployed. Hence, Say's Law in the limited sense holds. But the purchasing power argument does not insure that supply of labour is also equal to the demand for labour.

If $E_D > 1$ for the particular product whose price decreases, the relative increase in the purchasing power of the fewer workers can only lead to expansion of output and employment in the innovative firms at the expense of output and employment in other firms. The increase in the revenues of the innovative firms implies an equal decrease in the revenues of other firms.[69] Hence, only the possible secondary effects on employment in other industries are offset. Those who are displaced by the machines still remain unemployed.[70]

If $E_D < 1$ the decrease in the revenues of the innovative firms is offset by an equal increase elsewhere. The result is the same, i.e., a shift in employment rather than any compensation.

As we have seen, if net saving takes place on the part of the employed workers, the result is further unemployment. The classical compensationists did not consider this case. Marx, however, sees the possibility that Say's Law may not hold even in its limited sense. Secondary unemployment in addition to the technologically displaced workers can result. Nevertheless, in Marx, Say's Law can hold while technological unemployment also exists.[71] The argument is not dependent on the failure of Say's Law in its narrow sense, i.e., the supply of commodities creates the demand for itself. We have already referred to this aspect earlier in this chapter.

Marx shows that the freed fund of the consumers through price

flexibility is not a source of compensation. This criticism, developed partially in the Theories of Surplus-Value,[72] has been developed more rigorously by others. Löwe's criticisms have been indicated. Hansen, to cite another example, says that "labour saving techniques redistribute purchasing power but do not of themselves create additional purchasing power."[73] The real purchasing power will be the same as before given the level of output. In our case, it is now shared by fewer consumers. Consequently, the concept of demand elasticity for consumer goods cannot be used to show compensation at the aggregate level as long as all the purchasing power is effectively used and the capital stock is fully utilized. It is useful only in analysing the shifts in employment among different uses. The fundamental weakness with the demand elasticity approach is that it ignores the supply of capital. Moreover, it confuses the shifts in employment at a micro level with changes at the aggregate level.

The analysis can be reproduced by utilizing the same notations previously applied to McCulloch's argument.

Δa: Savings of consumers or increase in purchasing power due to lower prices

Δb: Savings of producers, i.e., increase in profits (surplus)

Δd: Decrease in the total cost of production due to technological change

In the present case, $\Delta b = 0$, and $\Delta a = \Delta d$. The increase in the purchasing power of the remaining workers is not a source of compensation. It is a demand for the commodities produced at the lower level of employment.

It may be objected that the output of consumption goods should not be held constant when technological change occurs. It is explicit in McCulloch's analysis that output expands upon the adoption of the new machines. Somehow, this increased output and the increase in the total real purchasing power, when all the cost reduction is reflected in lower prices, are claimed to be a source of compensation. The implication is that consumer demand when the output is constant may not be a source of compensation but that if technological change increases the output, compensation will take place.

If the total output, as a result of the labour saving machine, is greater than before, this means that the fewer employed workers are producing a greater output than that which was produced by a larger number of workers before the introduction of the new machines. Their real income will be greater than the real income of all the workers before the net displacement.

In Marx, the output may remain constant or increase with labour displacing technological change. He says that it may even diminish.[74] But he does not see this as a strong possibility. The increased output does not require the services of additional labour and hence, no compensation is possible in its production; it only means that the workers still employed enjoy a much higher level of real income. He states:

> As the supply relative to the demands would have grown, they [commodities] would fall in price, and as a result of this fall in price, their consumption would rise, even if the 100,000 workers [displaced workers] were starving to death.[75]
>
> These means of subsistence, in the first place, do not by any means confront those [displaced] workers as capital.[76]
>
> The price need not even fall. Perhaps less of these means of subsistence is imported or more of them exported.[77]

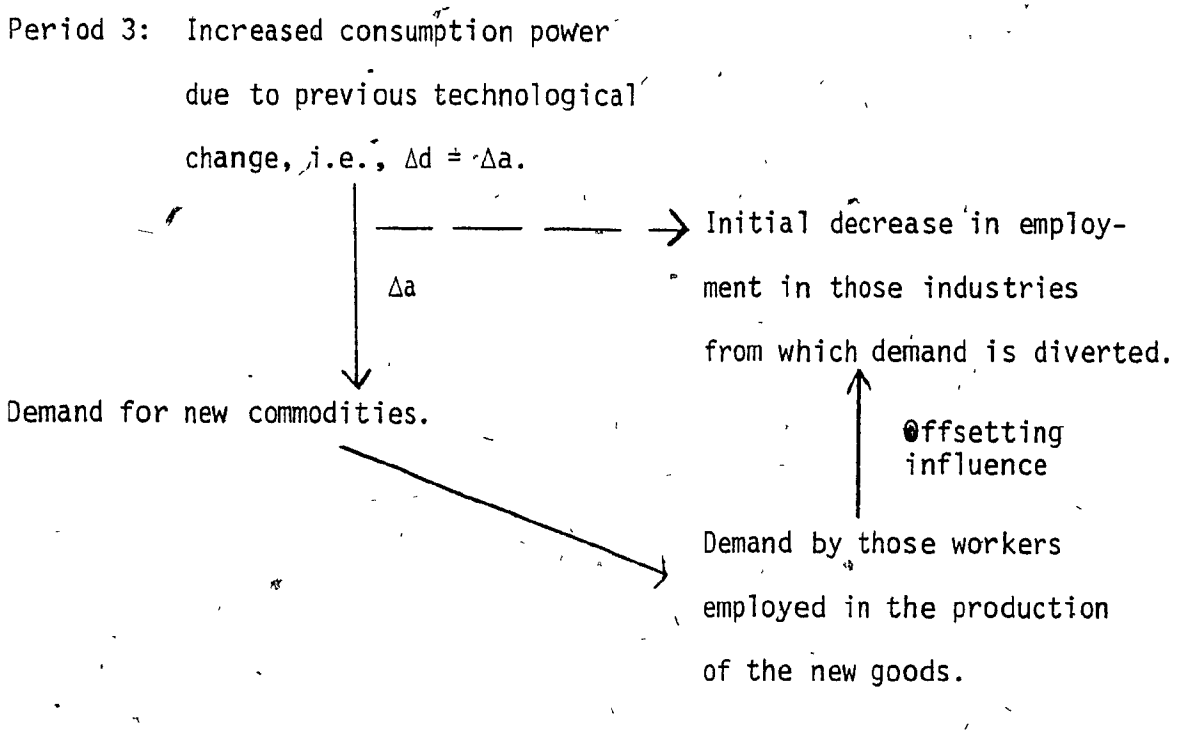
The important conclusion is that if a labour displacing technological change leads to an increased output or results in a constant one, the fact that effective demand keeps up with it does not assure an increase in employment. It only assures that those who have produced it are still employed. This is the inevitable result particularly in the case of consumption. If, on the other hand, a part of the output is diverted to surplus, it can, then, be used to equip additional workers.

Marx, however, admits that an increased output with fewer workers employed can be an indirect source of compensation through the effects of the reduced prices on the wage rate prevailing in the economy. This aspect will be analyzed in the next section on the wage flexibility. It does not belong in this section because it implies that the capitalists are able to recover some surplus from technological change. Then, the emphasis must be placed on the role of surplus arising from technological change and not on the case where all the benefits of technological change accrue to the consumers. We will, then, see that the positive employment effect of the increased output is not due to an increased purchasing power for the workers. The opposite is the case. If the cheaper wage goods make it possible to reduce the wage rate, the increased surplus will be a source of compensation by enabling accumulation.

Even though we have implicitly assumed the extreme case when the benefits of the technological change accrued totally to the consumers in lower prices, the results will not be different if the decrease in the price is not equal to the decrease in the average cost of output. The increase in surplus in the hands of the capitalist will not be a source of compensation if it is used for consumption of the goods that have been produced. Obviously, Marx does not see the major function of a capitalist

as a consumer but as one who accumulates.

Before we leave this section which dealt with consumption demand as a source of compensation, we wish to return to an issue that was raised earlier. Can a shift in the increased purchasing power towards new goods and services that are not on the market be a source of compensation? Paul Mandy, in Progrès Technique et Emploie, implies that this is a major source of compensation.[78] We will present this view through the following illustration. We must note that this illustration does not exist in Mandy. However, it captures the essence of his arguments. The lines indicate the flow of demand among the different branches of the economy.



This, it is alleged, is a case which could possibly be a source of full or partial compensation due to shifts in consumer demand in response to the introduction of the new goods. The consumers shift some of their purchasing power to the new goods. Employment in these firms increases. The temporary reduction in employment in those firms from which the workers bought the

older types of goods is offset by the spending of the workers employed in the production of the new types of goods. It is, then, possible that the shift in demand to new goods as a consequence of the prior increase in purchasing power caused by labour displacing technology can be a source of compensation. This is an argument which also incorporates the concept of diminishing marginal utility. The marginal utility of older goods will decrease and will induce the introduction of newer goods. P. Mandy uses this in arguing that technological change which is only limited to production processes is labour saving.[79] His argument is very much based on shifts in demand. In reference to Marx he states: "Since, according to Marx, the process of production is essentially a process of accumulation, his views were limited to progress in means of production."[80] He criticizes Marx for not having seen the flexibility of capitalism in conquering external markets as well as creating new needs. He adds: "If one limits the analysis of technical progress only to progress in the processes, in the manner of the Marxist conception, the phenomenon of technological under-employment would pose an insoluble problem."[81]

It should be noted that Mandy's criticism of Marx is directed towards the underconsumptionist view in Marx.[82] He misses completely the main line of argument in Marx which is based on the availability of capital even when Say's Law holds. Mandy does not base his analysis on wage-price flexibilities and factor substitution either, but he fails to explain where the required capital comes from for the introduction of new goods or for expansion into new markets. In fact, he does not even link this compensation mechanism to prior changes that may have displaced labour.

Marx's argument is based on the sources of supply of capital, more specifically, on the availability of capital. The demand shift argument

cannot be exaggerated. In fact, this argument encounters the same type of criticisms that we have posed against the argument which is formulated in terms of elasticities of demand. If demand shifts towards new goods, this implies that there must be a reduction in demand for the goods already produced. If the output of new commodities and the simultaneous employment of labour in its production increase, we cannot assume that this increase in employment will be a compensation for the technologically displaced workers. On the surface, it would appear that the workers employed in the production of the new commodities will be a form of compensation because they can use their incomes to purchase the existing goods from which demand has been diverted. Hence, not only the circuit is completed but also an expansion in employment takes place. Yet, this is not correct. This argument ignores the fundamental question: Where does the capital which is necessary for the production of the new goods come from? To isolate the effects of technological change in our short term analysis, we cannot allow an independent source of real capital which can be advanced to produce the new goods. If the capital that was used in the production of the goods from which demand has been diverted is now shifted to the production of the new goods, then a displacement in that sector or branch will occur. Hence, the production of the new goods will not be a source of compensation for the workers who were initially displaced by the machines but only a compsensation for the secondary displacement due to a shift in demand.

Yet, one can also argue that the increase in output due to technological change can be so great that a shift in demand may free a part of this output which can, in turn, be used as constant and variable capital in the production of the new goods. This, however, depends on the absolute amount of capital necessary for the production of the new goods. Moreover, how

much labour it will set into motion depends on the organic composition of the advanced capital. If, in fact, this shift is towards goods whose production exhibits a much lower q than the average q that prevailed in the economy earlier, some compensation is possible. It must, however, be noted that this consideration would also apply to those shifts in demand among the goods that already exist. Hence, the introduction of new goods is in itself not important when the main concern is the supply of capital rather than a concern about underconsumption. Obviously, if the increased purchasing power is shifted towards services that require little or no constant capital, for example, the Ricardian case of menial servants, then these servants would receive the incomes and spend them on goods that were previously consumed by those who are now consuming the services of the servants. Kruse, in his criticism of the traditional compensation mechanisms, also relates this case to Ricardo and presents an illustration similar to ours.[83] In this case, Say's Law in its limited sense would still hold. But an increase in employment would also occur. As we have indicated earlier, Marx does not see such unproductive employment as compensation. He can be criticized for it. Yet, regardless of this criticism, one must still consider the constant capital that may be necessary in the expansion of employment in producing these services. Moreover, these services do not add to material production directly. They would not facilitate any further absorption of labour in productive sectors for they produce neither means of production nor means of subsistence that can be advanced as commodity capital. Marx does not accept that unproductive labour may lead to material production or that it may, somehow, increase the material or commodity wealth in an indirect manner.[84] We have already referred to unproductive labour. It is beyond our task to analyze the significance of this concept any further.

Returning to Mandy, what is implicit in his argument is that sufficient capital exists to start the new fields of production. Hence, the problem is not one of capital shortage, but of effective demand. Capital exists in abundance. In our analysis, if and only if such capital can be shown to be the consequence of a prior labour displacing technological change, then the labour absorption in the production of new goods can be considered as a legitimate source of compensation. Otherwise, it is but an independent source of what we will later call "general compensation" due to accumulation in general, not specifically linked to technological change of the Marxian type. In short, such compensation through the introduction of new goods or services is relevant only if the organic composition of advanced capital in their production is low enough so that the freed consumption power can finance their introduction. If their introduction requires additional capital not arising from the previous labour displacing technological change, the labour absorption resulting from this independent source of capital cannot be considered as compensation in its narrow sense.

The theoretical issues related to the failure of Say's Law are ignored in the rest of this chapter and the following one. In the chapter on crises, we will return to some of these issues in the Marxian context. Meanwhile, we will continue to assume that the output creates the demand for itself. The clear implication in Marx is that technological unemployment can, at one level, be separated distinctly from the arguments based on the inadequacy of demand for the existing goods or for the potential output given the capacity of production. In the last chapter of this study, a possible reconciliation of the two types of unemployment will be presented.

Wage Flexibility and Compensation

Neither McCulloch nor Ricardo studied the effects of wage flexibility as a source of compensation. Neisser states that the classical analysis deprived itself of one of the important mechanisms.[85] Wage flexibility and the effects of unemployment on the wage rate as a compensation are a part of the neo-classical apparatus. This compensatory mechanism will be developed in the appendix to this chapter since it does not exist in that particular form in Marx. It should presently suffice to note that wage flexibility in the neo-classical model performs an adaptive function. The change in the wage rate, i.e., a decrease in the wage rate relative to the price of capital upon the displacement of labour leads to a reversal in the techniques of production towards a more labour intensive one and, hence, to full compensation. The implicit assumptions behind this adaptive function of wage flexibility and the theoretical difficulties with the analysis do not presently concern us. Marx also sees a partial adaptive function in wage flexibility. It can slow down the rate at which labour saving technological change is introduced.[86] However, this function is significantly different from the one in the neo-classical model. In Marx, wage flexibility does not lead to a reversal in the techniques in use. Hence, not a compensation but a slowdown in the rate of displacement takes place. The displaced workers are not compensated for in this version. Further displacement is postponed temporarily. Thus, wage flexibility in Marx does not serve as a compensation by leading to a reversal in the factor choices in favour of current labour. The impact of wage flexibility and the role of relative factor prices in Marx will be further developed in the appendix to the next chapter.

Some compensation due to wage flexibility can occur in Marx even without a reversal in the techniques of production. Expansion in employment

can take place on the basis of the higher organic composition of capital if labour displacement depresses the wage rate and contributes to the surplus arising from technological change itself. The industrial reserve army is replenished through technological unemployment and serves as a check on the "pretensions" of those employed.[87]

Before we proceed with the rest of this analysis, we should clarify an important point. Our intention in this section is not to develop the theory of wage determination in Marx. The weaknesses and strengths of this have already been discussed and are still being debated by many economists both in the Marxian and non-Marxian traditions. Even though there are explicit statements in Marx which give weight to the criticism that the wage rate in Marx derives from his theory of value, i.e., the real wage is equal to the cost of production of labour itself, there are other statements to indicate that the wage rate is also influenced by the industrial reserve army. The meaning of "cost of production" becomes unclear with respect to labour when the subsistence wage rate can fluctuate due to historical and social conditions as well as due to fluctuations in the IRA.[88]

Rather than trying to locate a consistent theory of wage determination in Marx, we will be applying the Marxian analysis to alternative cases. Since our task is not to study the welfare aspects of technological change with respect to the effects on income distribution per se but to identify the employment effects of technological change, we will not be concerned about the more refined arguments in this area.

Let us assume that the real wage rate in period 0 is not at an irreducible level. This is realistic because Marx does not have a theory of Iron Law of Wages like Lasalle's.[89] The increased IRA due to

technological displacement of labour may, then, reduce the wage rate in period 3 below its previous level through the competition of workers for fewer jobs.

We need to explain what we mean by the previous period. If technological change is introduced more or less simultaneously in most firms and the reduction in costs is reflected immediately in lower prices, the real wages of the workers still employed will have increased above their level that prevailed before the introduction of the new machines by the total amount of the increase in labour productivity. As we have indicated, this is an unrealistic case. However, it can be used as a theoretical apparatus to illustrate how the increased IRA may indirectly enable the capitalists to acquire all of the increase in productivity of labour due to technological change or even an amount in excess of it. If the increase in the IRA is substantial and the real wage rate is reduced to the level that existed prior to the introduction of new technology, the capitalists will have recovered all the benefits of technological change. If the wage rate is pushed even below the previous level, then they will have acquired an additional amount. In other words, technological change will have created not only unemployment but it will also have made those workers still employed worse off in real terms. Obviously, the latter result depends on the magnitude of technological unemployment relative to the size of the employed population. In Marx, there is little evidence that the workers employed will be worse off than before. In fact, as we have seen, he often points out that they may enjoy a higher standard of living than before. In that case, we can say that the increased IRA enables the capitalists to recover a part of the increase in the productivity of labour or all of it even though the capitalists cannot initially avoid the decrease of the price to the lower average cost caused by technological

change. In this case, we assumed that the level of total output did not increase due to technological change. If, on the other hand, output expanded simultaneously with a reduction in the level of aggregate employment upon the adoption of the new machines, the compensatory effect of wage flexibility is more favourable.

Assuming that the increased output is in terms of wage goods, cheaper goods will enable the capitalists to offer lower money wages to the workers still employed. The money wage can sink below the level that prevailed before the introduction of the machines even though the real wage rate, due to lower prices, may be above that level. In this case, the real surplus captured by the capitalists may still be above the level when the output was constant. The relative share of capitalists in s + v, i.e., net output, will have increased even though the employed workers enjoy a higher living standard. Then, the capitalists could advance a part of this surplus or all of it to employ additional workers. Marx indicates the compensation through wage flexibility in the following manner:

> If wages fall in consequence of a depreciation in the value of labour power (which may even be attended by a rise in the real price of labour), a portion of the capital hitherto invested in wages is released.... [This released variable capital can now be used] to exploit more workers.[91]

If the real wage rate were to sink to the level that prevailed before the introduction of the new machines or it did not rise in the first place, the compensation for employment will be even higher since all of the increase in output will accrue to the capitalists who can advance it to employ more workers. Once again, the magnitude of such absorption will depend on the magnitude of total capital necessary and on its organic composition. The former is important when the constant capital to be advanced is indivisible, i.e., a minimum scale of production is necessary.[92]

We can summarize this part of the analysis by pointing out that wage flexibility can be a source of compensation in Marx either by reducing the real wage rate below the level that prevailed before the introduction of the machines or by increasing the rate of exploitation, $\frac{s}{v}$, in relative terms when both s and v increase. In the latter case, s increases faster than v because of the larger output that enables the capitalists to allocate a smaller share of it to the workers. Clearly, the possibility of absorbing the displaced workers arises when the output increases and when this increase in output is not consumed immediately but advanced to employ other workers. Marx is not very clear on this aspect. The most likely interpretation is that the surplus generated will not be sufficient to employ the displaced workers. In other words, the surplus arising from the technological change will not be sufficient to employ the workers on the basis of the higher composition of advanced capital. Such a relative shortage of real capital is implied by Marx when he says that "not enough means of production are produced to permit the employment of the entire able-bodied population, under the most productive conditions."[93]

It should be pointed out that Marx's approach on this question is on a solid theoretical foundation. When output with fewer workers increases, no automatic compensation exists if the increase is used for immediate consumption. If it becomes a part of the surplus to be advanced as v and C, considerations such as the increased q still exist: Hence, a relative capital shortage is still possible.

The role of increased output has been a source of confusion in modern literature. One good example is a work by Dieter Schwartz and Adolf Wagner on the effects of technological progress on labour in the region of Baden-Württemberg.[94] They conclude that when output is constant and

capital per worker increases, there will be a displacement of labour but not when output increases. They state: "The labour displacement effect of labour saving technical progress will then be compensated through economic growth."[95] They do not specify where the capital comes from to increase the output. Neither do they specify how this increased output can be a source of compensation.

Even though we have presently abstracted from the effects of changes in the income distribution on aggregate demand and employment, a note should be added in anticipation of the chapter on crisis and technological unemployment. There, it will be seen that Marx also sees the reduction in the wage rate as a source of further unemployment. This is clearly linked to the underconsumptionist view which can be traced in Marx. A contradiction appears. On the one hand, wage flexibility, by increasing the surplus, can be a source of compensation. On the other hand, it increases the level of unemployment inherent in the theory of the underconsumptionists. Without presently developing a full analysis, it should suffice to note that the apparent contradiction can be resolved. Marx's theory of technological unemployment can be developed independently of his underconsumptionist arguments. If the underconsumptionist argument is added, not even partial compensation may occur because the accumulation process will be halted periodically due to the impossibility of realizing the surplus. Marxian technological unemployment can be shown even when increased output is sold and surplus realized. It does not require cycles. In this case, technological unemployment can be a permanent feature of Marx's accumulation process which, according to Schumpeter, is "prosperityless" and "depressionless."[96] In this form, technological unemployment is fundamentally due to the increasing organic composition of the advanced capital. It is on this ground that Marx's approach should be evaluated

or judged. However, one can see the complicated nature of Marx's analysis. The capitalist system increases the productivity of labour by leaps and bounds, but it does not increase the surplus sufficiently to equip all of the available labour supply with the means of production since q also increases. On the other hand, it also increases output in excess of the purchasing power of the workers. Thus, relative scarcity of capital and over-production of output are observed simultaneously. If the system overcomes the problem of underconsumption, it still faces the problem of relative capital shortage. Full capacity utilization does not eliminate technological unemployment. Underconsumption can accentuate the seriousness of unemployment.

Finally, the analysis of the wage rate as a compensation mechanism leads to a source of confusion which is inherent in Marx's concept of the organic composition of capital. This was already indicated in Chapter II. However, it requires further elaboration in the present context.

Once wage flexibility is allowed, the organic composition of capital becomes an ambiguous concept. If the v decreases due to a reduced wage rate, q will increase. However, this is a relative increase in q. It does not mean than this further decrease has come about due to an additional reduction in employment. The number of workers employed remains constant while v decreases. Obviously, such a relative increase in q as opposed to an absolute increase, due to an increase in C at the expense of v, is favourable to further employment creation. Thus, an initial absolute increase in q caused by the adoption of the new machines at the expense of v can lead later to a countertendency through the effects of a reduced wage rate.[97] This countertendency is shown by a further increase in q, but this is a relative one. This explanation indicates that countertendencies to

the rise in q in Marx should be understood in the context of this distinction between absolute and relative increases in q. The relative increases are also countertendencies which may have compensatory employment effects. In this sense, a technological change which initially uses more constant capital by displacing some workers can, through the market mechanisms, further free v without simultaneously freeing workers, and, thus, enable the capitalists to reabsorb some of the displaced workers. A constant capital using and labour displacing change can ultimately lead to a partial compensation through wage flexibility. It again should be noted that, in Marx, this has nothing to do with factor substitution or reversal in techniques. The additional workers still have to be equipped with similar machinery and equipment. The technical composition of advanced capital does not change.

Moreover, the decrease in the wage rate can also affect C. The construction of the new machines will cost less given the lower wage rates. Not only v but also C may decrease even though the technical composition may remain constant. Wage flexibility will augment the surplus through the savings in the constant capital as well. Marx indicates other forms of market forces that save constant capital.[98] However, the clear message is that they will not be sufficient to bring about full compensation. They do not stop C from growing at the expense of v.[99] The value of the individual components of C may decrease, but the total C in relation to v still increases.[100] This is clearly related to Marx's view of new machines as a system of machines or tools which are technically linked to each other. The individual components cannot be used separately.

In summary, Marx sees wage flexibility as a compensation mechanism through its effects on the surplus and subsequent accumulation. However,

he perceives it to be inadequate given the increase in q. This contention cannot be proven in a theoretical framework. It depends very much on the rate of increase in q, the rate of increase in productivity and output, and its distribution among the classes. However, neither can it be claimed that Marx's argument is impossible. Little compensation may occur if technological change of the Marxian type does not substantially increase the output and the share of capitalists so that the increase in surplus will be sufficient as to employ the displaced workers on the basis of a higher q. This result will even be more likely if reversal in techniques is not occurring. In a dynamic economy where technological change is continuous and where the system does not have sufficient time to adjust to the disruptions of any single change, such reversal may become more difficult.[101] When such factor substitution is ruled out, wage flexibility may not free sufficient funds to achieve full compensation. Moreover, for such a significant degree of wage flexibility to occur, the increase in the IRA due to displacement must be very large. The role of class struggle and workers' resistance to a reduction in wages must also be considered.

In the next section, we will assume a given wage rate and constant output in order to simplify our presentation. The foregoing analysis should be kept in mind to understand the implications of wage flexibility and increased output.

Surplus and Compensation

It will be recalled that technological change is introduced by the capitalists in order to increase their surplus. When the workers are displaced, "the immediate result of machinery is to augment surplus-value and the mass of products in which surplus-value is embodied."[102] Marx

sees this freed fund of the capitalists as the major source of any possible compensation. In this more realistic case, the increase in the productivity of the remaining workers is not immediately passed on to consumers in lower prices or to workers in higher real wages. Since most of the other capitalists have not yet adopted the new technology, the price of the product does not sink to its average social value.

Accumulation is the conversion of Δs to ΔC and Δv.[103] It must be recalled that this Δs is due to technological change proper and does not include surplus that is normally acquired by the capitalists independently of technological change. This distinction is essential to understand why, in the long term accumulation process to be analyzed in Chapter IV, accumulation increases the absolute level of employment. This is mainly because accumulation also involves surplus which would have existed even if no technological change occurred.

Marx, as indicated in Chapter I, is aware that the capitalists may increase their consumption out of the increase in surplus. However, "in order not to complicate the formula," he assumes that "the entire surplus-value is accumulated."[104]

Marx's arguments on the compensatory influence of Δs can be illustrated in the following way:

Δs_2: Change in surplus due to reduction in the aggregate advanced capital, i.e., $AAC_0 - AAC_2$, in period 2.

W: Given wage rate where $W_0 = W_2 = W_3$

The additional employment that can be created in period 3 through the conversion of Δs_2 to ΔC_3 and Δv_3 will be equal to $\frac{\frac{\Delta s_2}{1 + q_3}}{W}$.

q_3 will be assumed, for simplicity, to be equal to q_2 which characterizes the economy upon the adoption of the new machines.

We have already seen that Δs_2 is less than the wage bill corresponding to the net displacement of labour, because a part of the wage bill of the displaced workers has been converted to constant capital. Then, even if q_3 is zero, no full compensation is possible at the given wage rate when output is constant. The partial compensation is even more limited due to the fact that q has also increased.

In the Marxian analysis, the surplus may even lie idle if it is not large enough to equip the workers, i.e., it may not be sufficient to finance the required constant capital per worker.[105] However, in an aggregate analysis where borrowing is possible, such an assertion cannot be made. Even though Marx sees the role of borrowing and credit facilities in reallocating surpluses in the economy,[106] he does not integrate this aspect into his analysis of technological unemployment. He often argues that idle capital and idle workers may coexist because of the fixed coefficients in production. He may be correct at a micro level when some firms basically depend on their internal funds. A generalization over the whole economy cannot, however, be made.

Whether there is borrowing or not does not affect the Marxian results because even the borrowed surplus must be due to labour saving technological change elsewhere. If it is an independent source of surplus, it should not be considered as a compensation mechanism. There may be full compensation in the broad sense but not by the intermediary of the capital that was already advanced and which is now restructured in terms of a higher q.

Conclusions on Compensation

It is clear that in Marx full automatic compensation owing to the changes associated with technological change is very unlikely given that initial accumulation or independent sources of surplus to absorb the displaced are ruled out. In that case, the only possibilities of compensation are through wage flexibility and the increase in surplus. The former is a means to increase the latter. If there is no wage flexibility and the output is constant, the freed surplus cannot be sufficient to absorb the displaced workers. In the first place, it is less than the wages of the displaced workers. In the second place, constant capital is needed to accompany their absorption. If the output and surplus increase, a greater degree of compensation is possible. However, even then, compensation is possible if the benefits of increased output are largely directed to the capitalists who will readvance these funds as capital.

In the theoretical approach developed, independent sources of compensation or changes which are not directly or indirectly associated with technological change of the Marxian type cannot legitimately be a part of the compensation mechanism. The classical mechanisms of price flexibility and consumption demand have been shown to be an inadequate compensatory mechanism. The machine construction and the surplus arising from technological change are partial compensation mechanisms in the short term as we have defined.

The observations in this chapter can be combined in an extended formulation by utilizing our previous notations.

$$\Delta L = L_0 - L_2 - \Delta L_3$$

Where: $L_0 - L_2$ = Net displacement in the aggregate level of employment due to the adoption of the new machines where $L_0 > L_2$

ΔL_3 = Employment created by the conversion of the additional surplus into ΔC and Δv in period 3

ΔL now measures the total compensation effects of both direct and indirect mechanisms in the short term. If it is 0, full compensation will have taken place. In the formula above, employment due to accumulation out of Δs_2 appears to be the only form of compensation. This is because L_2 already includes the partial compensation due to the machine construction. The criticism against this has already been indicated on the basis of Beach's approach according to which $L_0 - L_2$ will usually be negative, i.e., the total level of employment increases, because the introduction of technological change requires accumulation.

This formula in terms of employment can be restated by using the concept of aggregate advanced capital:

$$\Delta L = \left(\frac{\frac{AAC_0}{1 + q_0}}{W} - \frac{\frac{AAC_2}{1 + q_2}}{W} \right) - \left(\frac{\frac{\Delta s_2}{1 + q_3}}{W} \right)$$

Where q_2 is equal to q_3 but greater than q_0. Given the wage rate, $AAC_0 - AAC_2 = \Delta s_2$.

This formulation captures the time element in the sequence of changes and it is, in this sense, a useful one to conceptualize the difficulties and our earlier assumptions to overcome them; for example, the assumption concerning the withdrawal of the independent surplus.

However, once we are aware of these difficulties and of the real processes behind the changes, the formulation can be further simplified. In this formulation, the implicit assumption is that the capitalists reduce

their advanced capital in period 2 to produce the same level of output. They realize Δs_2 which, in turn, is readvanced in period 3. Instead, we can assume that the capitalists advance the same amount as AAC_0 on the basis of higher q_2 in period 2.

Then:
$$\Delta L = \frac{\frac{AAC_0}{1 + q_0}}{W} - \frac{\frac{AAC_2}{1 + q_2}}{W}$$

Where $AAC_0 = AAC_2$.

This, in essence, captures the Marxian short term hypothesis according to which the existing capital is ultimately restructured through the conversion of v to C and that no net accumulation occurs in bringing about technological change. In this case, $L_0 - L_2$ yields the net displacement when the total capital is restructured on the basis of a higher q.

There is, however, a major difference between the two formulations. In the first one, the extra surplus is realized by reducing the required aggregate advanced capital for a certain level of output. Part of the output that previously accrued to workers as advanced v is now freed as surplus. In the second one, the same result is achieved but it occurs not through the initial decrease in AAC but through the increase in the total output given a constant but restructured AAC on the basis of a higher q. The difference can be stated in other terms; in the former case, the surplus is realized even before the firms adopting the new machines produce the output. They immediately reduce their advanced capital at the beginning of the production process in period 2. This means that a part of the output that was advanced in period 0 is not advanced as v. So realization occurs before the output at the end of period 2 comes on the market. Clearly, if the competitive pressures are not strong, an additional Δs will also be

captured at the end of period 2. If the other capitalists adopt the same techniques rapidly, this surplus at the end may not be realized. In the second formulation, the realization of the extra surplus comes at the end of the production period 2 through the increase in output given a constant AAC with a higher q. It would appear that the latter is a riskier way to realize the surplus directly arising from technological change for it will occur in the future. It can be eliminated by the competitive pressures that may reduce the price and divert the benefits of technological change to the consumers.

It is clear that in both cases the output will ultimately increase. In the first case, once the immediately realized Δs is readvanced, the output will increase. In the second case, since the same capital is advanced without any temporary decrease, the output will increase. If, in the first case, the readvanced capital from Δs leads to permanent increases in s, net accumulation will result. In the second case, if the capitalists can expropriate that part of the increased output, net accumulation will take place. AAC will grow. Our formulations do not capture these possible sources of increase in AAC through the accumulation that may arise from the immediate effects of technological change.

The clear implication is that if the capitalists can hold on to their extra surplus originating from the particular technological change over several production periods, then net accumulation will occur and the likelihood of full compensation arises. Marx is not attentive to this. His implicit assumption is that the competitive forces will eliminate the initial advantage. If Δs is realized either in the first case by initially reducing AAC or in the second case by capturing the total increase in output, and if it is readvanced as additional capital, the increases in

surplus can be cumulative. This can be illustrated in the following manner: Δs_i arising from technological change $\longrightarrow (\Delta C_{ii} + \Delta v_{ii}) \longrightarrow \Delta s_{ii} \longrightarrow (\Delta C_{iii} + \Delta v_{iii})$, etc. In this way, C and v will be increasing cumulatively. Marx sees net accumulation but does not seem to link it to technological change whose benefits, according to him, are temporary for the capitalist class.

The implication of the foregoing analysis is important. It appears that if the prices are sticky and the surplus can be maintained over many production periods, the process of accumulation can be a source of compensation. Consequently, it is not only the size of the immediate surplus arising from technological change but also its duration that must be considered. The longer such surplus can be maintained, the higher will be the possibility of compensation. These points are also emphasized by Kruse.[107] Obviously, then, problems associated with demand and investment opportunities arise. These questions are not within the scope of this chapter which is based on the assumption that there are no realization problems and that investment opportunities are unlimited.

Finally, we should point out that our specific formulations at the end of the chapter bear significant similarity to those developed by Gottheil[108] and Mitnitzky.[109] The main difference lies in the analysis of the logic underlying these formulations. Gottheil undertakes a discussion of the technological unemployment question in Marx without dealing with the compensation controversy. The theoretical apparatus underlying Marx's analysis of this question is not made clear. It is possible that our presentation may have gone beyond Marx in our specification of the meaning of compensation in a manner which cannot be defended exclusively on the basis of references to Marx. Yet, we believe that our interpretation is consistent with Marx's hypothesis and his conclusions. It also clarifies

the limitations of Marx's view of technological change.

Mitnitzky, a German economist from the early part of the twentieth century, arrives at formulations which are much closer to ours. He also undertakes a general critique of the compensation arguments. Even though his work is clearly in the Marxist tradition, he makes few specific references to Marx. He does not deal with the historical aspects of Marx's argument with respect to the classical economists. Neither does he indicate the limitations of Marx's argument. The integration of technological unemployment in Marx to crises and the relationship of the crises to Marx's long term technological unemployment are absent in the works of both authors.

However, our evaluations with respect to consumption demand as a source of compensation also exist in Mitnitzky. He states:

> The consumer can, through price decreases, increase his real income, but he cannot purchase more than what has been produced. His demand can never lead to an increase in employment. The consumption demand is not a source of compensation.... The only source of compensation that remains is capital accumulation.[110]

He, like Kruse, sees monopolistic profits when the price decrease does not occur as a source of compensation.[111] However, he does not present Marx's views on these issues. Neither does he undertake a rigorous analysis to specify the assumptions and the limitations of his own arguments.

APPENDIX

NEO-CLASSICAL VIEWS ON COMPENSATION AND MARX

In this section, we will outline briefly the neo-classical views on compensation. Given the scope of our study, the following is cursory, and it is intended only to show that the modern approach is essentially an extension of the classical arguments and to indicate the main differences between the Marxian and neo-classical approaches.

Instead of reviewing all the literature in this area or analyzing the appropriateness of the neo-classical tools for the question of technological unemployment, we will rely on the specific arguments of Mentor Bouniatian[1] and Nicholas Kaldor.[2] Kaldor is, in general, not considered a neo-classical economist. However, his views on the question of technological unemployment are very much in that tradition. The arguments by these authors have an important historical significance because these economists challenged the pessimistic views that began to reappear in the early part of the twentieth century. E. Lederer wrote a book emphasizing the possibility of technological unemployment.[3] He also challenged the compensation theories. Although we will be referring to him often, it is not our objective to review his arguments in detail. Moreover, his arguments are not in the Marxist tradition. We will only underline the major elements of his analysis and emphasize the criticisms of Bouniatian and Kaldor against him.

In 1933, Bouniatian challenged the ideas of Lederer. In return, Lederer restated his case in the same year in response to Bouniatian.[4]

Lederer sees 3 types of technological change that can benefit the producer but that may have very different employment effects.[5]

(i) Technical improvements to reduce the cost of producing a given level of output by reducing the amount of labour employed.

(ii) Replacement of one product by another.

(iii) Introduction of entirely new products not competitive with the old ones.

His conclusion is that (i) and (ii) can cause displacement of labour whereas (iii) will lead to growth and more employment. He then goes on to criticize Bouniatian's criticisms. To state the latter's criticisms, we will refer to his own article. He basically argues that savings to consumers, in addition to the profits arising from technological change, will be sufficient to reabsorb the displaced workers. In effect, he suggests the formulation that we have used earlier to depict Marx's two freed funds and the alleged full compensation through them in McCulloch's article.[6] His argument is based on the notion of the indestructibility of purchasing power.

His alternative mechanism is through the "change in the composition of the existing capital."[7] In other words, the possible displacement and the subsequent changes in the relative prices of capital and labour lead to a reversal in techniques that now become more labour intensive and assure full employment equilibrium which may have been disturbed initially by the introduction of new technology. He states: "In this way a constant volume of capital can provide employment for an increasing number of workers."[8] In short, Bouniatian lists all the previous compensation mechanisms and also adds the neo-classical factor substitution to ensure

reversal in techniques of production. Capital can be instantaneously shifted from wages to fixed capital and vice versa. There is the use of a long run equilibrium analysis to deal with what is essentially a short run problem. Ex-post substitution is unlimited. He also assumes that the savings of the consumers will be channelled to new products and create demand and increase in employment. This should be evaluated in the light of our previous critique within the context of the Marxian assumptions and theoretical approach to compensation. Lederer accepts this form of compensation but does not see it as an automatic consequence of the types of technological change that may displace labour.[9] He argues that there are limitations caused by insufficient elasticity of demand, flexibility of prices, etc.[10] The origin of the necessary capital for the introduction of the new goods is not discussed by Lederer.

The two authors also discuss the relationship of technological change to crises. Lederer sees the labour displacing technological change as a factor in intensifying the crises.[11] Bouniatian does not see a direct connection between the two.[12] This aspect is beyond our objectives in this section. In the chapter on crises, we will be referring to Lederer in conjunction with Marx's remarks.

A more extensive criticism of Lederer was advanced by Kaldor. He points out that in Lederer, technological change reduces the national dividend. Capital is withdrawn from the other industries, and their output decreases. On the other hand, output in the innovating firms remains constant. He argues, however, that technological change almost always leads to an increase in output. It may stay constant in the innovating firms only if:[13]

(i) Invention is known only to one firm.

(ii) The firm, moreover, is a monopoly.

(iii) The elasticity of demand is less than 1.

He comes to the conclusion that if output increases, no displacement should occur. He also integrates wage flexibility into his argument. If unemployment appears, it will be due to the rigidity of the wages. In the long run, the elasticity of demand for labour cannot be zero even though in the short run, some firms may experience fixed coefficients. However, even in the short run, the rigidity of coefficients is not applicable to all the firms, and elasticity of demand for labour will still be greater than zero given some wage flexibility.[14] "... A fall in wages will stimulate industries using relatively more labour and discourage industries employing relatively less labour, and this process will continue until the available labour is reabsorbed."[15] In essence, he links the temporary unemployment to the divergence of the wage rate from the equilibrium level.[16] Moreover, he, at one point, uses the means of net accumulation to absorb the displaced labour.[17]

Given our evaluation in this chapter, the differences between Marx's approach and the neo-classical approach are clear. What lies behind the latter approach is ultimately the readjustment process in the production techniques due to the flexibility of the wage rate. We have already shown that the Marxian process does not incorporate this reversal in techniques. In his case, wage flexibility, even if it were to occur, would only serve to increase the surplus. Once reversal in techniques is ruled out in the short term, it is not guaranteed that the surplus can be sufficient to employ the displaced workers on the basis of a higher q. If a long run mechanism of the neo-classical type is substituted, the implicit assumption is that no further technological change will occur in between. Otherwise,

relative price structures will be changed continuously. More on this in the appendix to Chapter IV when we specifically analyze the influence of wage flexibility on the choice of technology in Marx.

It must also be noted that A. Hansen, in an article published in 1932, accepted much of the criticism against the compensation theories.[18] As we have cited earlier, he criticized, in particular, the compensation argument based on the purchasing power. Nevertheless, he ultimately relied on wage flexibility and additional investment. But his conclusions were much less optimistic. He did not see significant wage flexibility in an economy that did not experience cycles. The cycles would depress the wage rate and allow the adjustments in the production techniques so as to eliminate technological unemployment in the long run. "With the business cycles ironed out, it can scarcely be doubted that the price and wage structures would become more rigid. The capacity to absorb labour displaced by technological innovations would therefore be reduced."[19] Hansen's doubts were criticized by Haberler who relied on the monetary adjustments. His argument is that, since the money supply and velocity are constant, the reduced price level will free an additional purchasing power by freeing money.[20] How this freed money becomes real capital is not explained by Haberler. Neither does Hansen indicate this real aspect in his response to Haberler.[21]

Even though Hansen makes no reference to Marx, the implications of his cycle-free process can, in effect, be applied to our analysis of Marx's long term model when we will abstract from cycles and ignore wage flexibility.

Hansen sees labour displacing technological change arising basically

from changes in the relative prices of labour and capital. The unions may push W up. Lower interest rates may lead to capital intensive techniques.[22] But as the marginal productivity of capital decreases, substitution ceases. Given wage flexibility, a reversal in techniques occurs.[23]

This view of seeing the labour displacement due to prior changes in the relative prices is essentially an analysis of movements along a given isoquant.[24] We will see that Marx's technological change cannot be interpreted in this sense, i.e., when the capitalist makes a choice among the already known techniques which are plentiful enough to enable changes in techniques back and forth. In Marx, the clear implication is that technological change makes the previous techniques obsolete forever, and that there are no reversals to earlier techniques with lower q's. One gets a strong impression from Marx's writings that technological change is, on the whole, exogenous to factor prices. We will return to this in the appendix to Chapter IV. Moreover, the marginal productivity argument has nothing in common with Marx's falling rate of profit since, in Marx, the machines introduced are not of the same type. The former applies to the additions in capital stock by increasing the quantity of the same types of equipment. It implies that there is no qualitative change in capital goods.

A final observation is that there is agreement, as evidenced by our brief review, between the neo-classical approach and the Marxian one; the immediate effect of machine construction and its adoption is generally one of net displacement. The former depends on wage flexibility and factor substitution in the long run to resolve the problem. Marx, on the other hand, does not emphasize this aspect. Beach's hypothesis, as we have

already seen, differs from both. It does not depend on factor substitution in the long run though it does not rule it out either. His argument is that the Marxian analysis cannot be countered on this basis. As we have already seen, in Beach's case, it is the necessary amount of investment in introducing the new technology that resolves the problem. Technological change usually requires net investment because of all the associated costs, including investment in education. Hence, the total level of employment increases even though labour input per unit of output may decrease. Thus, non-reversing technological change is compatible with increases in employment. This hypothesis is a critique of both the neo-classical approach that relies on reversing changes and the Marxian approach from a perspective that is neither neo-classical nor Marxian. As we have done earlier in this study, we will continue to refer to this critique because it can be posed in the Marxian context without using the neo-classical apparatus that is alien to Marx.

NOTES TO CHAPTER III

1. Kruse, Technischer Fortschritt und Arbeitslosigkeit.

2. Gourvitch, Economic Theory on Technological Change.

3. Kähler, Die Theorie der Arbeiterfreisetzung durch die Maschine.

4. Neisser, "'Permanent' Unemployment."

5. Kruse, p.13.

6. Bouniatian, p.343.

7. Kruse,pp.10-11.

8. Heertje, Technical Change, p.36.

9. Marx, Theories of Surplus-Value I (Moscow: Progress Publishers, 1969), 228. (hereafter cited as Marx, TSV I.)

10. Marx, Capital I, 415.

11. Ibid., p.412. Also see TSV I, 217.

12. Belfer, p.15.

13. Marx, Capital I, 415.

14. Ibid., p.600.

15. This weakness is also shared by some modern economists who point out historical improvements in real income as if such an observation is sufficient to prove that there should be no concern about the technological unemployment question.

16. Marx, TSV III, 432; TSV I, 152, 157.

17. Marx, TSV I, 174, 176-7, 217; TSV II, 571, 579. For Ricardo's argument, see Ricardo, p.384.

18. For a discussion of the distinction see P. A. Baran, The Political Economy of Growth (New York: Monthly Review, 1957), pp. 24-43; J. Morris, "Unemployment and Unproductive Employment", Science and Society 22 (1958), 193-6. H. B. Davis argues that the distinction should be dropped. "The Unproductive Notion of 'Productive' Labour", Science and Society 25 (1961), 20-5.

19. Braverman,pp.114-5.

20. Marx indicates that even in agriculture this ratio will increase and that agriculture cannot be a permanent source of compensation. TSV III, 558.

21. Marx. Capital I, 412.

22. Schumpeter, History, p.683.

23. Ibid.

24. Ricardo, pp.386-7.

25. Marx, TSV II, 577.

26. Ricardo, p.388.

27. Schumpeter, Capitalism, Socialism, p.37.

28. See C. Gide and C. Rist, A History of Economic Doctrines, 2nd ed. (Boston: D.C. Heath, 1948), p.195. Also see Mandy, p.71; Heertje, Technical Change, pp.19, 25; B. J. Gordon, "Say's Law Effective Demand, and the Contemporary British Periodicals 1820-1850", Economica XXII (Nov. 1965), 445.

29. M. Blaug, Economic Theory in Retrospect, 3rd ed. (London: Cambridge University Press, 1978), p.180.

30. For Marx's criticisms of Malthus, see TSV III, 40-68. Marx is clearly aware of Malthus' error on the machinery question, but does not develop it. Ibid., pp.59-68. In his criticisms, he also shows how Malthus adopted Sismondi's ideas.

31. McCulloch, p.104.

32. Ibid., p.111.

33. Ibid., p.106.

34. Ibid., p.112. For a brief summary of McCulloch's compensation mechanism, see Blaug, Economic Theory, p.197.

35. McCulloch, p.112.

36. Ibid., pp.112-3.

37. Löwe, p. 234.

38. Douglas, pp.925-38.

39. A. S. Skinner, "Say's Law: Origins and Content", Economica 34 (May 1967).

40. Marx, TSV III, 119-120.

41. Marx, TSV II, 564.

42. McCulloch, pp.114-115.

43. See Löwe, p.234; Blaug, Economic Theory, pp.196-7. Marx criticizes Mill for failing to see the role of the constant capital. He cites the following quotation from Mill: "The capital itself in the long run becomes entirely wages, and when replaced by the sale of produce becomes wages again." Capital I, 553-4.

44. Neisser, "'Permanent' Unemployment", p.62.

45. McCulloch, p.116.

46. Ibid., p.121.

47. Ibid., p.114.

48. Blaug, Economic Theory, p.197.

49. Gourvitch says: "All theoretical notions of a tendency toward automatic reabsorption of displaced workers may be traced back to Say's Law of Markets which proclaims the possibility of an indefinite expansion of production without assignable limits." p.47.

50. McCulloch, p.115.

51. Marx, TSV II, 558.

52. He says "...[W]ith the accumulation of capital a change takes place in its organic composition and the constant part of the capital grows at a faster rate than the variable." Ibid., p.562.

53. Kruse, pp.13-4.

54. Marx. Capital I, 420.

55. Marx, Capital II, 123.

56. Salter, p.66. Also see p.73.

57. Marx, TSV I, 217.

58. T. E. Gregory, "Rationalisation and Technological Unemployment", EJ 40 (Dec. 1930), 552-67.

59. Heertje, Technical Change, p.28.

60. Douglas, p.929.

61. Marx's arguments on this are not very clear. However, his critique of Ricardo in TSV II, 562-4, justifies our interpretation.

62. Marx uses both increased and constant output to attack the compensation theory. Ibid.,pp.561-73.

63. Ibid.,pp.553, 554, 557-8.

64. In reference to the capitalist who has installed new machines, he says: "...[H]is discharged workers have ceased to consume, and therefore to buy his own articles, though they did before." Ibid., p.562.

65. Ibid.,pp.563-4.

66. Ibid., p.562.

67. Ibid., p.563.

68. Löwe, p.234.

69. Kruse,pp.17-8.

70. Ibid.,pp.21-2.

71. B. Shoul, "Karl Marx and Say's Law", in J. J. Spengler and W. R. Allen, eds., Essays in Economic Thought: Aristotle to Marshall (Chicago: Rand McNally, 1960),pp.454-67.

72. Marx, TSV II, chap. XVIII.

73. Hansen, "Theory of Technological Progress", p.73.

74. Marx, TSV II, 548.

75. Ibid., p.559. He says: "Incidentally, while one section of the workers starves, another section may be better fed and clothed, as may also the unproductive workers and the middle strata between worker and capitalist." Ibid., p.561.

76. Ibid., p.559.

77. Ibid.,pp.559-60.

78. Mandy,pp.141-5.

79. Ibid.,pp.78-86.

80. Ibid., p.129.

81. Ibid., p.190.

82. He says: "Dès lors, l'impossibilité de dépenser les revenues en biens de consommation, sur laquelle Marx insiste, cesse de dominer le processus économique, dès que des biens nouveaux de consommation font leur apparition." Ibid., p.129

83. Kruse, p.23.

84. Marx, TSV I, 176, 410.

85. Neisser points out that the wage flexibility mechanism is the "offspring of modern equilibrium theory" and that it "has a greater theoretical validity" than the "Law of Markets School." This school tried to show that "the wage level would not be affected." "'Permanent' Unemployment", p.62.

86. Marx, TSV II, 574-5, 583; Capital I, 371.

87. Marx, Capital I, 598.

88. R. L. Meek, Studies in the Labor Theory of Value, 2nd ed. (New York: Monthly Review, 1975), p.185.

89. See Schefold, p.814; Meek, p.186.

90. Marx, Capital III, 114.

91. Ibid., p.115.

92. Ibid., p.250.

93. Ibid., p.258.

94. D. Schwartz and A. Wagner, Technischer Fortschritt und Arbeitsmarkt in Baden-Württemberg (Tübingen: J.C.B. Mohr [Paul Siebeck], 1970).

95. Ibid., p.11. Also see Clague and Greenberg, p.118. They argue that as long as the growth in GNP is equal to the sum of the growth rates in the productivity and the labour force, there can be no problem of unemployment.

96. Schumpeter, Capitalism, Socialism, p.40.

97. Marx, Capital III, 235.

98. Ibid., pp.80-82.

99. Marx says: "The cheapening of raw materials, and of auxiliary materials, etc., checks but does not cancel the growth in the value of this part of capital." TSV III, 369.

100. Marx, Grundrisse, p.766.

101. Kalecki points out that continuous technological change rules out any equilibrium analysis. "A Theorem on Technical Progress", RES VIII (1941), 178.

102. Marx, Capital I, 419.

103. Ibid., p.543.

104. Marx, Capital II, 81.

105. This is related to Marx's contention that some capital may lie idle as "latent capital" which can be used only "when it swells to a certain volume." Ibid., p.325.

106. He says: "With the development of the credit-system, which necessarily runs parallel with the development of modern industry and capitalist production, this money no longer serves as a hoard but as capital; however not in the hands of its owner but of other capitalists at whose disposal it has been placed." Ibid., p.185. Also see pp. 239, 362.

107. Kruse, p.77.

108. F. M. Gottheil, Marx's Economic Predictions (Evanston: Northwestern University Press, 1966).

109. Mitnitzky, pp.74-83.

110. Ibid., p.110.

111. Ibid., p.88.

NOTES TO APPENDIX

1. Bouniatian, "Progress and Unemployment."

2. N. Kaldor, "A Case Against Technical Progress", Economica XII (May 1932).

3. Lederer, Technischer Fortschritt.

4. Lederer, "Technical Progress."

5. Ibid.,pp.4-5.

6. Bouniatian,pp.330-31.

7. Ibid., p.339.

8. Ibid.

9. Lederer, "Technical Progress", p.17.

10. Ibid.

11. Ibid.,pp.20-24.

12. Bouniatian,pp.346-7.

13. Kaldor, "Case Against", p.188.

14. Ibid.,pp.188-90.

15. Ibid., p.190.

16. Ibid., p.192.

17. Ibid.

18. Hansen, "Theory of Technological Progress."

19. Ibid., p.31.

20. G. Haberler, "Some Remarks on Professor Hansen's View of Technological Unemployment", QJE XLVI (May 1932), 559.

21. A. Hansen, "A Rejoiner", QJE XLVI (May 1932).

22. Ibid., p.28.

23. Ibid., p.29.

24. See E. F. Beach, "Technological Unemployment - A Failure in Theorizing", Relations Industrielles/Industrial Relations 31 (1976); Blaug, "Technical Change and Marxian Economics."

CHAPTER IV

ACCUMULATION, TECHNOLOGICAL CHANGE AND UNEMPLOYMENT IN MARX'S LONG TERM MODEL

1. Introduction

The theoretical boundaries of the compensation controversy were specified in the previous chapter. Technological change and unemployment were analyzed in a framework which excluded accumulation. Marx's criticism of the classical compensation theory belongs to this essentially static framework. Any compensation had to be sought, according to Marx, in the surplus generated by technological change. On the other hand, surplus that is normally extracted even in the absence of technological progress was ignored by Marx because it had no necessary connection with the technological change under consideration. This is why the employment effects of accumulation out of total surplus were not included in our analysis. We abstracted from accumulation and focused only on the direct and indirect employment effects of technological change. This interpretation is, as we have seen, explicit in Marx.

However, once long term accumulation is considered, it is not only the extra surplus but the total surplus that becomes the source of employment. Then, the narrow concept of compensation as defined in the last chapter can no longer be maintained. It should be pointed out that

Marx does not make such a distinction between narrow and broad concepts of compensation. Yet, as we will see, he clearly distinguishes the employment effects of technological change from the employment effects of accumulation in general. Compensation, in its narrow sense, is sought in the direct and indirect effects of the former in the absence of accumulation, whereas compensation in its broad sense or general compensation lies in accumulation. Whether such a distinction is theoretically valid will be a question that we will evaluate critically later in this chapter.

Technological change, according to Marx, creates net unemployment or a decrease in the absolute demand for labour in the absence of accumulation, but the latter increases the absolute demand for labour. Moreover, he argues that when both occur simultaneously the employment effects of accumulation will offset the effects of technological change. In this sense, there is general or broad compensation. On the surface, it would appear that there would be no technological unemployment in the long term. Marx, nevertheless, claims that unemployment will also occur in this case. There will be compensation in the aggregate sense for those who are displaced, and some of the new entrants into the labour force will also be absorbed, but accumulation will not be high enough, because of the effects of technological change, to absorb all the new entrants. This complex relationship will be developed in the present chapter.

It should be noted that such a prediction about long term technological unemployment does not have a counterpart in the classical thought. In Ricardo, the problem is a temporary one. Even though Marx makes use of the concept of the falling rate of profit, a concept which was central to classical analysis, he does not attribute it to the diminishing returns in agriculture. On the contrary, he links it to rapid technological change.

Our analysis will indicate the significance of this concept as it relates to technological unemployment. Whereas the classical economists argue that the capitalist system will arrive at a stationary state due to the falling rate of profit, Marx maintains that the system will break down by a revolution. Long term unemployment is not a part of the classical analysis. It becomes a permanent feature of the Marxian model and plays a part in this eventual revolution.

The system experiences increasing levels of unemployment even though the absolute level of employment also increases. This interpretation of increasing levels of unemployment in Marx is also shared by R. Eagly who states: "Thus, the capitalist economy moves from cycle to cycle, the level of unemployment increases from trough to trough (and peak to peak)."[1]

The classical long term analysis deemphasizes the role of technological change. It is, in fact, the lack of it which leads the system to a stationary state. Yet, full employment is maintained while the wage rate fluctuates around the subsistence level because of the Malthusian mechanism. Marx is very critical of this mechanism. He states:

> According to them [classical economists], wages rise in consequence of accumulation of capital. The higher wages stimulate the working population to more rapid multiplication, and this goes on until the labour-market becomes too full, and therefore capital, relatively to the supply of labour, becomes insufficient. Wages fall, and now we have the reverse of the medal. The working population is little by little decimated as the result of the fall in wages, so that capital is again in excess relatively to them, or as others explain it, falling wages and the corresponding increase in the exploitation of the labourer again accelerates accumulation, whilst, at the same time, the lower wages hold the increase of the working-class in check. Then comes again the time, when the supply of labour is less than the demand, wages rise, and so on.[2]

This lengthy quotation has been cited for two reasons: Firstly, it indicates

very clearly the view which Marx held about the Malthusian population mechanism, and secondly, it shows that the classical economists saw the excessive growth in population as a cause of temporary unemployment, i.e., the population grew much faster than accumulation. This disproportion was periodically checked through lower wages which reduced the rate of growth in population and restored full employment. The creation of a reserve army through technological change is not a part of this accumulation model.

In this chapter, we will see that Marx tries very hard to set up a model incorporating long term unemployment which is independent of the rate of growth in population. It will also be seen that his attempt to achieve this task is not very successful and depends on some dubious assumptions.

In Marx technological change seems to work both against the workers and the capitalists as noted by J. Robinson.[3] It creates an ever increasing industrial reserve army. A part of the population is condemned to idleness. It also works against the capitalist class by reducing the rate of profit in the long term. We believe that in Marx the negative effect of technological change on the working class is through unemployment rather than through the depressed real wages. The industrial reserve army checks the rate of growth in the real wages and may temporarily depress it, but there is no evidence in Marx's works that it continuously reduces it to a minimum subsistence level as Lasalle argued or as in the Malthusian mechanism. Even though there are certain passages in which he comes close to this view, one can hardly trace it as a consistent view integral to his analysis.[4]

His arguments on the impoverishment of the working class are ambiguous if this impoverishment is to be interpreted in terms of wages. Even though Marx does not believe that the introduction of new machines will benefit

the working class, his arguments concerning the absolute living standard of the employed workers are not very clear. We have already cited several specific examples where he sees the possibility of an increase in the real wage rate when productivity is increased. Obviously, one could also trace other references where he is defending the opposite case. One could, moreover, argue that he is indicating a relative impoverishment, i.e., a relative shift in wealth in favour of the rich accompanied by an absolute increase in the real wage rate of the workers still employed. In short, the analysis of the income distribution in Marx is ambiguous. On the other hand, when one focuses on technological unemployment, such ambiguity ceases. It is mainly those who find themselves in the IRA who are impoverished.

It is not our task to make a case for discarding the Marxian notions on income distribution. The foregoing comments indicate only an alternative interpretation based on technological unemployment. Not much emphasis has been placed on this by Marxist or non-Marxist economists. We will continue to emphasize this aspect and refer to the role of income distribution only insofar as it is directly relevant for our study.

Given the brief summary above, Marx's long term analysis of technological change and employment was novel for its time. It goes beyond Ricardo who saw the problem as a temporary inconvenience. It becomes a long term problem. Marx states: "...[S]ince machinery is continually seizing upon new fields of production, its temporary effect is really permanent."[5] The individuals in the reserve army may not be the same people for extended periods. H. Jerome points out that such unemployment "may be a pool made up of ever changing individuals but even at that it represents in a sense a more or less permanent addition to the volume of unemployment."[6]

Marx's long term analysis abstracts from the periodic capitalist crises arising from the difficulties of realization. As we have seen, Say's Law in its narrow sense holds, i.e., all output is sold at its value. Unemployment is not due to the inability to sell the output and, hence, to recover the advanced capital in addition to a normal rate of profit. On the contrary, given full capacity utilization, it is due to the decreasing labour absorptive capacity of an ever increasing capital stock in the accumulation process. This decrease in the absorptive capacity, as we will see, is directly and indirectly caused by technological change.

In summary, the Marxian long term analysis is based on a model of capital shortage which is attributed to rapid technological change. We have already cited Marx in the previous chapter with respect to the insufficiency of the means of production to employ available labour. Löwe also points out that "the case for a 'capital shortage' found a new protagonist in Marx."[7] However, he does not analyze how this capital shortage occurs in Marx. Our analysis in this chapter will demonstrate the rationale behind this shortage.

We admit that a long term analysis which excludes cycles (crises) is but a partial exposition of Marx's arguments. Even though Marx himself offers such a crisis-free analysis in his reproduction schemes in the second volume of Capital,[8] his discussions elsewhere indicate the inevitability of periodic interruptions in the accumulation process.[9] When he analyzes these, he abandons Say's Law.[10] We will be treating the crises separately in Chapter V. It should be sufficient to note that the relationship of technological change and unemployment to crises is very sketchy and incomplete in Marx. What is much more explicit in his works is the effect of technological change on employment when there is continuous

capital accumulation. It is our objective, as already indicated in Chapter I, to identify the different levels of analysis to clarify the meaning of technological unemployment in Marx. Hence, the crisis-free long term accumulation is an explicit level of analysis in Marx. Whether the short term, long term and crises models can be reconciled is an important question which we will return to both in this chapter and at the end of the next chapter. Marx does not achieve this reconciliation. In this sense, technological change, which is the richest field of investigation in Marx's works, is also the least rigorous one. Dialectically speaking, it is the strongest as well as the weakest theme in Marx.

Assumptions

The following key assumptions will be maintained throughout this chapter:

(i) Surplus is the only source of accumulation and all of it is used for accumulation. The workers consume all their incomes and do not contribute to capital formation through personal savings. However, Marx sees that the workers may also save. But their motivations are different from those of the capitalists, i.e., they do not save in order to increase their wealth. Their savings serve as a hedge against "old age", "crises", periods of "illness", etc.[11] These savings will increase the capitalists' power to accumulate.[12] Marx does not see this fund as significant.

We have previously indicated that he also takes capitalists' consumption into account. He seems to assume a constant propensity to consume on the part of the capitalists.[13] The rate of accumulation is not determined by an increased propensity to save. Although Marx can be criticized on this ground, he could not have calculated this propensity.

Moreover, this is not a source of difficulty in the present context. As we have already seen, if the capitalists consume all of the surplus, no accumulation will take place and consequently, no compensation. On the other hand, equating surplus with accumulation, i.e., saving with investment in modern parlance, can be objected to within the Keynesian theoretical framework.[14] The important point is that the Keynesian objection cannot refute Marx's long term technological unemployment hypothesis. Inadequate demand will only accentuate the level of unemployment which exists in the Marxian model even when Say's Law in its narrow sense holds. In the Keynesian context, unemployment is due to inadequate demand when the stock of capital is given. Hence, additional capital requirement to equip workers is not an issue.[15]

(ii) Profits and surplus are identical. In other words, the surplus product extracted in the production process is assumed to be sold and its value is realized in an equal amount of profits. Surplus is, moreover, the sum of rent, interest and industrial profit.[16]

(iii) Machines are employed at full capacity. Marx is not explicit on this. However, this assumption must be made for two reasons:

(a) The organic composition of advanced capital becomes an ambiguous concept if machines are used below their full capacity. This may imply a reduction in the number of workers and an increase in q without technological change.[17]

(b) Full capacity utilization means that to increase employment, further accumulation in both constant and variable capital must be forthcoming. Otherwise, employment can be increased without an increase in constant capital. Again, this assumption is a restatement of Say's Law in its narrow sense.

(iv) The length of the working-day is unchanging.[18] In this way, the creation of absolute surplus is ruled out in order to focus on technological change and the creation of relative surplus. The intensity of work, however, can change with technological progress.

(v) The periods of turnover of constant and variable capital are constant. This assumption will be maintained even though it is a serious simplification, because technological change embodied in new machines extends the durability of the machines and hence, the turnover period of constant capital. It may also reduce the turnover period of the advanced variable capital by intensifying work and by shortening a single period of production. Marx discusses the effects of the changes in the turnover periods on the rate of profits and accumulation.[19] We will return to the questions of the durability of constant capital and obsolescence through technological change in Chapter V.

(vi) Population and the supply of labour are growing. Marx's discussion of the role of the growth in the supply of labour is a source of difficulty which we will evaluate critically.

The assumptions listed above are the fundamental ones. A given wage rate cannot be assumed. It increases in the long term. We have already seen that allowing the wage rate to vary introduces ambiguity in the definition of q. It also damages the use of changes in v as an index for the changes in employment. Marx is aware of this difficulty. If wages increase, then, "increase of variable capital...becomes an index of more labour, but not of more labourers employed."[20] This ambiguity cannot be eliminated in the Marxian context unless one is to discard the employment question. In our mathematical formulations, we will maintain a constant

wage rate in order to simplify our formulations. The significance of the changes in W has already been evaluated in the previous chapters and need not be repeated.

2. Scope of the Chapter

In the present chapter, we do not intend to develop or reproduce the Marxian models of simple and extended reproduction. These two-sector models were not designed to analyze the effects of technological change. The simple reproduction model involves neither accumulation nor technological change. The extended reproduction model as formulated by Marx indicates only the necessary conditions for a balanced growth, i.e., when disproportionality does not occur. In this model, Marx assumes an unchanging q and a given rate of exploitation. We agree with the criticism voiced by Desai, who states: "The tendency of the rate of profit to fall, for the organic composition of capital to rise, for the reserve army of labour to swell-all these have no place in the scheme of expanded reproduction as outlined in Volume II of Capital."[21] Similar criticisms have been made by Yaffe and Morris.[22]

Our emphasis will be on the literary comments made by Marx elsewhere in his works where these elements are analyzed in conjunction with technological change and unemployment. The long term accumulation model under study in this chapter is not to be confused with Marx's specific extended reproduction scheme which excludes technological change. The major similarity between the two is that they both abstract from crises. What we will be suggesting is that Marx also has a crisis-free accumulation model which incorporates technological unemployment. This is to be traced through his less formal comments.

3. Types of Accumulation and Technological Change

Marx indicates basically two types of accumulation in a capitalist system:[23]

(i) Accumulation on the basis of a given q, i.e., when no technological change occurs.

(ii) Accumulation on the basis of an increasing q, i.e., when technological change is embodied in the old as well as the additional capitals.

He considers (i) to be unrealistic for extended periods. He calls any assumption that long term accumulation will occur on the basis of a given q a "nefarious presupposition."[24] Such accumulation does not incorporate technological change and cannot be maintained with a given supply of labour or with one which is growing at a slower rate than the rate of accumulation.[25] The capitalists are obliged to introduce technological change to offset the effects of the increase in the wage rate or to increase the rate of exploitation under competitive conditions even if the wage rate does not increase. In this sense, accumulation in Marx always involves technological change. In the chapter on the "General Law of Capitalist Accumulation," he states: "The most important factor in this inquiry is the composition of capital and the changes it undergoes in the course of the process of accumulation."[26]

The quantitative increase in capital goes hand in hand with a simultaneous change from v to C. Accumulation on the basis of a given q is a phase whose duration is progressively reduced owing to the competitive struggle. "The intermediate pauses are shortened, in which accumulation works as simple extension of production on a given technical basis."[27]

As technological change is embodied in the additional capital, this change also revolutionizes the previously advanced capital or the capital already in existence. "Every introduction of improved methods, therefore, works almost simultaneously on the new capital and on that already in action."[28] It is important to note that when Marx refers to technological change, he often uses the term "revolution" to indicate that the new technology is significantly superior to the techniques already in use.[29] This is probably related to his implicit assumption that reversal in techniques will not occur even if the wage rate falls substantially.

The foregoing section summarizes the types of accumulation and the interrelationships between them. However, in this form, Marx's comments are too general and overlook certain difficulties.

Even if it is accepted that the Marxian bias,[30] i.e., the tendency of q to increase, exists, it cannot be argued that it will accelerate. The capitalistic motivations are not sufficient to warrant this. For this bias to accelerate, one must also assume that scientific and technological knowledge are readily forthcoming. Even then, technological change will not "simultaneously" affect all the branches of the economy; new and old capital alike. He does not analyze the determinants of the rate of diffusion of technology. He contends that "the very progress of capital accumulation involves simultaneously a large volume of capital destruction."[31] The clear implication is that technological change increases the rate of obsolescence of the machines in use in such a way that they are scrapped faster. He must, then, be assuming that the new machines reduce the total cost of production for a given level of output in such a way that the savings are greater than the residual value of the machines to be scrapped.

Gourvitch points out that in Marx there are two types of "destruction

of capital":[32] the first type consists of idle machinery and equipment and the second one corresponds to the depreciation of values. Clearly, in the first case unemployment will increase. However, in the second case capital destruction is not necessarily injurious to employment. In fact, it may facilitate expansion by restoring profitability particularly in a recession. Capital destruction will be analyzed in detail in Chapter V on crises because its significance in crises is rather substantial.

It has also been pointed out that "a constant organic composition of capital is compatible not only with economic growth based on one technique, but also with rapid technical change," and that "a change in the organic composition of capital is not necessarily accompanied by technical change."[33] This is a valid criticism and shows the limitations of Marx's apparatus. Nevertheless, we have already indicated that Marx cannot be criticized for having overlooked these objections. We have seen that h can change independent of technological change in Marx and that the rise in q, if in relative terms because of a decrease in W, is not, in fact, labour displacing. Marx's qualifications in Theories of Surplus-Value indicate this awareness.[34] But, in his general arguments, he tends to dismiss many of the forces such as savings in constant capital and technological change that may require no additional constant capital (not in aggregate sense) as inadequate countertendencies. According to him, they will not offset the tendency of q to rise.

Whether technological change takes place rapidly or slowly does not appear to be significant in Marx's analysis.[35] The gradualness or the rapidity of change are more important in the classical analysis.[36] If changes are gradual, the market adjustments may have more time to become effective to eliminate the short term inconvenience of unemployment.[37]

However, Marx's analysis does not appear to depend on subsequent market adjustments through the choice of inputs, but on accumulation.

His assumption on fixed coefficients excludes adjustments on the basis of a given technology.[38] It must, nevertheless, be pointed out that rapidity of technological change must be playing a part in Marx's analysis. He sees a continuous wave of changes that are clear breaks from the existing techniques. They make the existing techniques obsolete under foreseeable price relationships. Clearly, this is still open to objection. Technological change is not always of this type.

Nevertheless, we believe that these weaknesses are not sufficient to refute Marx's hypothesis. As we have often indicated, a more fundamental weakness lies in his separation of technological change from accumulation. In other words, he does not see a high rate of accumulation as being possibly necessary for technological change, even though the former, according to him, always incorporates the latter. He states: "The additional capitals in the normal course of accumulation serve particularly as vehicles for the exploitation of new inventions and discoveries, and industrial improvements in general."[39] His model is an incomplete portrayal of technological change. This is a criticism which can be directed at his analysis within his own framework. The criticisms which hold that not all technological change increases q or that technological change is not so rapid as to make the neo-classical mechanisms ineffective are tenable. Even though we will integrate these criticisms into our analysis, we will point out that the weakness indicated above is probably as serious if not more. This aspect has not attracted much attention in literature.

The role of centralization is also crucial to Marx's analysis.[40] The

centralization of capital in the hands of fewer capitalists makes it possible to increase q without accumulation. He states: "...[W]hilst centralisation thus intensifies and accelerates the effects of accumulation, it simultaneously extends and speeds those revolutions in the technical composition which raise its constant portion at the expense of its variable portion, thus diminishing the relative demand for labour."[41] In fact, centralization occurs faster than accumulation.[42] It is hastened through the development of credit facilities and the elimination of smaller capitals.[43] Centralization makes it possible for some capitalists to acquire large amounts of capital from the other branches of the economy since "large installations of fixed capital presuppose possession of large amounts of capital."[44] Smaller capitalists are excluded.[45]

We must note that this centralization process offers a further explanation for our contention that Marx does not see the necessity for net accumulation for the introduction of new technology. Capital which is in use in other branches of the economy is restructured so that the organic composition of the existing capital increases. In fact, this explanation can be used for our short term analysis in Chapter III where initial surplus was disallowed in the introduction of the new machines. Moreover, his contention that centralization will occur faster than accumulation implies that q may increase even faster than accumulation. This analysis supports our view that rapid technological change in Marx does not require high rates of accumulation. Moreover, we will see in this chapter that even the reduced rates of accumulation do not appear to slow down technological change. In Chapter V, it will also become clear that he sees the depression period as a time when substantial technological change of the labour displacing type occurs.

In the rest of this chapter, we will not refer to centralization. Its effects on accumulation and technological change will be taken for granted. It is, however, important to realize that Marx's analysis has the rudiments of a theory on the formation of monopolies through technological change and accumulation. The possible modifications implied by this could be integrated into the Marxian prediction concerning technological unemployment in a non-competitive context. Since we intend to remain within the original Marxian framework, such an analysis will not be carried out.

4. The Marxian Race

Marx's accumulation model embodying technological change is a portrayal of a race between workers and new machines. It is a race in which the workers are the losers in terms of employment but not necessarily in terms of wages.

With a given q, the demand for labour is a direct function of the rate of accumulation.[46] A 10% increase in capital (both v and C) will, then, mean an equivalent percentage increase in employment. Both v and C must grow proportionately even though it is the increase in v that is directly relevant in measuring employment. Yet, employment cannot be expanded without the machines. It is the size of required C that presents the real bottleneck.

When q also increases in the accumulation process, the demand for labour is not only determined by the rate of accumulation but also by the rate of change in q. Accumulation increases the absolute demand for labour but technological change reduces the relative demand for it, i.e., the demand for labour grows at a slower rate than the rate of accumulation. We will

shortly derive some mathematical relationships in order to analyze and critically evaluate this race. Presently, we wish to cite several quotations from Marx to illustrate it. Even though they are lengthy, we believe that they will facilitate our subsequent analysis.

> On the one hand, therefore, the additional capital formed in the course of accumulation attracts fewer and fewer labourers in proportion to its magnitude. On the other hand, the old capital periodically reproduced with change of composition, repels more and more of the labourers formerly employed by it.[47]

> This qualitative change in mechanical industry continually discharges hands from factory, or shuts its doors against the fresh stream of recruits, while the purely quantitative extension of the factories absorbs not only the men thrown out of work, but also fresh contingents.[48]

> What are set free are not only the labourers immediately turned out by the machines but also their future substitutes in the rising generation, and the additional contingent, that with the usual extension of trade on the old basis would be regularly absorbed.[49]

> ...[A] relative decrease in the number of hands is consistent with an actual increase.[50]

Marx is explicit in two of the quotations that the absolute level of employment will increase in the long term. There are many other passages where he repeats this.[51] He does not appear to give support to the very pessimistic view that at some point in time, capitalism may virtually eliminate the jobs of most people through automation.[52] We will, however, indicate that despite Marx's different claim, his logic can be used to arrive at this pessimistic view which he, at one point, also supports explicitly.[53] This aspect will be postponed in our discussion.

We will assume, as Marx does, that the displacement effects through the actual adoption of the machines are being more than fully offset through accumulation in general. In this case, technological change reduces the

rate of expansion in employment. The Marxian race can be, then, divided into two parts:

(i) Net displacement of labour occurs as the organic composition of advanced capital which already exists increases. The implicit assumption is that the previously advanced capital is recovered in total, and that it undergoes the change explained in Chapter III.

(ii) Decreasing capacity of the additional capital to absorb the displaced workers plus the additional workers entering the labour force for the first time.

We have fully analyzed (i) in Chapters II and III in the absence of simultaneous accumulation. This is still a component of the accumulation process.[54] When accumulation is also occurring, technological change is embodied in the additional capital while it also transforms the old capital. Then, (i) and (ii) are processes that can be separated at a theoretical level. In the real world, the processes are more complicated.

The increase in the aggregate level of employment will be due to (ii). This distinction between (i) and (ii) must be maintained in a theoretical context because it is fundamental to Marx's analysis. He distinguishes technological change from accumulation even in the long term when both are taking place simultaneously. As we have frequently indicated, this view is open to criticism.

The general compensation for (i) is not, according to Marx, because of technological change. In fact, technological change works against employment in two ways:

(a) The increase in q decreases the absolute level of employment in the absence of accumulation or decreases the relative demand for labour when accumulation takes place. We will call this "the direct effect" of

an increase in q. This is a direct effect in the sense that the effect of the increase in q on the rate of profit and accumulation is excluded.

(b) The increase in q has an indirect effect on employment through its effect on the rate of profit and hence, on accumulation.

Marx does not make this distinction. In fact, he does not clearly integrate (b) into his analysis of technological unemployment. We will, in most of this section, limit our study to (a) by ignoring the alleged secular tendency of the average rate of profit to fall which is behind (b). Later, it will be integrated into our discussion.

After this necessary detour, we return to the concept of general compensation which is explicit in Marx. Even though accumulation in the future will eventually compensate more than fully for the immediate effects of technological change unaccompanied by simultaneous accumulation, Marx is not consistent on the duration of such unemployment. On the one hand, he tends to argue that the particular individuals displaced may remain unemployed for prolonged periods because it may take time for capital to achieve a sufficient size to be advanced on the basis of a higher q. Then, compensation will be through the employment of fresh contingents in the future. However, in the quotes cited, he argues that the displaced ones may also be absorbed. More realistically, once borrowing and credit facilities are allowed into the model, compensation will be partly in terms of the displaced workers and partly in terms of the new contingents.

Given this general compensation in the long term, it would appear, as earlier indicated, that there should be no technological unemployment. Yet, this is not the case in Marx. Even though accumulation offsets the immediate labour displacement effects of technological change, i.e., the absolute employment increases, the level of unemployment also increases.

Stated differently, the rate of growth in employment is less than the rate of growth in the supply of labour. It is not clear whether Marx means increasing rates of unemployment or only increases in the number of workers unemployed. Even a decreasing rate of unemployment is consistent with increases in the absolute volume of unemployment. Since there is not clear evidence in Marx for choosing one interpretation over the other, we will be using the "level of unemployment" instead of "rate of unemployment" and refer to the absolute number of workers unemployed. Further specification is not essential for our analysis. In the chapter on crises, we will see that the earlier quotation from Eagly will also find some support.

According to the last two quotations cited, Marx equates the decreasing capacity of additional capital to absorb labour with an increase in actual unemployment. It will become clear later in this section that this decrease in the relative demand for labour cannot be equated with an actual increase in the industrial reserve army (IRA). Further assumptions are required. Before we develop this analysis, we will first formulate and discuss the conditions under which there can be full or over-full compensation in the Marxian scheme when accumulation and technological change occur simultaneously.

For only full compensation to take place, the following relationship will have to hold:

$$0 = \left(\frac{\frac{AAC_0}{1 + q_0} - \frac{AAC_0}{1 + q_1}}{W} \right) - \left(\frac{\frac{\Delta AAC}{1 + q_1}}{W} \right)$$

where: $q_1 > q_0$.

The additional capital in the accumulation process, i.e., ΔAAC, embodies new technology as reflected by a higher q. Ignoring time lags, the old

capital, AAC_0, undergoes the same type of technological change. The first term on the right indicates the decrease in employment. This, of course, need not occur when accumulation is occuring simultaneously. The second term shows the compensatory effect of accumulation. When the net result is zero, the absolute level of employment remains constant. Marx does not have such a formulation but comes close to it in the Grundrisse when he states:

> The total capital which would be necessary in order to employ the old labour time is therefore = to the old labour fund multiplied by the denominator of the fraction which now expresses the relation of the labour fund to the new capital.[55]

Our formulation is essentially the same as the one derived in Chapter III. The only difference is that in this case, ΔAAC represents the total surplus invested and not only the savings due to technological change. This formulation can be reduced to:

$$0 = \frac{\frac{AAC_0}{1 + q_0}}{W} - \frac{\frac{AAC_1}{1 + q_1}}{W}$$

where: $AAC_1 = AAC_0 + \Delta AAC.$

We can use this relationship to separate the effects of changes in q and the rate of accumulation, and to specify the conditions under which full compensation takes place. Since W is common to both terms, we can eliminate it.

(i) $$\frac{AAC_0}{1 + q_0} = \frac{AAC_1}{1 + q_1}$$

(ii) $$\frac{1 + q_1}{1 + q_0} = \frac{AAC_1}{AAC_0}$$

$$\text{(iii)}\quad \frac{1 + q_1}{1 + q_0} = \frac{AAC_0}{AAC_0} + \frac{\Delta AAC}{AAC_0} \qquad \text{(Since } AAC_1 = AAC_0 + \Delta AAC\text{)}$$

$$\text{(iv)}\quad \frac{1 + q_1}{1 + q_0} = 1 + \frac{\Delta AAC}{AAC_0}$$

$$\text{(v)}\quad \frac{1 + q_1}{1 + q_0} - 1 = \frac{\Delta AAC}{AAC_0}$$

$$\text{(vi)}\quad \frac{(1 + q_1) - (1 + q_0)}{1 + q_0} = \frac{\Delta AAC}{AAC_0}$$

$$\text{(vii)}\quad \frac{q_1 - q_0}{1 + q_0} = \frac{\Delta AAC}{AAC_0}$$

$$\text{(viii)}\quad \frac{\Delta q}{1 + q_0} = \frac{\Delta AAC}{AAC_0}$$

In (viii), the term on the right indicates the rate of accumulation whereas the one on the left is an approximation of the rate of change in q. Clearly, the latter is less than $\frac{\Delta q}{q_0}$. When the numerator increases as technological change of the Marxian type takes place, $\frac{\Delta q}{1 + q_0}$ will tend to approach $\frac{\Delta q}{q_0}$. We will, therefore, refer to it as the rate of change in q even though it is only an approximation. (It must be recalled that q is normally greater than 1 in Marx).

When the rate of accumulation equals the rate of increase in q for the economy as a whole, the absolute level of employment remains constant. Marx does not emphasize this case except when he states: "Consequently, accumulation does not have to set new labour in motion, it may simply direct

the labour previously employed into new channels."[56] He also states that for "the same mass of labour to be employed", when the "working population is constant", the invested capital would have to increase if q is also increasing.[57]

When the rate of accumulation is greater than the rate of growth in q, the absolute level of employment increases.[58] In this case, there will be more than full compensation for the effects of technological change. This result is the dominant one in Marx's works.[59] We are in this analysis assuming that the supply of labour is forthcoming. The complications raised by this assumption will shortly be integrated into our analysis.

Given our mathematical relationship, it is also possible that the absolute level of employment may fall in the long term. This will occur when the rate of accumulation is less than the rate of increase in q. Even though Marx does not appear to emphasize this possibility, at one point, he says: "A development of the productive forces which would diminish the absolute number of labourers...would cause a revolution, because it would put the bulk of the population out of the running."[60] Also in his criticism of Ricardo's view that accumulation, by increasing the demand for labour, will put pressure on the wage rate, he states that "the demand for labour can decrease absolutely or relatively."[61] Most of his explicit analysis of technological unemployment, however, gives little support to the more pessimistic view that absolute level of employment will decrease. Nevertheless, these quotations reveal a degree of confusion in Marx. Given the mathematical formulation and the underlying logic which are explicit in Marx, this result must be a possibility. Why Marx implicitly assumes that the rate of accumulation will be greater than the rate of increase in q so as to increase the absolute level of employment

is unclear. This choice appears to be arbitrary and does not follow from his theoretical framework. It will be seen that his contention concerning the falling rate of profit, i.e., the indirect effect of the rise in q on accumulation, can also be used to support the more pessimistic view.

Marx's choice is most likely based on historical observations rather than on a theoretical foundation. Given the distinction he makes between technological change and accumulation, a distinction which is explicit in our formulation, there is no theoretical reason why the rate of change in q cannot exceed the rate of accumulation. Given his implicit assumption that the rise in q does not necessitate prior net accumulation to be used in bringing about the technological change, such an outcome cannot be excluded. If he had suggested that the rise in q necessitated a prior increase in total capital advanced, he might have avoided some of the confusion. One could, then, plausibly claim that the rate of accumulation might exceed the rate of increase in q so as to increase the absolute level of employment. However, even this would require a qualification because a prior net accumulation does not necessarily mean that q will increase less than the rate of accumulation. In short, why he assumes that the rate of accumulation will exceed the rate of increase in q cannot be explained on a theoretical basis.

On the other hand, if he suggested that technological change required much higher rates of accumulation, his short term analysis could not be maintained. His results would be reversed because the construction and adoption of machines would be accompanied by increases in the absolute level of employment. Presently, it should suffice to note that Marx's prediction which maintains that the absolute level of employment will

increase is historically correct, but his separation of technological change from accumulation is also consistent with the opposite result. His theoretical apparatus does not explain his correct observation. One way to resolve this ambiguity is to argue that Marx also saw accumulation in some firms occurring on the basis of a given q which, in turn, depressed the rate of increase in the average q in the economy below the rate of accumulation. Even though this is a tenable explanation, it contradicts Marx's assertion that accumulation without technical change will be less significant as capitalism develops.

We will not resolve this problem presently. We will continue to assume that the absolute level of employment increases in order to outline his analysis. We will later see that the problem cannot be resolved on the basis of his approach.

5. Constructive Technological Unemployment and Long Term Unemployment

As indicated earlier, Marx equates the relative diminution in the absorptive capacity of capital with an actual increase in the reserve army in the long term. This argument requires an assumption about the growth of the labour supply. In order to specify the conditions under which the relative decrease in demand for labour corresponds to an actual increase in the IRA, we will introduce a theoretical concept of unemployment which does not necessarily correspond to actual unemployment. We call this "constructive technological unemployment." The term "constructive" is borrowed from H. Jerome's work outside the Marxist tradition. He calls the theoretical technological unemployment, "constructive displacement."[62] However, our use of it in the Marxian context is fundamentally different from Jerome's usage where it is applied to the changes in productivity

without reference to the availability of capital. An application similar to that of Jerome is implicit in the Baden-Württemberg study cited earlier.[63] (See reference for the formulations in this study.)

The CTU, in our context, is the difference between the level of demand for labour, which would have been generated on the basis of a given q, and the level of demand actually generated when q increases in the accumulation process. The CTU is a theoretical measure of saving in labour with respect to capital. Whether this saving corresponds to an actual unemployment depends on the rate of growth in the supply of labour. Marx's analysis implies that if the CTU does not exist, then, "the usual extension of trade on the old basis" will regularly absorb the increase in the labour force.[64] He implies that when the CTU exists, i.e., when q increases, it will tend to reflect itself in actual unemployment. We will show that equating the CTU with actual unemployment is not correct.

$$CTU = \left(\frac{\frac{AAC_0}{1+q_0} - \frac{AAC_1}{1+q_1}}{W}\right) - \left(\frac{\frac{AAC_0}{1+q_0} - \frac{AAC_1}{1+q_0}}{W}\right)$$

where: $AAC_1 > AAC_0$ and the absolute demand for labour increases even though q also increases.

The first term on the right indicates the actual increase in demand for labour when accumulation is accompanied by an increase in q, whereas the second term measures the additional demand that would be created if accumulation were to occur on the basis of q_0. The formulation can be reduced to:

$$CTU = \frac{\frac{AAC_1}{1+q_0} - \frac{AAC_1}{1+q_1}}{W}$$

In this reduced form, we are dealing with total levels of employment

under alternative conditions. The first term on the right shows the total demand for labour that would have been created if AAC_1 were advanced on the basis of the lower q, i.e., q_0. The second term shows the actual demand for labour given that q has increased to q_1. Obviously, as long as $q_1 > q_0$, the CTU will be positive. This is not, however, a basis for arguing that technological change will cause unemployment. For this to occur, the rate of growth in the supply of labour must be greater than the actual growth in the demand for labour. We can illustrate this in the following manner:

L_0: Initial level of employment

ΔL: Increase in actual demand for labour when accumulation and the rise in q take place simultaneously

S_0: Initial supply of labour

ΔS: Increase in the supply of labour

Assuming that CTU > 0, the following formulations indicate the conditions under which the CTU corresponds to an actual reserve army. We will for simplicity, assume that full employment initially exists in order to make $S = L_0$. This assumption is made for mathematical convenience only. It does not exist in Marx. We will, in addition, assume that the rate of increase in demand for labour, i.e., $\frac{\Delta L}{L_0}$, is made possible by net accumulation.

(i) The CTU will have an equal counterpart in the IRA if:

$$\frac{\Delta S}{S_0} \geq \frac{\Delta L}{L_0} + \frac{CTU}{L_0}$$

In this case, there are two possible outcomes:

(a) If the rate of growth in the supply of labour is equal to the sum of the terms on the right, all of the unemployment can be attributed to the labour displacement by technological change. In this case, if

accumulation were to take place without a change in q, the CTU would be zero. Full employment would be maintained. According to the quote cited earlier where Marx assumes that the increase in the supply of labour may be fully absorbed if q is constant, he is clearly implying that unemployment will be caused by the rise in q. In other words, his technological unemployment is the one depicted by (a). He does not, however, specify the necessary conditions for it to hold.

(b) If the growth in the supply of labour exceeds the sum of the terms on the right, the CTU will still have a full actual counterpart in the IRA. The increase in the IRA will, however, be greater than the CTU. Not all of the unemployment can be attributed to technological change. In other words:

$$\frac{\Delta S}{S_0} - \frac{\Delta L}{L_0} > \frac{CTU}{L_0}$$

Thus, if accumulation takes place on the basis of a given q, i.e., if CTU = 0, unemployment still exists. Part of the unemployment appears to be caused by the inadequate rate of accumulation.

Marx does not carry out such an analysis. Since he equates the CTU with the increase in the IRA, both (a) and (b) appear to be consistent with his contention. It is, however, clear in case (b) that not all of the increase in the IRA can be explained by the CTU.

We should briefly indicate that Marx, in order to free his theory from a dependency on an excessive growth in population, offers an explanation for the inadequacy of the rate of accumulation. This explanation is based on the indirect effect of the rise in q on the rate of profit and hence on accumulation. In this sense, the technological unemployment is not only caused by the direct effect of the rise in q but also by its indirect

effect on the rate of profit. His technological unemployment is not only the counterpart of the CTU but also the unemployment resulting from the reduced rate of accumulation. Then, case (b) can also be explained totally in terms of technological change. We will presently ignore this indirect effect. The main reason for this is that Marx's argument on the falling rate of profit is, as we will see, untenable. His attempt to divorce his predictions from their dependency on excessive rates of growth in population is not very successful even though the chapter on crises will alleviate some of the criticisms to be stated in this chapter.

(ii) We will, now, look at the case when the CTU may not have a full or even a partial counterpart in the IRA. This will be the case if:

$$\frac{\Delta S}{S_0} < \frac{\Delta L}{L_0} + \frac{CTU}{L_0}$$

Here, too, there are two possible outcomes:

(a) If $\frac{\Delta S}{S_0} > \frac{\Delta L}{L_0}$, then the CTU will have only a partial counterpart in the actual reserve army. In other words: $\frac{\Delta S}{S_0} - \frac{\Delta L}{L_0} < \frac{CTU}{L_0}$. Stated literally, the relative saving in labour for any amount of total capital accumulation is greater than the actual unemployment.

(b) If $\frac{\Delta S}{S_0} \leq \frac{\Delta L}{L_0}$, then the CTU has no counterpart in the IRA. In fact, there is no IRA. Given an increase in q, the CTU will be positive, but it cannot be a source of concern. On the contrary, this situation is the most favourable one from the point of the working class. Full employment will be maintained and, with the increase in productivity, the real wages will tend to increase. This clearly is not Marx's long term prediction. The capitalists will introduce new technology to offset the rise in wages. However, the relationship between the rate of growth in the supply of

labour, the rate of accumulation, and the rate of increase in q may be such that the economy may maintain full employment without any pressure on the rate of profit given a sufficient increase in the rate of exploitation. We shall see that Marx does not see this as possible due to the alleged indirect negative effects of the rise in q on the rate of profit.

To prepare the framework for the next sections, we will summarize the important aspects of the foregoing analysis. Firstly, when the indirect effect of q is excluded, the Marxian analysis equates the CTU with an actual increase in the IRA. It is clear that such an argument cannot be maintained without explicitly introducing the supply of labour into the analysis. Moreover, without specifying the rate of accumulation, the demand for labour cannot be determined. Secondly, when the alleged indirect effect of the rise on q is introduced, the rate of accumulation and the rate of increase in q cannot be treated separately. Then, the demand for labour is determined by both the increase in q proper and its indirect effect on the rate of accumulation.

Given the initial assumption that the absolute level of employment will increase, the alleged long term technological unemployment must be analyzed in a context where the demand for and the supply of labour must be treated simultaneously.

In the discussion of the role of supply of labour in the Marxian model, we will consider only the direct effects of the rise in q without specifying the determinants of the increase in capital. It will, then, be seen that in the absence of the falling rate of profit, the Marxian unemployment depends on a particular assumption on the rate of growth in the supply of labour. It cannot be generalized. Later, we will analyze

the role that the rate of profit plays in influencing the rate of accumulation and employment. Marx's argument appears to depend on this if the growth in the supply of labour is not to be the most important factor behind technological unemployment.

Our critical evaluation in the next two sections will be within the logical framework of Marx without introducing criticisms from a non-Marxian tradition. Our objective is to demonstrate that Marx's long term analysis is faulty even within its own parameters. It must again be stressed that these criticisms are raised against the crisis-free long term model.

6. Supply of Labour and Technological Unemployment

In Marx, the supply of labour grows faster than the demand for it in the long term, excluding presently the alleged factors depressing the rate of accumulation and thus, the demand for labour. The CTU, then, has either a full or a partial counterpart in the IRA. How this increase in the supply of labour comes about is problematic. There may be two possibilities according to Marx:

(i) Technological change increases the supply of labour available to the capitalist sector even with a given population.

(ii) Population growth increases the size of the labour force.

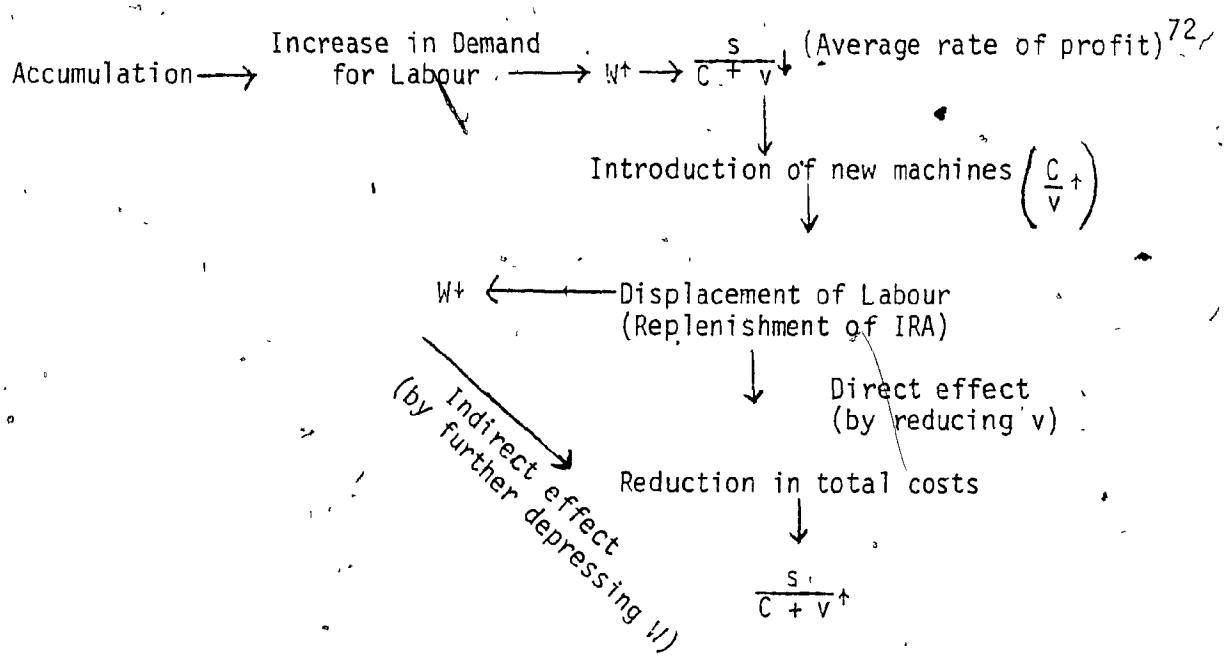
Marx uses both of these mechanisms. He is clearer on (i) than on (ii). We have already seen how technological change, by reducing the requirements of skill or strength, draws women and children into the labour force.[65] In this case, Marx is relying on his historical observations. Another source of labour with a given population is the coexistence of the pre-capitalistic modes of production with the capitalistic sector. Workers or peasants freed from handicrafts and semi-feudal agriculture become

available to the capitalistic sector as these primitive modes of production are transformed through technological and institutional changes, for example, enclosures. This is also emphasized by Lenin in his analysis of the development of capitalism in Russia.[66] Thus, the Marxian approach makes the supply of labour an endogenous variable determined by the capitalistic relationships. Both the supply and the demand are determined by the movements of capital. He states: "Capital works on both sides at the same time."[67] Accumulation of capital increases the demand for labour and exhausts its supply while the increase in q displaces workers.

Even though this analysis finds considerable support in the early stages of capitalism, it cannot be applied once the total economy has been transformed to capitalistic relationships. Then, the reservoir of labour, for example, the "latent" component of the IRA in agriculture,[68] will have been exhausted. There is little support in Marx's works for the view that capitalism will always maintain a non-capitalistic sector in a complementary relationship. The same view is expressed by Lenin. He states: "It cannot be asserted that the number of workers in small industrial establishments or in manufactories must increase in a developing capitalist society, for the factory constantly eliminates the more primitive forms of industry."[69] This is also parallel to our earlier interpretation of Marx that the more primitive sectors characterized by low q's cannot be sources of compensation for too long.

It is also possible in Marx that accumulation may take place over short periods with a given population even if the sources above do not exist.[70] When the total demand for labour increases, and the wage rate is

pushed up during accumulation, the capitalists introduce more sophisticated machines to displace workers. This can be illustrated in the following manner:[71]



Excluding the question of the movements in the rate of profit, a relative surplus population is created through technological change even if the population is given. This is the best depiction of how Marx substitutes technological change and IRA for the Malthusian mechanism. However, this mechanism is applicable to short periods. Marx emphasizes that the capitalist development requires an absolute increase in the supply of labour. In other words, he opts for (ii).

In his long term accumulation model, he no longer maintains a constant supply of labour. Unreconciled by Marx is the shift from showing how the capitalists' demand for labour can be satisfied endogenously by the changes in the composition of existing capital to showing an exogenous growth in the supply of labour in the long term as necessary for capitalist development. He seems to have fallen back on the classical notion that labour supply will increase rapidly through population growth. Since he so

vehemently attacks Malthus, he does not offer an explanation along the classical line.[73] At one point, he gives employment opportunities, not the high real wage rate, as a cause for the growth in population.[74] He also points out the role of early marriages.[75] However, he has no complete explanation. He says: "If accumulation is to be a steady, continuous process, then this absolute growth in population...is a necessary condition."[76] He does not explain why it is necessary. In relation to the demand created in the accumulation process, he states: "We...shall assume that the portion of the newly created money-capital capable of being converted into variable capital will always find at hand the labour power into which it is to transform itself."[77] Morishima also states that this assumption underlies the Marxian accumulation model.[78]

It appears that the Marxian technological unemployment, i.e., the counterpart of the CTU, is caused by an excessive growth in the labour supply because of population growth. Krelle points out that Marx "gave no reason why population should rise faster than employment; he took that for granted."[79] One should, however, point out that even today, the long term relations between population growth and economic conditions are not well understood. On this score alone, one could not criticize Marx. One could, however, criticize him for not seeing that the population growth was very much a part of his contention about technological unemployment. In other words, his long term prediction appears to be dependent on an exogenous variable.

Given that Marx accepts the growth in the absolute level of employment as the normal outcome in capitalist development, i.e., the rate of accumulation exceeds the rate of increase in q, it is not clear why the CTU should have a counterpart unless the rate of growth in population is

very high. Once the argument becomes dependent on a particular relationship between the rate of growth in demand for labour and the rate of growth in the supply of labour, the Marxian prediction amounts to a special case.

Ironically, if he had accepted the Malthusian theory partially, he could have built into his analysis fast rates of growth in population. Given that Marx's analysis emphasizes the increase in productivity and the possibility of increases in the wage rate over long periods, the high rates of growth in population need not have resulted in pushing the wage rate back to subsistence. Technological change could, then, have been tied to high rates of population growth as well. However, an analysis by Marx along this line would lead to other problems and should not be pursued. It should suffice to note that Marx might have overreacted to the Malthusian population theory when he saw that this theory plus the alleged diminishing returns in agriculture effectively ruled out the analysis of the dynamics of capitalism that Marx wanted to emphasize. Moreover, the Malthusian theory was used as a conservative argument against the possibility of any long run improvement in living standards as a result of social policy. Population growth would eliminate any real benefits. This might have been another reason behind Marx's aversion to this theory. He could have, on the other hand, incorporated some aspects of the Malthusian theory without necessarily limiting himself within the boundaries of the classical analysis that made very few distinctions between the modes of production. He dismissed the population theory as "false and childish."[80] He states: "Malthus derives surplus population from capital not being accumulated (that is, reproduced on a growing scale) as rapidly as the population."[81] The clear implication is that, in his own model, unemployment is not due to an excessive growth in population but due to technological change through its direct and indirect effects.

A sympathetic interpretation of Marx would be that it is the inadequate rate of growth in demand for labour that renders a part of the growing population superfluous. In other words, accumulation and technological change adjust to the rate of growth in the supply of labour so as to render the increase in demand for labour always less than the increase in the supply of labour. He says:

> The fact that the means of production, and the productiveness of labour increase more rapidly than the productive population, expresses itself, therefore, capitalistically in the inverse form that the labouring population always increases more rapidly than the conditions under which capital can employ this increase for its own self-expansion.[82]

According to this, it is still the increase in q which makes it impossible to absorb the increase in population. Given Marx's belief that the absolute level of employment will increase, one cannot claim that the increase in q is, by itself, sufficient to explain the increase in the level of unemployment. If the rate of accumulation is sufficiently higher than the rate of increase in q, there is no theoretical reason to expect that the CTU will have a counterpart in the IRA. If there is no limit on the rate of accumulation, then the implicit assumption must be that it is the growth in the supply of labour that is excessive. Hence, the Marxian prediction is not saved from depending on an exogenous population growth as long as the rate of accumulation is indeterminate. The rate of increase in q is not by itself sufficient to explain the Marxian contention. The only remaining manner by which to disassociate his argument from the population growth is to analyze the alleged indirect effect of the rise in q on the rate of accumulation. Marx does not explicitly do this. However, his argument on the falling rate of profit provides an alternative explanation. It implies that the rate of accumulation cannot be substantially greater than the rate of increase in q because the increase

in q depresses the rate of accumulation through indirect effects. This, as we will see in the next section, reduces somewhat the reliance on population growth but still not entirely. Moreover, the falling rate of profit argument is difficult to maintain in a secular framework detached from the crises.

7. Falling Rate of Profit and Technological Unemployment

Introduction

Marx does not clearly link the falling rate of profit to the question of technological unemployment in the long term.[83] Given his attempt to prove his contention independent of the growth in the supply of labour, the tendency of the rate of profit to fall and, consequently, to reduce the rate of accumulation relative to the rate of increase in the supply of labour, must be implicit in his long term analysis. He says:

> ...[I]t is not the increased rate either of the absolute, or of the proportional, increase in labour-power, or labouring population, that makes capital insufficient but conversely, the relative diminution of capital that causes the exploitable labour-power, or rather its price, to be in excess.[84]

The "relative diminution" of capital cannot be explained only in terms of the direct effect of a rise in q. As long as the rate of accumulation is high, the relative diminution in labour absorption can be offset by high rates of growth in C and v. It must, then, be the indirect effect of the rise in q that is reducing the rate of accumulation. He states:

> A fall in the rate of profit and accelerated accumulation are different expressions of the same process only insofar as both reflect the development of productiveness. Accumulation, in turn, hastens the fall of the rate of profit, inasmuch as it implies concentration of labour on a large scale, and thus a higher composition of capital. On the other hand, a fall in the rate of profit hastens the concentration of capital and its centralisation through expropriation of minor capitalists, the few direct producers who still have anything left to be.

> expropriated. This accelerates accumulation with regard to mass, although the rate of accumulation falls with the rate of profit.[85]

It must be pointed out that this fall in the rate of accumulation is not caused by a voluntary reduction in accumulation on the part of capitalists who react to the fall in the rate of profit. Marx, here, is referring to the ability to accumulate, i.e., the relative reduction in surplus that can be advanced. This interpretation, we believe, is correct because in the paragraph following the quotation above, he gives the reduced willingness of the capitalists as a separate reason. In other words, the rate of accumulation will fall because of the falling rate of profit even if capitalists invest all their surpluses. However, it will fall even below this rate when the capitalists withold further investment. Thus, crises compound the effects of capital shortage on employment.

If it can be demonstrated that the rise in q limits the rate of growth in surplus and accumulation, technological unemployment can, then, be a possibility with any given rate of growth in the supply of labour not only because the direct effect of a rise in q but, more importantly, because the indirect effect will also reduce the magnitude of compensation in its broad sense.

Yet, even if we assume that the falling rate of profit due to a rise in q is tenable, a problem that was earlier mentioned still exists. Why doesn't this indirect effect lead to an absolute decrease in the level of employment by eventually depressing the rate of accumulation below the rate of increase in q? Even though history disproves this, Marx's analysis does not. The internal logic of his approach, i.e., the separation of technological change from accumulation, can lead to this unrealistic result particularly when the falling rate of profit is integrated into his model.

To assert that the absolute level of employment will increase, there must be a particular relationship between the rate of increase in q and the rate of increase in accumulation. In other words, the increase in q must be high enough to reduce the rate of profit but not high enough to reduce it to the point where the rate of accumulation will fall below the rate of increase in q. He never states this relationship which must implicitly underlie his model.

In the following section, it is not our intention to add to the endless controversy over the meaning of the tendency of the average rate of profit to fall in the long term. Marx calls it "the most important law of modern political economy."[86] A great deal of literature already exists on this "tendency." However, it has only been marginally applied to the analysis of technological unemployment in Marx. First we will present Marx's argument on the falling rate of profit and briefly survey some of the familiar criticisms of it. We claim no originality in this task. We will, then, relate it to technological unemployment. It is this aspect which has not drawn much attention in the literature. It will become obvious that once this alleged tendency is shown to be untenable, the Marxian long term analysis is seriously damaged. It falls back on excessive rates of growth in the supply of labour. The attempt to use technological change as an explanation for the reduction in the rate of accumulation fails. It becomes unclear as to why capital should not be plentiful enough to offset the increase in q so as to maintain high levels of employment.

The Tendency of the Average Rate of Profit to Fall

Marx follows the classical tradition in claiming that there is a secular tendency for the average rate of profit to fall. In Ricardo and J.S. Mill,

this tendency is derived from the law of diminishing returns to agriculture.[87] Marx does not differentiate between agriculture and industry.[88] Moreover, profit or surplus consists of interest, rent and industrial profit. The average rate of profit is the sum of the three divided by the total value of the advanced capital. In his case, the average rate of profit, (p), will fall not because of diminishing returns, i.e., the lack of adequate technological progress in agriculture, but, on the contrary, because of technological change which is forthcoming readily. He criticizes Ricardo's argument which is based on diminishing returns by saying that Ricardo "flees from economics to seek refuge in organic chemistry."[89] He claims: "We have demonstrated the necessity of this tendency without any reference to ground rent, nor did we have to refer, e.g., to rising demand for labour, etc."[90] Hence, the fall in p is due neither to the increase in the wage rate nor to the increase in the share of rents at the expense of industrial profits.

Rapid technological change, particularly in agriculture, can offset the classical prediction. In Marx, the fall in p occurs because of technological change and not due to its absence. "The rate of profit thus falls, not because labour becomes less productive, but because it becomes more productive."[91]

This secular tendency is distinct from the fluctuations in p during periodic crises. 'It is not due to the realization difficulties,[92] i.e., the difficulty in converting the surplus product into profits in money terms at expected prices. In this manner, Marx claims to have discovered a law or a tendency that is peculiar to the capitalist mode of production even in the absence of crises.

The remarks above are general in content, and they indicate the major

differences between the classical economists and Marx on this question. They do not explain why the rate of profit must fall as q increases. We will see that his contention is open to fundamental criticisms that render it untenable. It is difficult to give meaning to this argument even within the logical framework of Marx.

To evaluate his contention critically, we will employ the following Marxian concepts:

s: total surplus in the economy (= profit since no realization problem exists)

v: variable capital advanced

C: constant capital advanced

$s' = \frac{s}{v}$: rate of exploitation or rate of surplus-value

$q = \frac{C}{v}$: organic composition of advanced capital

$p = \frac{s}{C + v}$: average rate of profit

If we divide both the numerator and the denominator of the rate of profit, $\frac{s}{C + v}$, by v, we get:

$$p = \frac{\frac{s}{v}}{\frac{C}{v} + \frac{v}{v}} = \frac{s'}{q + 1}$$

The rate of profit, then, is directly related to s' and inversely to q.[93] This relationship is also stated by Marx: "With a given rate of surplus-value, the rate of profit depends on the organic composition of capital."[94] He argues that this ratio will yield a secular decrease in p during capitalist development.[95] Why this result must be inevitable is not shown in any systematic or clear manner. At times, he tries to demonstrate this inevitability by assuming that s' is constant and that q is constantly

increasing. He says:

> ...[T]he gradual growth of constant capital in relation to variable capital must necessarily lead to a gradual fall of the general rate of profit, so long as the rate of surplus-value or the intensity of exploitation of labour by capital, remain the same.[96]

J. Robinson calls this a "tautology." She says: "...if profit per man employed is constant and capital per man employed is rising, the rate of profit on capital is falling."[97]

Robinson's criticism is valid. A tendency cannot be proven by defining the variables such that the result is determined a priori. However, outside the few instances where Marx appears to be making this error, he frequently states that s′ will also increase as q increases. This has to be so because q and s′ are not independent of each other.[98] Since he equates the increase in q with the increase in labour productivity, he cannot assume that a change in productivity will not affect s′. He says that p "changes, rises or falls (insofar as this action is not rendered ineffectual by movements of the other remaining factors), with the rate of surplus-value."[99] But he still contends that p will fall even if it is accompanied by a rise in the rate of surplus. He says: "...[T]he rate of surplus-value, at the same, or even a rising, degree of exploitation, is represented by a continually falling rate of profit."[100]

The formulation above can be used to show several possibilities which Marx does not specifically discuss.[101]

(i) If s′ increases faster than the denominator, p will increase. Hence, a rise in q is consistent with a rise in p.

(ii) If s′ increases at the same rate with the denominator, p will remain constant. Again, an increase in q need not lead to a fall in p.

(iii) If s′ increases at a slower rate than the denominator, p will

fall. Obviously, one need not hold s´ constant in order to defend the falling p. In fact, given his repeated statements that s´ will increase, (iii) must be the case he has in mind.

The cases where p may increase due to countertendencies such as a drop in q through savings in C or a decrease in the wage rate which leads to a relative increase in q can be deduced from this formulation. They are explicit in Marx's lengthy discussion on countertendencies.[102]

Given the possibilities where the rise in q may not lead to a falling p, Marx's choice for case (iii) is problematic. He sees this as the main tendency. It should be recalled from an earlier discussion that his "laws" are tendencies in the sense that they can be modified, temporarily suspended or reversed by counteracting tendencies. There is a tendency for p to fall.[103] However, "the same influences which produce a tendency in the general rate of profit to fall, also call forth countereffects which hamper, retard, and partly paralyse this fall. The latter do not do away with the law, but impair its effect."[104] He still believes that these countertendencies will not be sufficient in the long term to cancel the particular relationship between s´ and q that makes p fall. "Thus the law acts only as a tendency. And it is only under certain circumstances and only after long periods that its effects become strikingly pronounced."[105]

Marx's argument is not convincing. Classifying one set of forces, for example, those which cause a rise in q, as tendencies, and another set as countertendencies seems arbitrary unless one shows the specific causal relationships between them, balances each tendency against a countertendency, and shows that the former is always dominant.[106] Moreover, such a distinction is not even possible in many cases.[107] A rise in q simultaneously

creates the incentive to economize constant capital. Hence, both tendency and countertendency are a part of the same process. Similarly, the rise in q and the rise in s´ cannot be called a tendency and a countertendency respectively because, once again, they constitute the same process. It appears that Marx is introducing a philosophical bias in the form of his dialectics without concretely analyzing the economic forces.[108] Since the contention cannot be defended on the basis of dialectics, a more realistic explanation is needed.

Let us now consider the case when s´ increases less than q and p falls. This can happen in two situations: Firstly, the increase in q does not increase the productivity of labour significantly. In that case, even with a given real wage rate, the rate of profit can fall. Yet, Marx does not give this explanation. In fact, since he tends to equate the increase in q with increases in productivity, such an explanation would contradict his overall analysis. According to him: "The progressive tendency of the general rate of profit to fall is...just an expression peculiar to the capitalist mode of production of the progressive development of the social productivity of labour."[109] Moreover, if the increase in q does not increase productivity proportionately or more, the cause behind the falling p would not be rapid technological change but the dimishing returns in classical tradition, a tradition from which Marx claims to have broken away. It should be noted that Marx, at one point, falls back on this tradition when he attempts to explain the increase in q in terms of the diminishing returns in agriculture.[110] He must have been vaguely aware that his attempt to prove the falling p in terms of rapid technological change was a cul-de-sac. Secondly, one could argue that the increase in q leads to much higher increases in productivity but that the share of the capitalists, i.e., $\frac{s}{v}$, does not grow as much as the growth in q.[111] This

would imply that technological change starves the capitalist class and enriches the working class. Clearly, this cannot be a Marxian explanation. Even if we ignore the implications of this on the concept of the impoverishment of the working class, such an explanation would be relying on increases in the wage rate as the reason for the fall in p. Then, Marx's contention that he has discovered a law independent of the rise in the wage rate would have to be rejected. He is clearly trying to prove that his theory does not depend on the increase in the wage rate when he states: "Nothing is more absurd, for this reason, than to explain the fall in the rate of profit by a rise in the rate of wages, although this may be the case by way of an exception."[112] Some economists have interpreted this alleged fall in p in terms of the increase in the wage rate.[113] Yet, this explanation finds little explicit support in Marx's work. Our interpretation does not refute the fact that Marx sees the possibility of an increase in the wage rate as evidenced when he says: "...[H]and-in-hand with the increasing productivity of labour, goes, as we have seen, the cheapening of the labourer, therefore a higher rate of surplus-value, even when the real wages are rising."[114]

It is not possible to give any meaning to the Marxian contention outside these two explanations. However, neither fits in his analysis. His contention cannot be proven within his logical framework. Others have tried to salvage his argument by relying on extensions from his works. It is not within the scope of this study to review and evaluate these extensions, which often introduce factors such as the effects of monopolies, imperialism, and inflationary finance.[115] Also these explanations switch the framework from a crisis-free model to periodic crises arising from the realization problems. The alleged secular tendency is discarded.

What appears to lie behind Marx's argument is the labour theory of value. Since surplus is created only through the exploitation of current labour, and since constant capital adds only its own value to the product, the decrease in the number of workers relative to constant capital advanced somehow reduces the rate of growth in s and hence, the rate of growth in s´ relative to the growth in q. Consequently, the rate of profit falls. He states:

> Inasmuch as the development of the productive forces reduces the paid portion of employed labour, it raises the surplus-value because it raises its rate; but inasmuch as it reduces the total mass of labour employed by a given capital, it reduces the factor of the number by which the rate of surplus-value is multiplied to obtain its mass.[116]

The increase in s´ may "check the fall in the rate of profit, but cannot prevent it altogether" because the increase in the exploitation of fewer workers "has certain insurmountable limits."[117] "The rate of profit does not sink because the labourer is exploited any less, but because generally less labour is employed in proportion to the employed capital."[118]

This unclear role of the labour theory does not add anything to the Marxian contention. Our criticisms still apply. Why should the productivity of current labour which is now accompanied by more sophisticated machines not increase such that it offsets the increase in q by raising the rate of surplus value above it? If the commodities get cheaper because they embody less current labour due to technological change, the same type of reduction in value and hence price will be experienced with respect to the constant capital. A general deflation will not alter the real rate of profit. Neither will it reduce the real variable and constant capital that the capitalist can command through advancing his s.

In conclusion, the alleged tendency of the average rate of profit to

fall in a secular fashion because of technological change is untenable in the Marxian context. The idea has been abandoned by a large number of Marxist economists.[119] At best, it can be maintained on the basis of explanations which are explicitly rejected by Marx and which find little support in his writings. Given that this tendency is untenable, the real capital shortage model in which the increase in q reduces the rate of accumulation cannot be easily defended.

In the next section, we will integrate the alleged tendency into Marx's long term model in order to complete his analysis.

Mass of Surplus, Falling Rate of Profit and Unemployment

Accumulation, according to Marx, is financed completely out of s. The tendency of p to fall reduces the rate of growth in s and, consequently, the rate of growth in capital, and the rate of growth in demand for labour.[120] He claims that the total surplus will increase despite the fall in the rate of profit.[121] This can simply be illustrated in the following manner:

Period 0:

AAC_0: Aggregate advanced capital $(C_0 + v_0)$

p_0: Average rate of profit

s_0: Total surplus derived at the end of period 0

Then: $s_0 = p_0 \cdot AAC_0$.

Similarly, for periods 1, 2, etc.:

$$s_1 = p_1 \cdot (AAC_0 + p_0 \cdot AAC_0)$$

$$= p_1 \cdot AAC_1 \text{ (since } AAC_0 + p_0 \cdot AAC_0 = AAC_1)$$

$$s_2 = p_2 \cdot [AAC_0 + p_0 \cdot AAC_0 + p_1 \cdot (AAC_0 + p_0 \cdot AAC_0)]$$

$$= p_2 \cdot AAC_2$$

It should be noted that in each period the surplus derived from the previous period is totally advanced. Also the capital recovered from the previous period is readvanced. For the total surplus to grow, the following must hold:

$$p_0 \cdot AAC_0 < p_1 \cdot AAC_1 < p_2 \cdot AAC_2, \text{ etc.}^{122}$$

The capitalist class has an increasing s even though the rate of profit falls. In this sense, the tendency of p to fall does not ultimately put an end to accumulation.

The integration of the alleged tendency into Marx's long term analysis complicates mathematical formulations. We have already seen that in Marx, the absolute level of employment increases, i.e., $\frac{\Delta q}{1+q} < \frac{\Delta AAC}{AAC}$. Now, it is obvious that q and ΔAAC cannot be treated independently. The former will affect the latter. A simple formulation which incorporates p would be:

$$\frac{\Delta q}{1+q} < p \quad \left(\text{Since } \frac{\Delta q}{1+q} < \frac{p \cdot AAC}{AAC} \text{ and } p \cdot AAC = \Delta AAC\right)$$

Hence, for the Marxian assumption, i.e., the increase of absolute employment, to hold, the rate of profit must be greater than the rate of increase in q. If it is less than the latter, there will be a reduction in the absolute level of employment since s may not grow fast enough to make the rate of accumulation exceed the rate of growth in q. In fact, the fall in p may be such that the rate of accumulation may fall below the rate of increase in q. It is not clear why the rate of profit should not fall faster than the increase in q if it is alleged that the latter does lead to such a fall.

In conclusion, it is evident that Marx's attempt to avoid a dependency on a population theory by introducing the falling rate of profit into his analysis does not save his prediction. Once it is accepted that

the negative effect of the rise in q on the rate of accumulation cannot be proven, the rate of accumulation can offset the direct effect of the increase in q such that the CTU need not have an actual counterpart in the IRA. At best, his technological unemployment would depend on excessive growth rates in the supply of labour. In this form, he would have to argue that the rate of accumulation is high enough to increase the absolute level of employment despite the change from v to C but not high enough to absorb all the new entrants into the labour force. Given the refutation of the alleged tendency of p to fall, there is no explanation for this inadequate rate of accumulation. Moreover, in this form, even if there was unemployment, it could not, strictly speaking, be explained in terms of technological change. It would be the result of the combined effects of an independent rate of accumulation, an independent rate of growth in population, and a high rate of growth in q. Their determinants are, however, not explained.

One could still argue that, regardless of the rate of accumulation, q may increase at such rapid rates that the Marxian unemployment is possible. In other words, there is no limit to the increase in q even though there may be limits to the increase in s.[123]

Yet, such an assertion cannot be made on a theoretical basis. Even though one can easily interpret Marx's argument in this sense, one cannot defend it. In the first place, the market forces do place limits on the growth in q. Secondly, even assuming that market forces do not reduce or eliminate this bias, increases in q cannot be realized exclusively through the conversion of prior v to C. They usually require accumulation out of additional s. If the growth in s is limited due to the alleged tendency of p to fall, then the increases in q will also be limited.

Hence, assuming no limitations on the growth in q may salvage the Marxian argument but it also reveals a major weakness in Marx's analysis; he does not see a necessary association between net capital accumulation and technological change.

In the next section we will undertake an analysis to synthesize Marx's short term and long term models. Some of the observations have already been stated in other parts of the study. However, after having completed the long term model, the following section enables us to synthesize these observations and add new ones. We believe that a certain degree of repetitiveness is justifiable in this case.

8. An Evaluation of the Short and Long Term Models

The discussion in Chapter II and the compensation theory studied in Chapter III constitute the short term analysis of Marx without prior accumulation. Even though he does not make a distinction between the short and long term models, this distinction underlies what is implicit in his analysis, i.e., the separation of technological change and accumulation. Technological change in the short term is financed through the conversion of v to C. We have already seen that this process faces a theoretical difficulty once the sequence of the associated changes is considered. Either the depreciation funds in the economy or the additional funds must be used to construct the new machines. The latter, however, may imply permanent accumulation. Marx's short term result, i.e., a decrease in the absolute level of employment upon the adoption of the machines, is more consistent with the first method. It is this model, in which technological change does not require net accumulation, which is the basis of Marx's technological unemployment.

On the other hand, he introduces the possibility of general compensation owing to the growth process. This compensation arises from the use of surplus in general and not only that extra part generated by technological change itself. It is this subsequent general accumulation that compensates for the effects of technological change in the short term. He still contends that given a large enough increase in the supply of labour, accumulation and technological change will lead to long term unemployment.

Marx's short term analysis is probably the most complete presentation of the pessimistic view with respect to the employment effects of technological change. With a premise that "when a machine replaces labour, it always demands less new labour (for its own production) than it replaces",[124] he defends the pessimistic view and rigorously challenges the classical compensation theory. He incorporates, then, the logic of the short term analysis into his long term one when accumulation occurs. However, he still separates technological change from accumulation. The old capital, once recovered, undergoes a transformation. A part of v is converted to C. Meanwhile, the additional capital also embodies the new technology. The transformation of the old capital causes a net displacement. The additional capital absorbs these workers (or the equivalent) and some of the new entrants into the labour force. Because of the displacement effects of the transformation in the old capital in addition to the increase in q in the additional capital, the increased total capital is not sufficient to absorb all the new entrants. Having already criticized the long term analysis in detail, we need not review its weaknesses.

There are two further criticisms that can be raised against the Marxian analysis. The first one is related to the long term analysis. The

second one is basically directed towards the short term analysis but it also has implications for Marx's analysis in general.

(i) One can assume that in a short period or at any given time technological change may reflect the Marxian bias, i.e., the ratio of constant capital to variable capital may increase in absolute terms as a result of the change. However, as we have argued in Chapter III, it is theoretically impossible to defend such a bias in the long term. Marx seems to assume that there is no limit to it except the influence of the temporary countertendencies. As we have indicated earlier, observations do not support this alleged bias.[125] Even though the role relative prices of capital and labour play in determining the rate and direction of technological change is unclear in the long term when fundamental conditions change, this role cannot be totally ignored. It has been argued by others that the absence of a bias over long periods is most likely due to changes in relative prices. To cite one example, Blaug states:

> Perhaps the reason that technical change has not exhibited either bias to any marked degree is that the long-term pattern of innovations is the outcome of successive adjustments to differential rates of growth in the factor supplies as reflected in relative prices.[126]

Even though the proportions in which constant and variable capital are combined may be more or less fixed at any given time due to limited technical possibilities with a constant level of technology, the introduction of new technology expands these possibilities. Hence, the inevitability of increases in q cannot be argued a priori unless one assumes, without a possible theoretical justification, that technological change of the Marxian type is always more profitable than the type that may reduce q or maintain it constant in the long term. The changes in the relative prices of capital and labour will influence the development of technology and the coefficients

of production. We shall, in the appendix to this chapter, show that Marx is not clear on the role of the relative prices in influencing technological change.

(ii) Another criticism can be raised against the Marxian analysis even if the Marxian bias is taken for granted. He does not fully consider the employment creation in the capital goods sector. At best, as we have seen, he appears to argue that displacement will also occur in this sector because similar machines will be introduced in the production of the capital goods.[127] Another possible interpretation is that, despite similar technological change in this sector, employment there will increase much faster than it will in the consumers' goods sector. He states:

> The greater demand for labourers in machine building can at most affect the future distribution of the number of labourers, so that a larger part of the generation entering the labour-market - a larger part than before - turns to that branch of industry.[128]

Thus in the long term as accumulation takes place, the distribution of employment changes. This interpretation is consistent with an increase in the absolute level of employment as accumulation occurs. Yet, his short term analysis when only a conversion from V to C occurs eliminates such net expansionary effect on total employment because he does not see that net investment in machine construction may be necessary to produce the new machines. It may be necessary because the construction of the new machines for the final goods' sector usually requires changes in the production processes of the capital goods' sector. This process may require significant net investment at the aggregate level even in the short term. Thus, when such accumulation accompanies the construction of the new machines, the level of employment and output will increase in the economy. Even if the adoption of the machines displaces particular workers, the net

effect may be positive in comparison to the period before the technological change.

As indicated frequently, the sequence of changes associated with the introduction of a new technology means that the conversion of v to C will occur upon the adoption of the new machines. The initial financing of the construction of the machines must, if net accumulation is ruled out, come from the accumulated depreciation funds in the economy. Marx is not clear about this. A realistic analysis requires the specification of the source of these initial funds. The use of the depreciation funds is, however, consistent with the Marxian models. If technological change is financed through the depreciation funds, the contraction in the absolute level of employment will ensue once the machines are bought through the conversion of v to C. If the depreciation funds originate from industries other than those buying the machines, the contraction in employment will be experienced in those industries. At the level of an aggregate analysis, the difference is immaterial. According to Marx, it is only accumulation, i.e., compensation in its broad sense, which can offset this effect of technological change. It should be pointed out that Birck, in "The Theories of Over-Production,"[129] discusses technological unemployment in relation to underconsumption and comes to a similar conclusion with respect to compensation in Marx. He links it with the increased rate of accumulation following technological change.[130] The major difference between our interpretation and his is that he thinks that it is the increased productivity caused by technological change and lower wages brought about by displacement which give rise to the increase in accumulation. Our analysis has shown, on the other hand, that technological change in Marx does not play this role. In fact, it depresses the long term

accumulation through the fall in the rate of profit. Birck's interpretation implies that the economy will fluctuate between periods of full employment and unemployment in Marx. We have already shown that Marx's long term model which implies capital shortage can hardly serve this task. A better interpretation is that chronic unemployment will exist. However, he agrees that "the socialist authors" would be right "whenever labour-saving technique increases at a quicker pace than capital."[131] This obviously underlines the case when the absolute level of employment may fall. Yet, it does not explain Marx's long term model when both the absolute level of employment and the level of unemployment increase.

A theoretical framework which associates technological change usually with net investment has been defended by E. Beach. His analysis has been a major source of some of our criticisms of Marx. Even though Beach's analysis yields the opposite result, the two economists also share strikingly similar views. Both economists see technological change as being generally embodied in machines and equipment.[132] Beach does not carry out his analysis in terms of capital-labour ratios as Marx does. Nevertheless, the increase in fixed capital due to technological change is explicit. Moreover, he extends the costs of technology to formation of scientific knowledge[133] which, in Marx, appears to be free.

Neither economist relies on the adjustment processes through the relative prices after the installment of the new machines in order to reabsorb the displaced labour. What is also implicit in this is that both have a theory of non-reversing change.[134] Consequently, they both see compensation in accumulation. Yet, there is a fundamental difference here. Beach does not use the term compensation because the term tradftionally

implies that any offsetting effects must be sought in those changes subsequent to the adoption of machines, namely, in relative price changes, consumer purchasing power, and profits arising from technological change. Both the classical economists and Marx agree on most of these mechanisms. Even today, this is the common view. Marx differs from them because he does not think that the changes following the technological change will be sufficient to offset the initial net displacement of labour. On the other hand, Beach is not concerned with the subsequent changes. Compensation in Beach, if the term can be used, accompanies the introduction of new technology because such technology, according to him, usually requires net investment, i.e., the use of a prior surplus in the Marxian terms. He says:

> One kind of effect that is generally excluded from consideration is the investment needed to bring about the technological change. The only investment allowed is that which occurs later, and as a consequence of the improvement in productivity, for example to increase the supply of raw materials for the commodity in question.[135]

Even if such technological change is introduced with a view to displace labour upon its adoption and does not lead to an expansion in output where it is installed, his contention is that the initial increase in employment will be very high during the construction of the machines. On the other hand, the possible displacement effects are in the future. His criticism is that a theory that weighs the sum of future displacements against the present increase in employment is a static equilibrium analysis that rules out any further change in between.

Given his theoretical framework, there should be little concern over the pace of technological change. "...[I]f this pace is increased, investment must be increased pari passu, and if the employment effects of

the investment are as substantial as they seem to be, the early increase in spending should help the displaced workers to find alternative jobs."[136] He also introduces the multiplier effects. In this context, continuous technological change becomes the engine that enables the level of employment to increase. He is critical of the neo-classical approach that takes a complacent view based on historical observations that there is no problem to deal with.[137] This approach, according to him, presumes that it is the subsequent market adjustments that have eliminated the possibility of long term technological unemployment. For Beach, this view is misplaced. His hypothesis is that it is the additional investment associated with technological change that has resolved the problem. Moreover, he emphasizes the employment effects of technological change in the short run because this is the cause of concern, whether valid or not, among the population. The neo-classical approach does not deal with this. It is assumed that there will be a temporary problem which will be solved in the long run through market adjustments. In Marx, the temporary problem becomes a permanent one because he does not allow these adjustments to take place. Marx also offers other arguments why the rate of accumulation will decrease. In Beach, the problem is resolved in the short run.[138] He does this "without the necessity of tracing through the multiplicity of such effects", namely, the subsequent changes.[139]

The Beach model does not deal with all the different aspects of capitalist development that are a part of the Marxian analysis. The similarities and the differences ought not to be exaggerated. It is not our objective to undertake a critical evaluation of the Beach hypothesis. This task is beyond the scope of this study. We have demonstrated only that it offers a serious challenge to Marx's analysis. Moreover, since

Marx's significant technological changes are also the types that Beach associates with additional investment, the challenge becomes more important. If Marx's changes cannot be financed through depreciation funds or capital which is already in use elsewhere in the economy, the Beach critique holds.

This critique does not challenge directly Marx's long term analysis when accumulation occurs. As we have seen, the long term analysis of Marx may hold under very special conditions, although it is plagued with other theoretical problems related to the falling rate of profit. Beach's approach, however, may constitute a critique for the long term analysis as well. If significant technological changes require large new investments, then the rise in q cannot be seen independent of the associated accumulation. The rise in q will be limited by the availability of these investments. It cannot, as implied in Marx, be without limits even when the rate of accumulation falls. Beach does not deal with this aspect in his critique of Marx, which has been stated several times in our study.

In conclusion, as we have stated in Chapter III, Beach's hypothesis can serve as a critique of Marx not because it is derived from the neo-classical paradigm that places the subsequent market adjustments in the center of its analysis, but because it can be posed within the context of the Marxian paradigm. The two major similarities earlier indicated are sufficient to warrant such an assertion.

APPENDIX

RELATIVE PRICES AND TECHNOLOGICAL CHANGE IN MARX

1. Introduction

Up to this point in our study, we have frequently indicated that Marx's analysis ignores the role of the relative prices of capital and labour in determining the direction and the rate of diffusion of technological change. In fact, we have abstracted from these in most of our discussion even though some observations were made to underline the general differences between the traditional approach and Marx's. Later, particularly the changes in W have been considered insofar as how they affect accumulation following the adoption of the new machines. Their influence on further changes in q has not been evaluated. Stated simply, the significance of relative prices in choosing a technology has not been analyzed. Clearly, this question is also an integral part of the alleged technological bias in Marx. The major reason for not having done this is that Marx is not clear on this aspect. Even though sometimes he refers to the role of the high wage rate in inducing labour displacing technological change, the evidence is mixed. There are other statements which are contradictory.

Before we proceed with this analysis, some general difficulties should

be underlined. The role of relative prices in the introduction of new technology is one that is unsettled even in modern theory. The neo-classical approach emphasizes the role of relative prices of capital and labour in the context of a given technological frontier as relative prices affect the movements along a product isoquant. However, the shifts involving technological change cannot be explained through the same mechanism. The shifts, then, appear as exogenously determined. There is no theoretical framework that incorporates technological change, relative prices and accumulation. The absence of such a theoretical apparatus in Marx is, then, not a major source of weakness in itself.

On the other hand, it is important to study the role of relative prices in order to understand the Marxian logic if one is not to misinterpret the meaning of technological change in Marx. As we will see, there is, at times, some evidence in Marx's writings for an interpretation along the neo-classical lines, i.e., the Marxian change can be seen as movements along an isoquant even though he makes no such distinctions.

In the rest of this section, we will analyze the role of the relative prices in relation to choosing a technology in order to further clarify the nature of Marxian changes. Our major objective is to develop the analysis insofar as it can throw more light on the question of technological unemployment. In this sense, a full critique of the meaning of technological change or of the differences between shifts in production isoquants and movements along them as they may apply to Marx is beyond the scope of this study.

Some most obvious differences between Marx's analysis of technological change and the neo-classical approach can be listed as follows:

(i) Marxian technological change is, on the whole, not equivalent to the change in the techniques of production which is explicit in the neo-classical analysis of movements along a product isoquant. His technological change is the introduction of hitherto unknown methods of production.

(ii) The Marxian analysis deemphasizes the role of relative prices in reversing the technique of production once a new technology is adopted. The new machines and equipment are not malleable. To state differently, substitution of the neo-classical type does not exist once the new technology prevails in the economy. The possibility of substitution arises when the constant capital in physical units has been recovered in money capital and is ready to be readvanced.[1] Even then, instead of a change in q on the basis of a given technology, the Marxian bias is reflected through the introduction of new technology that raises q further.

2. Relative Prices and Their Influence on Technological Change

Marx often links the introduction of new machines to the rise in the wage rate. When the demand for labour exceeds the supply of available workers, the wage rate increases and the rate of profit falls. Without technological change drive for accumulation is blunted. Unemployment ensues. Then, "the price of labour falls again to a level corresponding with the needs of self-expansion of capital, whether the level be below, the same, or above the one which was normal before the rise of wages took place."[2] Here, it would appear that the IRA may be exhausted when accumulation occurs without technological change. But once technological change is integrated into the analysis, it then becomes the lever through

which profitability is maintained or increased at least during short periods. Technological change is substituted in place of the Malthusian population growth.[3] It enables the formation of an IRA and the continuation of accumulation without shortages of labour.

At the outset, the wage rate appears to be the only inducement for technological change in Marx. Such clearly is the case for the Ricardian change.[4] However, this can be a source of possible confusion if it leads one to an interpretation along the neo-classical lines. It can, then, be perceived as pure mechanization on the basis of a given technology. The totality of Marx's analysis gives little support to this interpretation. We offer the following reasons:

(i) When such a substitution of the neo-classical type occurs along an isoquant due to the increase in W, the average cost of production will have to be higher than that which existed before the substitution. This has to be so if we assume that the initial choice of technique is the most profitable one given the set of known techniques. Then, the price of the commodity cannot decrease below the level that prevailed before the substitution. The more likely result is that it will increase to reflect the increase in costs.

Such a result does not correspond to Marx's analysis. In his case, the use values get cheaper after the introduction of the machines. Hence, the machines must be superior to the ones that are known or that already exist in the market. The advanced capital will, in the Marxian case, be less than the amount advanced before the change takes place.

There still exists, however, some degree of ambiguity. Even in the neo-classical analysis, the total advanced capital when the switch to

another technique occurs, will be less than the amount which was advanced when the rise in the wage rate took place, i.e., before the switch to an alternative technique already known. If our interpretation of Marx is correct, the advanced capital must also be less than the amount that is advanced before the rise in the wage rate. Only this is consistent with the cheapening of the use values over time. Since Marx does not make such distinctions, we cannot further substantiate our contention. This contention may be weak by itself because it raises a fundamental question: Why then does technological change not occur in the absence of a relative rise in W since it can reduce the advanced capital below the level preceding the rise in W? The answer to this will be given in conjunction with the observations to follow.

(ii) A second reason for disassociating the Marxian technological change from the movements on an isoquant lies in that Marx frequently deemphasizes the influence of the wage rate in the introduction of technological change. In other words, he does not show the increase in W as a permanent influence. He cites that, in the second half of the 18th century, population increased, wages decreased, but that the adoption of machines was accelerated.[5] He also asserts: "Machinery inserts itself to replace labour only where there is an overflow of labour powers."[6]

Admittedly, the meaning of the quotation above is unclear. One possible interpretation is that the machines are introduced even when there is a high level of unemployment. The wage rate does not stop the Marxian technological change. The wage rate is never low enough to stop it even though high wage rate accelerates it. One impression, though not very clear, is that the relative scarcity of labour may accelerate, or its abundance may slow down the adoption of new technology.[7] These, however,

neither cause a reversal in techniques nor lead to an offsetting technological change that reduces q over long periods. In summary, the direction of technological change does not appear to be significantly affected by the fluctuation in the wage rate.

(iii) A third explanation for why the Marxian technological change is not the neo-classical analysis of movements along an isoquant is that, in Marx, at any given time, the coefficient of production is more or less fixed. "A definite number of labourers corresponds to a definite quantity of means of production...."[8] This statement may be interpreted in two ways: (a) Once a technology is adopted and reflected in concrete means of production, the relationship of constant to variable capital cannot be altered; (b) The latest technology will be more profitable than all the techniques known in the past even in the context of subsequent variations in relative prices within realistic limits set by institutional characteristics. In Marx, these characteristics cannot be ignored. Hence, in practice, the coefficient in production may be fixed over long periods.

The possible explanations and reasons given above are those that can either be traced in Marx's works or inferred from them. Since the Marxian analysis can hardly be comprehended within the neo-classical framework, we will not pursue these arguments further. It is true that there is still an element of indeterminacy in the Marxian analysis. Why technological change should always increase q in absolute terms remains inexplicable or, at best, it is dependent on some very particular conditions which involve downward rigidity in the wage rate. Models built on rigidity in factor prices can, of course, have unemployment.[9]

A more important question related to the foregoing analysis is the following: Would it alter the Marxian analysis if the neo-classical

substitution and perfect wage flexibility were allowed? The answer must be affirmative. Then, it could be argued that the changes caused by the increase in the wage rate would be reversed once the wage rate was depressed through the effects of the increased IRA. Technological unemployment might be a temporary inconvenience.

Given the Marxian analysis, such a reversal in the technique of production is not likely. Technological change not only increases the life span of the constant capital, i.e., new machines, but it also increases its absolute amount. The reversal in techniques may become economically unfeasible for long periods unless the wage rate falls in such a way that the losses involved in scrapping the machines are offset by the decrease in the wage bill. Including the historical and social element in wage determination, such significant fluctuations in the wage rate are unlikely in the Marxian context. Moreover, even if substitution along the neo-classical lines is possible in the long term, the period in between will be marked by further changes in technology and in other market forces. The price relationships will be continuously altered. The necessary assumption for the neo-classical result is that fundamental conditions do not change until the adjustment takes place. This is difficult to maintain in a dynamic framework. As Kalecki points out, once continuous technological change occurs, the equilibrium analysis cannot be used.[10]

Even though this criticism indicates a major weakness of the compensation theory implicit in the neo-classical approach, it does not prove the necessity for q to rise over long periods. It only shows that, if technological change of the Marxian type occurs, the neo-classical mechanism may not be adequate to reverse the result. Technological change would reduce the fluidity of capital.[11] In this sense, the Marxian

approach, which holds that accumulation is the major source of compensation,[12] is an alternative to the neo-classical approach whose long run adjustment mechanisms may hold under a slow pace of technological change or under technological changes that do not represent revolutionary innovations. As Rymes points out, the movements along an isoquant come into effect when technological change is slowing down.[13] Heertje indicates that "as the importance of the production function increased, so the question of technical change receded into the background."[14] If the Marxian change were to occur rapidly or if technological change was so significant as to render all of the known techniques obsolete, then the neo-classical approach would face serious problems. This divergence, however, also reflects the fundamental difference between the views held by the Marxists and the non-Marxists on the nature of capitalism. It cannot be limited to the question of technological change and unemployment alone.

Marx never discusses the role of the price of capital in technological change. He sees interest as the cost of money capital.[15] But he attaches no importance to it in the introduction of new technology. The increase in demand for the funds to be advanced as constant capital does not appear to reverse the bias in q. The importance attached to the role of interest in traditional economics when techniques are chosen on the basis of a given technology cannot be applied to a framework when the level of technology is continuously changing. Given the wide degree of scepticism among most economists on the relationship of interest rate to investment and to the choice of technology, we will not pursue its relevance to the Marxian analysis.

Finally, it may even be misleading to speak of the role of relative prices in Marx since the only input is labour according to the labour

theory of value. The price of capital goods is reduced to the value of the amount of labour embodied in the machines. In this sense, the wage rate becomes the major allocative influence. Hence, the Marxian assumption must be that even if the new machines become expensive due to the increase in the wage rate, their introduction may still be more profitable because they may reduce the total amount of labour expended in the production process. He also indicates that the new machines will get cheaper as they are produced in larger quantities. He has no upward sloping short run supply curve for the new machines. A better interpretation would be that he has a long term downward sloping supply curve in mind. His reference to Babbage illustrates this point.[16]

NOTES TO CHAPTER IV

1. R. V. Eagly, The Structure of Classical Economic Theory (New York: Oxford University Press, 1974), p.117.

2. Marx, Capital I, 597.

3. J. Robinson, "Keynes and Ricardo", Journal of Post Keynesian Economics 1 (Fall 1978), 17-8.

4. Marx often indicates the possible effects of technological unemployment on the wage rate and laments the fate of the workers pushed into low wage industries. Yet, his analysis of the fluctuations in the real wage rate is neither rigorous nor consistent. We have already indicated that he accepts the possibility of increasing real wages for the workers who are still employed. His analysis of the employment question is the more cogent one. For a discussion of the effects of cycles on the wage rate see Capital I, 596.

5. Ibid., p.407. Also see Marx's criticism of the arguments emphasizing only the short term inconvenience. Ibid., p.416.

6. Jerome, Mechanization, p.388.

7. Lowe, pp.234-5.

8. Marx, Capital II, 369-527.

9. Marx, TSV II, 496-535; Capital III, 241-60.

10. Shoul, "Karl Marx and Say's Law", in Spengler.

11. Marx, Grundrisse, p.285.

12. Ibid.

13. Marx, Capital III, 524.

14. Even though this is a criticism which can easily be raised against Marx's long term accumulation model, his fragmented comments on crises indicate that capitalists' profits will not automatically flow into accumulation.

15. Even if this is true in the developed capitalist world, the capital shortage argument is dominant in literature dealing with the underdeveloped countries. H. J. Brutton points out that the growth models developed in the post-war literature are inadequate to deal with these countries because they tend to assume away the question of the supply of capital. He says: "The unemployment is caused [in these

countries] by a shortage of investment, but the shortage of investment is caused not by a deficiency of aggregate demand but simply by a shortage of capital." "Growth Models and Underdeveloped Economies", in A. N. Agarwala and S. P. Singh, eds., The Economics of Underdevelopment (New York: Oxford University Press, 1970), p.229. For further references on the question of technological unemployment and supply of capital, see the same article. It is also significant to note that D. Hamberg criticizes Harrod's model, which specifies the equilibrium condition necessary for full capacity ulilization of capital as net investment takes place. Yet, the growth rate of income necessary for this equilibrium is not identical with the full employment growth rate when the supply of labour increases. Thus, full employment growth may exceed the full capacity growth. Hamberg points out that this is, in fact, the Marxian unemployment. He points out that this unemployment is not due to deficient demand. He says: "Lowering the savings function in this case would serve only to further such inflationary forces as are present." "Full Capacity vs. Full Employment Growth", QJE LXVI (Aug. 1952), 448.

16. Marx, Capital III, 243.

17. Hence, the measurement of q during crises would be particularly difficult.

18. Marx, Capital I, 382.

19. Marx, Capital II, chaps. XV-XVI.

20. Marx, Capital I, 595. He also says: "The number of labourers commanded by capital may remain the same, or even fall, while the variable capital increases. This is the case if the individual labourer yields more labour, and therefore his wages increase...." Ibid.

21. Desai, p.83.

22. D. S. Yaffe, "The Marxian Theory of Crisis, Capital and the State", Economy and Society 2 (1973a), 210. J. M. Morris "Reproduction and Crises: Contrasting Observations", Science and Society 28 (1964), 80.

23. Marx, Capital I, 590.

24. Marx, Grundrisse, p.390.

25. Marx says: "Capitalist production can by no means content itself with the quantity of disposable labour-power which the natural increase of population yields. It requires for its free play an industrial reserve army independent of these natural limits." Capital I, 594. This function is fulfilled by labour displacement.

26. Ibid., p.574. Also see Birck, p.27.

27. Marx, Capital I, 590.

28. Ibid., p. 567. Also see p.589.

29. Marx sees technological change as a "revolution". Ibid., pp.354, 355, 362, 373.

30. Blaug, "Technical Change and Marxian Economics."

31. Quoted in Gourvitch, p.78.

32. Ibid.,pp.495-6.

33. Furth and others, p.263.

34. Marx, TSV III, 382-8.

35. He says: "When machinery seizes on an industry by degrees, it produces chronic misery among the operatives who compete with it. Where the transition is rapid, the effect is acute and felt by great masses." Capital I, 406. Also see Heertje, Technical Change, p.43

36. For an example see Ricardo, p.386.

37. Ibid.,pp.386-7. Also see Gregory, p.555.

38. Marx, Capital III, 145.

39. Marx, Capital I, 588-9.

40. Ibid., p.586.

41. Ibid., p.588.

42. Ibid. For a discussion of factors giving rise to centralization, see pp.586-7.

43. Ibid., p.587.

44. Marx, TSV III, 389.

45. Marx, Capital III, 263. For a discussion on concentration, see pp.218-9. Also Capital I, 587.

46. Marx, Capital I, 575.

47. Ibid., p.589.

48. Ibid.,pp.427-8.

49. Ibid., p.598. He says: "The impulse that additional capital, seeking an outlet, would otherwise have given to the general demand for labour, is therefore in every case neutralised to the extent of the labourers thrown out of employment by the machine." Ibid., p.599.

50. Ibid., p.423.

51. Marx, Capital III, 220.

52. E. Reiner also attributes such a view to Marx. "Some Remarks on Automation", Science and Society 28 (1964), 446.

53. See note 60.

54. Marx, Capital III, 399.

55. Marx, Grundrisse, p.393.

56. Marx, TSV III, 441.

57. Marx, Capital III, 223.

58. Marx says: "In other words, for the variable portion of the total capital not to remain the same in absolute terms, but to increase absolutely, in spite of it falling in percentage of the total capital, the total capital must grow at a faster rate than the percentage of the variable capital falls." Ibid., p.223.

59. He says: "At any rate, it is but a requirement of the capitalist mode of production that the number of wage-workers should increase absolutely in spite of its relative decrease." Ibid., p.263.

60. Ibid.

61. Marx, TSV III, 541.

62. Jerome, Mechanization, p.375.

63. The following summary of the formulations can be found on p.13 in Schwarz and Wagner.

F_{t*} = Theoretical displacement.

F_t = Actual displacement.

A_t = Employment in time period t.

A_{t*} = Theoretical employment.

Then: $F_{t*} = A_{t-1} - A_{t*}$

The authors integrate the labour coefficient into their formulation by specifying the former as "a".

$$a = \frac{\text{Employment (A)}}{\text{Total output (Y)}}$$

Then: $F_{t*} = a_{t-1} Y_{t-1} - a_t Y_{t-1}$

$= (a_{t-1} - a_t) Y_{t-1}$

In this formulation, Y_{t-1} is equal to Y_t, i.e., the output is held constant. Obviously, F_t will depend on the growth in a and Y. However, the authors do not explain where the capital originates from.

64. Marx, Capital I, 598.

65. Ibid.,pp.372-9. Also see TSV II, 477.

66. V. I. Lenin, "The Development of Capitalism in Russia", in Collected Works 3 (Moscow: Foreign Languages Publishing House, 1960), 228-37.

67. Marx, Capital I, 599.

68. Ibid.,pp.601-2.

69. Lenin, p. 496.

70. Marx, Capital I, 599.

71. Ibid.,pp:597-8.

72. Marx, Capital III, 242-3; Grundrisse, p.753.

73. For criticism of Malthus see Marx, Capital I, 597; Grundrisse, pp.605-6; TSV II, 115-7, 121, 540; TSV III, 13-68.

74. This is a point made by Barton and Marx agrees with it. TSV II, 582.

75. Marx, Capital I, 600; TSV III, 245.

76. Marx, TSV II, 477.

77. Marx, Capital II, 505. He says: "It therefore follows of itself from the nature of capitalist process of accumulation...that the increased mass of means of production that is to be converted into capital always find a correspondingly increased, even excessive, exploitable worker population." Capital III, 219. Also see TSV I, 229.

78. M. Morishima, Marx's Economics (London: Cambridge University Press, 1974), p.117.

79. W. Krelle, "Marx as a Growth Theorist", German Economic Review 9 (1971), 127.

80. Marx, Grundrisse, p.605.

81. Marx, TSV II, 77.

82. Marx, Capital I, 604.

83. For a few vague statements see Marx, TSV III, 247-50.

84. Marx, Capital I, 581.

85. Marx, Capital III, 241.

86. Quoted by Christiansen, p.20. For a brief discussion on this law see Marx, Capital III, 211-231.

87. Dobb, "Falling Rate of Profit", p.99.

88. Marx, Grundrisse, pp.753-4.

89. Ibid., p.754.

90. Ibid. Also see TSV II, 439.

91. Marx, TSV II, 439.

92. P. Mattick, "Value Theory and Accumulation", Science and Society 23 (Winter 1959), 34. Also see N. Okishio, "Notes on Technical Progress and Capitalist Society", Cambridge Journal of Economics 1 (1977), 96; M. E. Weisskopf, "Marxian Crisis Theory and the Rate of Profit in the Postwar U.S. Economy", ibid. 3 (1979), 243.

93. For an exhaustive treatment of the falling rate of profit see H. Denis, "Rate of Profit and National Income", Science and Society XXIII (Fall 1959); Robinson, Essay, pp.35-42.

94. Marx, TSV II, 426. Also see Capital II, 260.

95. Marx, Capital III, 213.

96. Ibid., 212. Also see TSV II, 426.

97. J. Robinson, "The Falling Rate of Profit: A Comment", Science and Society XXIII (Spring 1959), 105.

98. Marx has frequently been criticized for ignoring this. See H. D. Dickinson, "The Falling Rate of Profit in Marxian Economics", RES XXIV (Feb. 1957), 123; A. Walker, "Karl Marx, the Declining Rate of Profit and British Political Economy", Economica XXXVIII (Nov. 1971), 363-5; Dobb, "Falling Rate of Profit", p.102.

99. Marx, TSV III, 232.

100. Marx, Capital III, 213. Also see pp.215, 226, 248.

101. For a discussion on the rate of profit when q and s' change at different rates see R. L. Meek, "The Falling Rate of Profit", Science and Society 24 (1960), 46-48.

102. Marx, Capital III, 232-40.

103. Marx calls the "general law" a "tendency". Ibid., p.232. Also see E. Varga, Essais sur l'Economie Politique du Capitalisme (Moscow: Progress Publishers, 1967), pp.21-2.

104. Marx, Capital III, 239.

105. Ibid. A. Pesenti defends Marx by saying: "These counter-tendencies do not justify the conclusions that the law has ceased to operate, any more than the fact that man now flies annuls the law of gravity." "The Falling Rate of Profit", Science and Society XXIII (Fall 1959), 240.

106. See Dobb, "Falling Rate of Profit", pp.99-100.

107. Mattick, "Value Theory", pp.35-6.

108. For a discussion on the relationship between dialectics and tendencies see D. C. Hodges, "The Method of Capital", Science and Society 31 (1967), 507-8.

109. Marx, Capital III, 213.

110. He makes a distinction between organic and inorganic processes. TSV III, 368. Walker must be basing his interpretation on this when he claims that Marx's analysis of the rate of profit was similar to that of classical economists. pp.372-3.

111. Denis, p.306.

112. Marx, Capital III, 240.

113. The use of the increasing wage rate as a means to salvage Marx's falling rate of profit is discussed by both Denis, p.306 and J. Morris, "Spurious Capital", p.305. Also see B. Fine, Marx's Capital (New York: MacMillan, 1975), pp.60-62.

114. Marx, Capital I, 566.

115. See Fine; Morris, "Spurious Capital"; P. A. Baran and P. M. Sweezy, Monopoly Capital (New York: Monthly Review, 1968), pp.108-11.

116. Marx, Capital III, 247. He says: "The drop in the rate of profit is not due to an absolute, but only to a relative decrease of the variable part of the total capital, i.e., to its decrease in relation to the constant part." Ibid., p.217. This also confirms our earlier interpretation that Marx sees the absolute growth in v as the dominant tendency. The relationship of a relative decrease in v to the falling p is also expressed on pp.212, 216.

117. Ibid., p.247. Also see Capital I, 289.

118. Marx, Capital III, 246. Also see TSV III, 311.

119. See P. M. Oppenheimer, "Accelerated Investment and the Average Rate of Profit: A Note", Economica XXXII (Nov. 1965); J. E. Roemer, "Continuing Controversy on the Falling Rate of Profit: Fixed Capital and Other Issues", Cambridge Journal of Economics 3 (1979), 380.

120. B. G. Pisliakov, "The Mathematical Model of Reproduction of Karl Marx and V. I. Lenin", Matekon XII (Fall 1975).

121. Marx, Capital III, 246, 242.

122. Marx states a mathematical relationship incorporating q and the rate of growth of capital. "For the mass of profit made at a declining rate of profit to remain the same, the multiplier indicating the growth of total capital must be equal to the divisor indicating the fall of the rate of profit." Ibid., p.222.

123. J. Morris, "Profit, Automation and the Cold War", Science and Society 24 (1960); "Spurious Capital", pp.303-4.

124. Marx, TSV III, 441. Also see TSV I, 217.

125. Blaug, "Technical Change and Marxian Economics", p.233. It must, however, be pointed out that capital intensity can be related to output as well as to labour. It is the second that Marx has in mind. S. Menshikov indicates that there are real forces operating in the economy which may reduce both the capital-output and capital-labour ratios. The Economic Cycle: Postwar Developments (Moscow: Progress Publishers, 1975), pp.200-201. For the distinction between the ratios see M. Dobb, "Second Thoughts on Capital-Intensity of Investment", RES XXIV (Feb. 1957); A. Sen, Employment Technology and Development (London: Oxford University Press, 1975), pp.47-8.

126. Blaug, Economic Theory, p.268. Also see W. Fellner, "Does the Market Direct the Relative Factor-Saving Effects of Technological Progress?" in Inventive Activity: Economic and Social Factors, National Bureau of Economic Research (Princeton: Princeton University Press, 1962). Also see Fellner, "Marxian Hypotheses and Observable Trends Under Capitalism: A 'Modernised' Interpretation", EJ LXVII (March 1957).

127. Marx, TSV I, 243.

128. Ibid., p.217.

129. Birck, "Over-Production."

130. Ibid., p.29.

131. Ibid.

132. Beach, "Failure in Theorizing", pp.125-6.

133. Ibid., 125. Also see by the same author, "Statics and Dynamics of Innovation", Relations Industrielles/Industrial Relations 31 (1976), 677.

134. Beach's arguments do not rely on long term adjustments of the neo-classical type. Ibid., p.679.

135. Beach, "Failure in Theorizing", p.127. Also see his "Hicks on Ricardo", p.919.

136. Beach, "Failure in Theorizing", p.129.

137. Beach, "Statics and Dynamics", p.680.

138. Beach, "Failure in Theorizing", p.130.

139. Ibid.

NOTES TO APPENDIX

1. Marx does not deal with this possibility adequately. See note 7 below.

2. Marx, Capital I, 581.

3. M. Wolfson points out that the low wages in Marx are "maintained by the rate of accumulation of constant capital exceeding the rate of growth of total capital." A Reappraisal of Marxian Economics (New York: Columbia University Press, 1971), p.120.

4. Ricardo says: "Machinery and labour are in constant competition, and the former can frequently not be employed until labour rises." p.387.

5. Marx, TSV II, 583.

6. Marx, Grundrisse, p.702. He adds: "[Machinery] enters not in order to replace labour power where this is lacking, but rather in order to reduce massively available labour power to its necessary measure." Ibid.

7. Marx also indicates that the redundancy of labour caused by machinery may lead to a reduction in the wage rate and retard the adoption of machines in the other branches of the industry. Capital I, 371.

8. Marx, Capital III, 145.

9. See Morishima, p.160; T. Scitovsky, "Capital Accumulation, Employment and Price Rigidity", RES VIII (Feb. 1941), 88.

10. M. Kalecki, p.178.

11. Seligman, "Philosophic Perceptions", p.3.

12. Marx, Poverty of Philosophy, p.215.

13. T. K. Rymes, On Concepts of Capital and Technical Change (London: Cambridge University Press, 1971), p.50.

14. Heertje, Technical Change, p.94.

15. Marx, Capital III, 353, 361, 369; TSV III, 378.

16. Marx, Capital I, 381.

CHAPTER V

TECHNOLOGICAL UNEMPLOYMENT AND MARXIAN CRISES

1. Introduction

In the preceding chapters, we have abstracted from the role of crises in capitalist development. The last chapter indicated the fundamental weaknesses of the long term crises-free accumulation model. However, a thorough examination of Marx's vision of capitalist development requires that we also consider the crises. In fact, one can even claim that Marx's accumulation cannot be studied without crises. Mattick sees this accumulation as the theory of crises.[1] Gourvitch points out that in Marx, the effects of technological change on employment are of a cyclical nature.[2] Moreover, we believe that the analysis of crises reduces the seriousness of some of the criticisms expressed in the last chapter.

Even though Marx frequently refers to the inevitability of crises in capitalism and offers several theories, his treatment of this area is not systematic.[3] Schumpeter says that it is the "unwritten chapter."[4] The relationship of technological change and technological unemployment to crises is even less clear. The latter is almost totally absent in his sketchy analysis. Consequently, the

Marxian crises have, on the whole, been studied by Marxists and non-Marxists without giving much consideration to this question. Although the role of the increase in q has often been indicated, for example, in relation to the disproportionality between the two departments in Marx's analysis, the effects of labour absorption and displacement due to technological change have largely been ignored.[5]

How are technological change and technological unemployment related to the different phases of the cycle? Does technological unemployment play any part in causing the crisis? Is Marx's long term accumulation model with increasing levels of technological unemployment consistent with unemployment due to crises?

These questions cannot be answered without ambiguity on the basis of Marx's specific comments. Our attempt to answer them will be based largely on inferences and on our preceding analysis.

The causes of crises in Marx have been an area of controversy among the Marxist economists and have received little attention from those outside the Marxian paradigm. The major aspects of the controversy among the Marxists have been presented by Paul Sweezy.[6] He classifies the different views on crises as deriving from either the falling rate of profit or the realization problems. The former is explained either in terms of the increase in q or the increase in the wage rate during the boom. The latter is explained either in terms of the disproportionality between the capital goods and consumer goods sectors or in terms of underconsumption. There does not appear to be, however, any single cause of the crisis that most Marxists agree upon.

Our presentation later in this chapter will be on the basis of a classification similar to that put forth by Sweezy. The only difference will be that, instead of using a general heading such as "realization" to cover the disproportionality and underconsumption arguments, we will analyze the falling rate of profit and these two arguments individually. Once the meaning of realization is specified, it becomes clear that all the Marxian crises are essentially realization crises.

2. Scope and Objectives of the Chapter

Particularly in this chapter, the danger of going beyond the main theme of the present study exists. This is inherent in the fact that the analysis of crises can be extended to cover the evolution of capitalism in jumps and spurts. Any thorough study of the crises would lead to a discussion of many topics such as the changes in income distribution, centralization and concentration, money and credit, changes in production methods, significance of exchange economy, role of new markets and colonies, and political factors. In fact, Marx makes use of all these concepts in his comments. It is even possible that the "unwritten chapter" on crises would have been the synthesis of the Marxian ideas. The alleged ultimate breakdown of capitalism would probably have been related to the intensification of the crises. The remarks on the crises are, according to Schumpeter, "previews" on the ultimate fate of the capitalist system.[7]

The subject of crises can reach unmanageable proportions. Any rigorous study must, by necessity, be carried out within narrower limits. This task is not, however, easy even if a particular aspect of the crises is specified as the subject of investigation. Marx's dialectical approach

renders the separation of "essentials" from "non-essentials" problematic. Hence, a certain degree of arbitrariness is unavoidable. It would be presumptuous for this student or for anyone else to deny this difficulty given the complex interrelationships of his ideas and his all-encompassing vision of capitalist development. Therefore, we will not attempt to justify our omissions or partial development of certain relationships. If we can establish some general relationships between the crises and technological unemployment, and indicate how Marx's long term unemployment might be made consistent with unemployment due to crises, our main objective will have been satisfied. The causes of crises and the different phases of cycles will be analyzed only insofar as they can be used to further clarify the meaning and significance of technological unemployment. The controversies regarding the causes of crises or a full theoretical development of the main types of crises are beyond the scope of this study.

We will show that technological change and technological unemployment can be introduced to all of the different types of crises in Marx. They can form a common characteristic shared by these seemingly different types of crises. We believe that the importance of this aspect has been more or less untouched in the ongoing controversies. We do not contend that the addition of technological unemployment leads to a synthesis of his often contradictory arguments. Our objective is limited. Since technological change leads to structural changes in the economy and affects the demand for labour, crises cannot be studied independently of these changes. It is our objective to show that the Marxian crises incorporate this aspect. It is not, however, our objective to evaluate the empirical validity of his arguments.

3. A General Survey of Cycle Theories

Before we deal with the Marxian crises in particular, we will present a brief survey of cycle theories in general so that Marx's theories can be placed in a historical perspective. The following is not an exhaustive review. Particularly the current theoretical developments or the Keynesian theories are excluded from this review. The discussion will be based mainly on secondary sources even though in some cases the original works of some cycle theorists affected Marx will also be reffered to.

Haberler's Prosperity and Depression[8] and Hansen's Business-Cycle Theory[9] are two major works that offer broad classifications of the cycle theories and the theorists associated with them. Schumpeter's History of Economic Analysis[10] does not contain as detailed a survey as these works. Yet, the historical significance that he attributes to Marx in this area surpasses the attention Marx receives from the other two authors. In fact, Haberler does not refer to Marx at all even though he includes authors influenced by Marx. We believe that Schumpeter's more general comments and insights not only capture the essential differences among the cycle theories but they also show that these theories must be understood in relation to a particular system and its characteristics. This historical perspective that is fundamental to the understanding of Marx is, as we will see, also emphasized by Hansen.

Haberler proposes three groups of cycle theories: (i) Theories that find the causes of cycles in purely monetary factors; (ii) Theories that emphasize over-investment; (iii) Theories based on underconsumption.

He also points out that the over-investment theories can be sub-divided

into: (a) Those that integrate the monetary factors with real factors; (b) Those that give a minimal role to money and, instead, emphasize inventions, innovations, discoveries of new markets, etc., as these lead to over-investment; and (c) Those that claim that changes in consumption demand give rise to more violent fluctuations in the production of producers' goods.

The underconsumption theories are also seen in two versions:

(a) One version emphasizes the role of technological change in creating excess productive capacity which grows ahead of the growth in consumer demand.

(b) The second version claims that somehow money is lost to the system and the crisis starts due to deflation. In other words, the quantity of money does not increase with the increase in output. Hence, consumption demand is limited, and a lack of purchasing power starts the crisis through deflation.

Haberler also classifies the economists associated with these theories. Marx does not appear in any of them. The economists influenced by Marx, for example, Aftalion, Spiethoff and D. H. Robertson are associated with the versions of over-investment theories that either ignore money or pay little attention to it. Hobson is cited as the central figure in the underconsumption theories. We will see that Marx, too, could be placed in the same groups that give money and credit a subsidiary role, and also in underconsumption theories that link excess capacity caused by technological change with inadequate growth in consumption demand. However, the direct effects of technological change on employment and the role of technological unemployment does not appear in this survey.

From our perspective, a more useful classification is advanced by Hansen who divides the cycle theories into 3 groups:[12] (i) Those theories that claim that the business cycle is a function of the capitalistic economy; (ii) Those theories that attribute the cycle to competitive and exchange economy; (iii) Those theories that see the causes mainly in monetary factors.

This classification, unlike the one by Haberler, underlines the significance of the particular social-economic system in understanding the cycles. The characteristics of capitalism are an integral part of this classification. However, Hansen does not fully develop this aspect. Its significance is emphasized more clearly by J. M. Clark in his Strategic Factors in Business Cycles,[13] which is not, however, a survey of cycle theories. He states: "The trouble seems to be not so much that business men mistake their interests-though that does happen, and aggravates some of the difficulties-as that their actual interests lie in doing the things which bring on the cycle, so long as they are acting as individual business men or representatives of individual business interests."[14] Schumpeter's evaluation of Marx stresses the same point when he states that Marx was the only exception to the economists before 1914 who superimposed cycles on an otherwise properly functioning capitalist system. Others saw the crisis as a "pathological" case.[15] In Marx, the crisis becomes an "essential form of capitalist life."[16]

Returning to Hansen, the theorists who see the business cycle as a function of the capitalistic economy are divided into 2 sub-groups.[17] One group sees the root of maladjustments causing the crisis in the unequal income distribution perpetuated by capitalist relationships. Hence, the large savings in the possession of the upper groups are turned

into investment which, combined with technological change, increases the roundaboutness of the production methods and increases the output of consumption goods. However, this increase in output is in excess of the consumption power of the workers. A crisis erupts. Hansen calls this first sub-group, the over-saving (underconsumption) theorists. He includes Lauerdale, Malthus, Sismondi, Marx and Hobson in this group.[18] He states that the implication of their arguments is that if distribution were improved, the cause of the crisis would be eliminated.[19]

Even though our objective is not to undertake a full critical analysis of these classifications, it must be noted that Hansen's conclusion cannot be applied to Marx. In the first place, according to Marx, under a capitalist system such a change in distribution is not possible because the capitalist class will resist it. If any improvement in income distribution takes place either through class struggle or through temporary competitive conditions, for example, in times of relative scarcity of labour when the wages are pushed up, the capitalists will change the methods of production in order to reverse the trend in income distribution. This is related to technological displacement and its effects through the reserve army. The absence of this aspect in Hansen's study leads him to an erroneous conclusion with respect to Marx. The relationship of underconsumption in Marx to technological displacement will be fully analyzed later in this chapter. Leaving this objection to Hansen's classification aside, his summary of the views in this sub-group indicates that over-saving, over-investment, technological change and underconsumption can be synthesized.

The second sub-group to those economists, who see the business cycle as a result of the capitalist system, emphasizes primarily the relationship

of technological change to cycles. The disruptions brought about by technological change cause the cycles. Since technological change cannot be controlled in a capitalist framework, the conclusion of this group regarding the possible elimination of cycles is much less optimistic. This sub-group is further divided into two groups. The first one argues that inventions, discoveries and innovations are the forces which disrupt equilibrium. The second group emphasizes the changing demand in conjunction with technological change. The first group includes Marx, Tugan-Baranowsky, Spiethoff, Schumpeter, and Robertson. The second group includes Aftalion, Pigou and J. M. Clark. Marx appears in both the capitalistic distribution and production sub-groups. We have indicated earlier that Marx's technological unemployment argument can be related to the underconsumptionist view through its effects on income distribution. We also agree with Hansen's classification in which Marx is also placed in the sub-group that emphasizes the effects of technological change on production. Yet, this is too general a classification. Marx's technological change is of a specific type, i.e., the type that increases q. All types of technological changes or innovations cannot be related to his analysis. Thus, as we shall see, Marxian technological change, on the whole, appears to have negative effects. Its expansionary effects are not of the Schumpeterian type. In Schumpeter, investments associated with innovations and the accompanying credit expansion are the causes of the boom. Marx's view of technological change is more limited. He does not emphasize the expansionary effects but rather the displacement effects. Placing Schumpeter and Marx together is misleading.

Moreover, even though Marx does not consider autonomous changes in demand, i.e., changes in consumer tastes, and role of marginal utility as emphasized by J. M. Clark, he, in fact, has much in common with him

on the labour displacement aspects of technological change in a depression. We will later refer to Clark within this context. It is, then, clear that when one considers the nature of technological change in Marx, Hansen's general classification is not adequate.

Hansen's second major group (ii) that sees the causes of the cycles in the competitive and exchange nature of the system does not include Marx. We essentially agree with Hansen since Marx, on the whole, stresses the relations within the production process. But, he also refers frequently to the fact that exchange takes place in time and space.[20] Disruptions in this process can lead to fluctuations in the economy. In an economy based on money, sellers need not buy. Marx gives this as a reason why Say's Law may fail in a money economy.

"The purchaser has the commodity, the seller has the money, i.e. a commodity ready to go into circulation at any time. No one can sell unless someone else purchases. But no one is forthwith bound to purchase, because he has just sold."[21] Use of money and the separation of exchanges over time "imply the possibility and, no more than the possibility of crises."[22]

Moreover, division of labour, specialization and interdependence in a competitive economy lacking central planning, can cause unbalanced growth and crises. The fact that capitalist relationships are not controlled by a "common mind"[23] creates the possibility of the crisis. Effects can become cumulative.

In short, the nature of a competitive economy based on money is an important theme in Marx's theories on crises.[24] The Marxian disproportionality argument, if it is understood as being due to the

"anarchy of competition,"[25] also lends support to such an interpretation. Yet, there is an inherent danger in trying to see too many similarities and to draw too many parallels. The real differences can be blurred. In fact, it has been argued that if the disproportionality argument is interpreted exclusively on the basis of the anarchy of competition, it cannot be used to explain crises as recurring and regular phenomena. Moreover, the clear implication of this argument would be that once better forecasting and planning are implemented by the capitalists, the possibility of crises vanishes. Such an interpretation has little support in Marx even though it has been rigorously defended by some Marxists.[26] At best, the difficulties due purely to exchange and individual oversight are subsidiary elements in Marx.

Since Marx cannot be placed in group (iii), that explains the crises purely in monetary terms, i.e., due to banking policies, expansion and contraction in money and credit, we will not be concerned with this group. Marx puts little emphasis on the influence of the changes in money supply and credit. The changes in the money supply are according to him the effects of the cycles and not their causes.[27]

Presently, we will underline the significance of Marx's theories by referring to a few economists who were influenced by Marx. The main criterion for our choice of economists is their recognition by the non-Marxist economists. Aftalion,[28] Kondratieff[29] and Robertson[30] can be cited in this group.

Aftalion's emphasis on the introduction of capital goods during the prosperity phase and the tendency to build excess capacity has much in common with Marx's accumulation and creation of capacity in excess of

demand.[31] However, Aftalion underlines the importance of the lag between the gestation period of the capital goods and the eventual production of consumption goods. The demand for capital goods increases due to over-optimistic expectations of even higher prices. Their construction takes a long time. Meanwhile, the demand for the goods to be produced by these machines may change, for example, it may decrease or may not grow at a rate equal to the optimistic forecasts of the capitalists. When the goods come on the market, the expectations are not fulfilled. Deflation starts.[32] Clearly, Aftalion's analysis ultimately rests on a lack of foresight on the part of the capitalists. Moreover, technological change in itself is not a part of his analysis.

Marx's influence is more clearly visible on Kondratieff.[33] His long cycles between 40-60 years are inspired by Marx's replacement cycles which are called the "decennial" cycles.[34] But these cycles are not directly related to technological change. They are based on the replacement of fixed capital which occurs in spurts.[35] Yet, such decennial cycles would be contradictory to Marx's views on technological change, which hastens obsolescence. In fact, Marx seems to be discounting the role of these decennial cycles when he also indicates that the life of fixed capital "is shortened. . . by the continuous revolution in the means of production," even though its physical life is extended.[36] Even in the absence of technological change, this theory is not a basis for a generalized theory of crisis. This point will be explained later.

D. H. Robertson makes use of Aftalion's lags based on the gestation period of the capital goods.[37] He stresses the indivisibility of investment.[38] Large investments are required for the production of the capital goods. He also refers to Marx's decennial cycles caused by the bunching of the

replacement demand and quotes Marx on this.[39] Even though he criticizes it, he does accept that it may be applicable to some trades.

Capital shortage, he claims, is the main cause of crises. He states: "The fundamental cause in such circumstances of the collapse of constructional enterprise, is thus seen to be not the high cost of constructional materials, but the scarcity of real capital available for investment."[40] He attributes this idea to two economists in the Marxist tradition, i.e., Spiethoff and Tugan-Baranowsky. He does not, however, relate this "shortage" to technological change which raises q.

In summary, our survey of the cycle theories and those economists directly influenced by Marx indicate the role of Marx in the area of cycle theories. More importantly, the discussion shows that Marx's treatment of technological labour displacement has not been seen within the context of crises. The Marxian theory that has attracted most attention is the "replacement" argument which has little to do with technological change.

In a theoretical study by two socialist economists, N. Cobeljic and R. Stojanovic,[41] the authors apply technological change to fluctuations in socialist societies and indirectly to fluctuations in a capitalist system. Even though they discuss technological unemployment briefly, they treat it separately from the cycles in a capitalist system.[42] In a few other studies, technological change, the rate of obsolescence and the rise in q have also been related to Marxian cycles.[43] Once again, the technological unemployment question has not been treated as a part of these discussions.

Clearly, much of the difficulty lies in distinguishing cyclical

unemployment from technological unemployment. Our analysis in the rest of this chapter will indicate that even though technological unemployment is related to the Marxian cycles in a very complicated fashion, it can still be given some meaning, and can be distinguished from cyclical unemployment.

4. A General View on Cyclical Unemployment in Relation to Long Term Technological Unemployment

Before we study the different types of crises and their relationship to technological unemployment, we will undertake a more general discussion to establish a continuity between the preceding chapters and the present one. Since those chapters essentially cover the essence of Marx's ideas on the effects of technological change on employment, a certain degree of consistency must be established between them and the present topic, which is but a different level of analysis of the same question, as we have specified in Chapter I. In particular, Marx's long term accumulation and employment model and the cyclical behaviour must be seen not as two independent forms of interpretation but as interdependent.

The major thrust of Marx's works is to reveal the laws determining the historical evolution of capitalism. The periodic crises are an integral part of this process. In this sense, Marx's long term crisis-free model as analyzed in the last chapter must be modified to account for these disruptions.

It is possible to attach two interpretations to Marx's long term analysis. (i) The capitalist system will experience increasing levels of technological unemployment even in the absence of crises in the long

term. (ii) The long term trend is reinforced by the crises. We have already analyzed (i) in detail and specified its weaknesses. The long term accumulation model which incorporates technological unemployment is based on a capital shortage argument. Since technological change increases q in absolute terms, the growth in capital is not adequate to absorb the increase in the labour force. As we have seen, Marx's attempt to link this inadequate growth in capital to the secular tendency of the average rate of profit to fall is untenable. If this argument is rejected, the rate of growth in capital becomes indeterminate. Then, technological unemployment largely depends on the rates of growth in q and in labour supply. Given his assumption that the absolute level of employment will increase, i.e., the rate of accumulation will exceed the growth in q, whether constructive unemployment will have an actual counterpart in IRA depends on the rate of growth in the labour supply. In short, the Marxian argument appears to rely on excessive growth in population. (Obviously, this conclusion would be very displeasing to Marx.)

These weaknesses encountered by the long term accumulation model can be partially overcome through the introduction of the crises. The crises can be used to: (i) reduce the dependency of Marx's prediction on excessive growth in population, (ii) show that capital destruction in physical terms during the depression can be substituted in place of the secular tendency of p in order to give meaning to capital shortage, (iii) strengthen Marx's contention that q will increase rapidly because of the effects of the depression on the organic composition of the advanced capital.

If such a synthesis is not achieved between the long term and cyclical phenomena, a contradiction remains unresolved. This can be summarized in the following way. The long term argument implies that there will be technological unemployment even if Say's Law holds. Stated differently, unemployment exists even with full capacity utilization of the available capital. However, once the crises are included, unemployment and idle machinery appear simultaneously during the depression, i.e., Say's Law does not hold in its limited or narrow sense. It might, then, appear that unemployment based on a capital shortage model is not consistent with the unemployment during the crises. In essence, the resolution of this apparent contradiction requires the specification of the meaning of technological unemployment.

As frequently stressed throughout this study, Marx's technological unemployment is associated with a shortage of real capital caused by the increases in q and not with the underutilization of the real capital available. If the concept of capital shortage is discarded, then there is little point in calling any type of unemployment technological. In fact, the term could then be used properly only in reference to structural unemployment. This occurs when technological change causes a mismatch of supply of labour and demand for it through the changes in the required skills. As we have argued earlier, Marx's unemployment is not "structural" in this sense.

Moreover, once the capital shortage argument is discarded, one could also argue that all unemployment is, in one way or other, technological because the most significant disturbances in a capitalist economy, barring wars or natural calamities, are caused by technological change. Even the

Keynesian unemployment can be linked ultimately to past technological change and future technological possibilities. The insufficiency of aggregate demand to absorb the total output and to bring about full capacity utilization can be related to the abundance created by past technological accumulation. The "psychological" factor behind the consumption schedule can also be interpreted within the context of technological changes, the subsequent increases in productive capacity and the high incomes which enable the psychological factor to operate. Similarly, the profit expectations of businessmen are largely influenced by prospective investment opportunities, i.e., by technological change in its wider sense. Even though such an approach may have its merits, it would also be so general that no specific meaning could be given to technological unemployment. The distinctions between different types of technological change and their differential impact on employment would disappear. It would, then, be a matter of indifference whether unemployment is called Keynesian or technological.

In Marx, technological unemployment can be given a specific meaning only if it is to be associated with capital shortage caused by technological change. Hence, the capital shortage must, somehow, be related to the cycles if unemployment observed during the cycles is, at least, to be called partly technological. Marx does not perform this task of reconciliation.

We believe that the Marxian cycles or crises can be related to the capital shortage argument. Yet, it must also be admitted that unemployment which is not caused by capital shortage, but by general disturbances arising from technological change, is also strongly present in his cycles. Hence, unemployment during the cycles cannot totally be explained

in terms of capital shortage but must also be linked to other effects of Marxian technological change. Clearly, unemployment in Marx takes a second meaning which is lacking in the crisis-free accumulation process. Both of these meanings will be seen in our discussion of the Marxian crises. It will also become clear that the second meaning which is not dependent on capital shortage is, in fact, the more prevalent one in the discussion of the cycles. The capital shortage argument can be introduced with much more difficulty. Yet, as it was stressed earlier, it can be introduced, and it is consistent with his long term analysis. The failure to do this by most Marxists has been a source of confusion. Consequently, Marx's analysis of unemployment has generally been divided into two types: (i) Unemployment with full capacity utilization; (ii) Unemployment with idle capital in cycles.[44] The links have not been established. Technological unemployment has been discussed under (i). Unemployment in (ii) has not been used to bolster Marx's long term prediction. Kähler indicates this particular dilemma encountered by the Marxists when he states: "..[S]ince the Marxian displacement and cycle theories were only loosely connected, it was difficult to see how cyclical unemployment might be used as statistical proof of the displacement theory."[45] Thus, the Marxists were not sure whether technological displacement should only refer to prosperity periods or whether it could also be linked to cyclical unemployment.[46]

Even a partial synthesis of these two types of unemployment could help resolve some of the ambiguity in Marx created by his use of Say's Law in some parts and by his rejection of it in other parts.

5. Significance of Dialectics in the Analysis of Crises

Regardless of whether the dialectical thought pattern that Marx inherited from Hegel is tenable in itself, his analysis of crises cannot be understood without it. In the "Afterword to the Second German Edition" of Capital, he states: "The crisis is once again approaching, . . . and by the universality of its theatre and the intensity of its action it will drum dialectics even into the heads of the mushroom-upstarts of the new, holy Prusso-German empire."[47] An essential part of the dialectical approach is that there is no permanent stagnation. "Permanent crises do not occur."[48] The "life of modern industry" is perceived by Marx as "a series of periods of moderate activity, prosperity, over-production, crisis and stagnation."[49] The term "stagnation" should, then, be interpreted cautiously. It cannot be interpreted as a chronic state. It has no basis in Marx's writings.

According to him, the crises are inevitable in capitalist development. Moreover, they are necessary if accumulation is to continue. They prepare "within capitalistic limits - a subsequent expansion in production."[50] Similarly, this expansion creates its own barriers and has the seeds of the next crisis.

The logic behind these Marxian notions is strictly a reflection of the dialectical approach. This approach is not the equivalent of the dynamic approach as understood in modern context. It does not only consist of the introduction of time and changes in the fundamental conditions. It is more. The changes in the fundamental conditions are

explained through the inherent contradictions of capitalism which occur due to the "incompatibility between the productive development of society and its hitherto existing relations of production."[51] The disruptions are caused by these contradictions which "lead to explosions, cataclysms, crises, in which by momentaneous suspension of labour and annihilation of a great portion of capital the latter is violently reduced to the point where it can go on."[52]

The solutions which are sought in a depression to overcome the barriers reflected by the low rate of profit "place these barriers in its way and on a more formidable scale."[53]

Once the dialectical nature of the crises is understood, the Marxian long term accumulation can no longer be called, as does H. Smith, "blind accumulation."[54] The capitalists are sensitive to the rate of profit. They refrain initially from investing when the rate of profit falls in the crisis. However, if they are to remain as capitalists under the objective competitive conditions which weigh on them, they will be compelled to seek new methods in a depression in order to increase the rate of profit.[55] Those aggressive capitalists who can reduce their costs capture the markets of others. Available capital seeks profitable avenues because unused capital does not make one a capitalist.

Even if the long term tendency of p to fall were true, long term accumulation is not inconsistent with it. As long as the capitalists can make a positive rate of return, it is not unimaginable that they can adjust to the rules of the game over long periods. This is not incompatible with periodic crises and the temporary reluctance of capitalists to invest when their expectations are shaped largely by the recent past and the near future.

The dialectical nature of Marx's analysis is best illustrated when he says: "The real barrier of capitalist production is capital itself."[56] The ultimate aim of capital is to increase surplus. Each capitalist operates on a scale which is not strictly determined by demand but by a desire to "produce the largest quantity of commodities with a given capital," and tries "to supplant its competitors and exclude them from the market competition of capitals."[57] At the same time, each capitalist views the workers employed by other capitalists as consumers[58] while each one attempts to reduce the consumption power of his workers in order to reduce his costs relative to the others. Hence, "a rift must continually ensue between the limited dimensions of consumption under capitalism and a production which forever tends to exceed this immanent barrier."[59]

Some of the arguments in the last paragraph are very much related to the role of technological unemployment. Adjusting output to the physical capacity rather than to demand is closely linked to the relative growth in constant capital in the form if indivisible capital goods and to the risks associated with its obsolescence. The last quotation can also be related to the effects of technological displacement on the growth of consumption demand. One can see it as a synthesis of technological unemployment with the underconsumptionist view. Marx does not develop these links clearly.

The foregoing presentation on the role of dialectics is cursory. Yet, it shows the importance of it in this chapter. The relationship of technological change to crises should be viewed in this context. Technological change is a method to overcome the crises, but it also sets the conditions for other crises through its complex effects on

employment, consumption and older capital goods. It will become evident in our later discussion that Marx emphasizes the negative effects rather than the expansionary effects. However, the dialectical nature of his approach necessitates that technological change contains these contradictory effects. Yet, why the negative effects of technological change should outweigh the positive ones cannot be explained on the basis of a philosophical approach. Marx's insistence on this result is, we believe, largely biased by his dialectics.

6. Crises and Technological Unemployment

Even though Marx does not do so, his theories on crises are classified generally in three groups. The criterion behind this classification is the difference in the causes precipitating the crises. The following are considered to be the main causes:[60]

(i) Disproportionality

(ii) Falling rate of profit

(iii) Underconsumption

As indicated earlier, all these crises are in essence realization crises. The realization process "includes the preservation of the prior value, as well as its multiplication."[61] Even though realization has traditionally been reserved for the realization of profit, we believe that such a definition may be misleading. Then, the main emphasis would appear to be limited to the conversion of the commodity surplus into profit in terms of money. Once technological change is introduced, the obsolescence of constant capital and risks associated with it become an important factor. If the previously advanced constant capital cannot be preserved because the new machines reduce its value, the concept of

realization must, then, be understood in a comprehensive sense. It must include the recovery of previously advanced constant and variable capital as well as the conversion of surplus into profit. This can be illustrated through the familiar Marxian circuit,[62] M - C - P - C' - M', where:

M: The initial money capital advanced to start the production process;

C: Machinery, equipment, raw materials, etc., and labour employed;

P: The productive process in which the means of production and labour are combined in a ratio determined by technology;

C': Commodity capital or finished products;

M': Money received upon the sale of the products.

Marx discusses the role of circuits and the associated time factors, for example, the turnover periods. For our purpose, it is not necessary to consider these in the present context. The essential point is that if accumulation is to be continuous, and if the circuit is to repeat itself on higher scales, M must come out of the circuit as M'. The difference bewteen M' and M must be positive, and the ratio of ΔM to M must be such that the normal rate of profit is realized.

The realization process includes both the self-preservation of M so that M is sufficient to re-establish the same scale of production as before and also the conversion of surplus to ΔM so that accumulation on a higher scale will be possible. The complete circuit includes simple reproduction, the preservation of M, as a part of the total accumulation process.[63] He states: "Realization of the surplus-value necessarily carries with it the refunding of the value that was advanced."[64]

The analysis of crises in Marx is essentially the specification of the forces or contradictions that disrupt this circuit and hinder its continuation at higher levels of production. The use of money, as we have already indicated, is already a source of such disruption. It creates a general possibility. However, Marx does not see it as one of the main causes of crises.

(i) Disproportionality

The disproportionality argument as a cause of the crisis has in most literature, been confined to the disproportionality that may occur between the capital and consumer goods sectors. Marx's analysis of accumulation in the third volume of Capital in terms of the balanced growth of the two sectors or departments has been taken as the basis of an explanation of the crisis when such balance can no longer be maintained.[65]

The familiar explanation can be presented by specifying the conditions for the uninterrupted simple reproduction.[66] We will not specify the conditions for reproduction on an extended scale because the logic of the argument does not change.[67]

Department I: Capital Goods

$$V_I = c_I + v_I + s_I$$

Department II: Consumer Goods

$$V_{II} = c_{II} + v_{II} + s_{II}$$

In these formulations V stands for the gross output of each department. We use "c" for constant capital advanced. Even though a capital letter has been used in this study, the distinction disappears if the total constant capital advanced is recovered at the end of the

single production period under consideration. For equilibrium to be maintained between the two sectors, the following has to hold: $c_{II} = v_I + s_I$. The assumption is that the capitalists consume all of their surplus. The same applies to the workers' wages.

The crisis is possible even in the simple reproduction scheme. The equilibrium need not hold in a capitalist economy which has no "common mind." It is possible that either $c_{II} > v_I + s_I$ or $c_{II} < v_I + s_I$. In the former case, there will be a relative over-production of consumer goods. In the latter one, an over-production of capital goods will take place. Even if prices are flexible, realization may be rendered impossible, and fluctuations at the aggregate level may follow.

In this form, a lack of foresight on the part of the capitalists, i.e., the anarchy of production in capitalism, appears to be the main cause behind the disproportionality. The implication is that better forecasting would eliminate the crisis. Sweezy points out that such disproportionality cannot be generalized as a cause of crises.[68] What needs to be explained is why a disproportionality between the two sectors should occur and why it should be large enough to cause aggregate disturbances periodically. The anarchy of production or lack of perfect foresight cannot be used to account for the periodical recurrence of of the crises.

In the expanded reproduction model, the Marxian disproportionality acquires a clearer meaning. This can be done by introducing technological change. Given Marx's emphasis that accumulation is almost always accompanied by technological change and by increases in q, the cause of the disproportionality should lie in technological change even though

the anarchic conditions of capitalism may also play a part.

In the accumulation process, technological change is embodied in new machines. Since q increases, the output of the capital goods' sector will have to increase. This requires an expansion in the productive capacity of this sector. Even if it is assumed that the initial demand for the new machines maintains the normal capacity utilization in machine construction, once the machines are installed, the new machines need not be replaced for extended periods. Marx, citing an example from the introduction of new machines into carpet manufacturing, says: "..[T]he machinery need not be renewed till it is worn out. Hence, in order to keep the increased number of mechanics in constant employment, one carpet manufacturer after another must displace workmen by machines."[69] Otherwise, the initial increase in aggregate employment due to machine construction cannot be maintained.

This argument must be evaluated critically if the role of technological change is to be understood. One interpretation would be that the machine construction sector recovers all of the advanced capital upon the sale of the new machines. Then, the firms producing the new machines start the same process all over in the next period. Since the new machines, however, last much longer than the gestation period of the machines, i.e., the period of their construction, the machine producers will be left with new machines for which no demand exists. Over-production of capital goods and lay offs may lead to crises. The decrease in output and income in the capital goods sector leads to a cumulative contraction in the consumer goods sector.

If this is the effect of technological change, crisis and unemployment

are due to the differences in the turnovers of advanced capital in the two sectors. In other words, the crisis is caused by the effect of technological change on the life span of the new machines that are built. Technological change causes a disproportion between demand and supply of capital goods as well as a disproportion between demand and supply of consumer goods as a subsequent cumulative effect.

Such disproportionality is possible. However, in this interpretation, there is no place for capital shortage. Since the advanced capital in the capital goods is totally recovered and can be readvanced elsewhere, the contraction in employment in the machine construction need not occur. The real cause appears to be a lack of investment opportunities. Technological change in a broad sense, for example, the introduction of new goods as well as new production methods and new markets, can provide such outlets. Given Marx's limited definition of technological change, these opportunities cannot be included. Marx's technological change, which is largely limited to the changes in the production process and the increases in q, would fail to explain why the recovered capital cannot be readvanced elsewhere. If investment opportunities are limited, unemployment will be caused by both the displacement in those firms buying the machines and the firms which have produced the machines but which have to lay off workers because of lack of further investment opportunities. The employment effects will, then, be intensified by a cumulative contraction process.

A second interpretation would be that capital advanced in the construction of the new machines is not recovered upon the sale of the machines. In other words, normal capacity utilization in the construction of machines at the end of a single period of production (when the new

machines are completed and sold) enables the recovery of only a part of the capital advanced. If the new machines last much longer than the single period of production in the capital goods sector, not only will the production in this sector drop but also real capital will be tied up. It will lie idle in the form of unused machines and plants. The workers will be laid off or "freed" without being accompanied by a freeing of real capital. In other words, the real resources will by lying idle while labour is also unemployed. The reduction in the purchasing power of workers can lead to cumulative effects through the contraction in output and employment in the consumer goods sector. The crisis erupts. The reabsorption of these workers elsewhere requires that the economy provide an equivalent of such real capital in alternative areas of production. In this sense, technological change can lead to a shortage of real capital during the boom by altering the periods of turnover of advanced capitals in the two sectors. If the average organic composition of advanced capital in the economy is high, the difficulty of absorbing these workers will become more serious. For purposes of employment elsewhere, the real capital tied up in the construction of machines is of no use. The possible abundance of money or credit does not solve the problem as long as the economy is unable to offset the enforced idleness of real capital by an increase in productivity and surplus elsewhere.

Clearly, our second interpretation of disproportionality synthesizes the concepts of capital shortage in real terms with over-investment and underconsumption. In this form, technological change leads to a disproportionality by altering the turnover periods between the two sectors, causing a real shortage of capital and consequently, under-

consumption because the unemployed workers lose their income. The consumption goods sector experiences over-production. The advanced capital and surplus cannot be realized at the expected prices. The rate of profit falls and the crisis erupts. It should, however, be noted that the inability to reabsorb the workers, who are displaced in the capital goods sector, in the consumption goods sector hinges on fixed proportions in the production process.

The second interpretation, we believe, is consistent with Marx's long term accumulation model. However, it has little support in Marx's own comments on the cycles. It must be treated as an attempt on our part to clarify the meaning of technological unemployment in Marx. It enables us also to give a clearer meaning to the disproportionality argument. This interpretation is, we believe, justifiable because it combines the concepts of disproportionality, capital shortage and increase in q. The first interpretation, on the other hand, can easily be carried out without the concepts of capital shortage or the increase in q. In fact, even disproportionality is not essential to it. The ultimate cause of the crisis, in that case, is the lack of further investment opportunities.

One objection to our interpretation based on real capital shortage may be that it is based on the assumption that technological change will tie up significant amounts of real capital in the capital goods sector and that it will create a situation which cannot be rectified by the conditions in a boom. This objection is valid. Hence, our interpretation is, at best, a possibility and cannot be generalized. Since our objective is not to show technological change of the Marxian type as the cause of

the crisis but only to relate it to his discussion of crisis, and indicate how it may play a part in the eruption of the crisis, we do not perceive this objection as one that must be analyzed fully.

A second objection may be that our interpretation relies heavily on Marx's decennial cycles in which the machines last for ten years. The productive capacity of the capital goods sector remains idle. Unemployment and subsequent disturbances cause the crisis. The recovery starts when the machines are to be replaced at the end of these ten years. Marx's emphasis on the life of the machines can be related to this argument on the decennial cycles. However, our interpretation is not based on it.

Finally, it may be said that the capitalists in machine construction need not simultaneously invest in an expanded capacity since the orders for the new machines are spread over time. The bunching of the orders at the same time may not be realistic. This is clearly true. If the new machines are being introduced gradually, the expansion in the capital goods sector will be gradual and no immediate drop in demand for the machines may occur. The quotation cited earlier implies this. If the other carpet manufacturers buy these machines, demand for machines may be kept stable. The gradual timing of the orders for the machines will, then, reduce the risk of over-expansion in the capital goods at one time. The gradual replacement demand will also reduce the magnitude of possible displacement in the machine construction.

This last objection cannot be refuted on theoretical grounds. Its validity depends on the rate of introduction of the new machines, i.e., on the competitive edge gained through their introduction. Marx's treatment of technological change during the boom is unclear. He seems

to emphasize more its role in the downturn or depression. Hence, our capital shortage argument during the boom does not have much support. If the gradual introduction of the machines is the more likely case despite the fact that the boom period may also be characterized by the Marxian technological change, our second interpretation would not hold. On the other hand, a bunching of demand for the new machines and a possible over-expansion in the capital goods are real possibilities.

In summary, the disproportionality argument can be integrated with Marx's technological change and technological unemployment in a complicated way. Just like any other type of technological change, the Marxian one can cause imbalance or disproportion among the different sectors of the economy due mainly to the fact that there is no overall planning of its introduction. In this sense, technological change can be become a source of crises if such disproportions become pronounced. It cannot be denied that this meaning exists in Marx. Capital shortage can be a consequence of this lack of planning.

(ii) Falling Rate of Profit

In the last chapter, we have seen that Marx's contention with respect to the secular tendency of p to fall is not tenable if it is to be explained only in terms of technological change. Consequently, the capital shortage model to predict long term technological unemployment encountered the familiar difficulties which have been restated several times in this study.

Marx has another explanation for the falling p. This is not based on technological change but on the rise in the wage rate during the boom phase of the cycle. Another reason he cites is the increase in the

prices of raw materials.[70] We will limit our discussion to the movement of the wage rate since this is directly relevant to our study.

Assuming that the potential supply of labour is more or less inelastic during a cycle, the rate of accumulation may eventually exceed the supply of labour and cause an increase in W during the upswing. The industrial reserve army is depleted. The average rate of profit falls, "but this time due to a change in the composition of capital not caused by the development of the productive forces, but rather by a rise in the money-value of the variable capital (because of increased wages) and the corresponding reduction in the proportion of surplus-labour to necessary labour."[71] Accumulation will slow down and reduction in output and employment will ensue. The increase in W appears to be the cause of the crisis in this argument.[72] The introduction of new machines is not a cause in this case. Yet, this need not mean that such machines are not introduced at all. It only means that the rate of accumulation far exceeds potential displacement effects of the increase in q. Consequently, with an inelastic supply of labour, constructive unemployment does not have an actual counterpart. Whatever the rate of technological change may be, it is not sufficient to maintain an industrial reserve army to check the growth in W. As long as the increase in productivity exceeds the growth in the real wage, accumulation will continue.[73] As the IRA is depleted, however, the relative share of v increases and pushes the rate of profit down. The motivation for accumulation is blunted and the crisis occurs.

The foregoing analysis is compatible with our earlier statement that, during the boom, the disruptive effects of technological change

on employment do not appear to be serious in the Marxian analysis. The falling rate of profit argument based on the increase in W is, thus, not consistent with our interpretation of the disproportionality argument in relation to capital shortage. The two arguments may be used as possible causes at different times and in different crises. Since causes, in the sense of being "aboriginal", can hardly be discovered, we will not pursue the sources of this difference.[74] In fact, if one accepts that different causes may lie behind different crises,[75] it is also possible to consider the falling rate of profit as a cause of one crisis which, later, lays the ground for a subsequent crisis due to capital shortage. The increase in W would hasten the search for machines and speed up their adoption, thus raising q, and giving rise to capital shortage in subsequent crises.

This is also compatible with Marx's analysis of long term employment in which the fundamental problem is the relative scarcity of real capital. The crises due to the falling rate of profit based on the increase in W would, then, become less frequent. The long term increase in unemployment would reduce the possibility that periodic booms would be sufficient to push the wage rate up such that profitability would be threatened.

Even though Marx's technological change is not the cause of the crisis in the case when W is pushed up, it can still be argued that technological unemployment is only postponed till after the crisis. In other words, the effects of technological change, which has taken place during the expansion phase, appear in the downturn. One can argue that those firms that introduce new machines during the expansion period acquire a competitive edge once the crisis erupts and contraction ensues.

They are able to withstand the deflation process better than those firms that have not adopted the same machines.[76] The deflation may reduce the extra profits that the former were making under the boom conditions. But the competitive edge acquired through the adoption of the machines allows them to survive when the prices are falling. In this case, technological change introduced during the expansion will lead to the elimination of the less efficient firms that have not adopted the machines. A prior technological change will also accentuate the direct deflationary effects of the crisis. Unlike the capital shortage case, the direct employment effects of the crisis and the postponed employment effects of prior technological change become much less distinguishable. They are intertwined. Whether a part of the total unemployment can be called technological is open to question.

It must, however, be explained how this postponement actually occurs. Why doesn't the elimination of the weaker firms take place during the boom? In other words, why are the cost advantages of the progressive firms not reflected in proportional decrease in prices during the boom? These questions cannot be answered without introducing the monetary aspects in the expansion process. The analysis must go beyond real relationships. Marx does not deal with the monetary factors fully. He sees, however, the movement in the general price levels during the cycles. He states:"...[W]hen the industrial cycle is in the phase of crisis, a general fall in the price of commodities is expressed as a rise in the value of money, and, in the phase of prosperity, as a fall in the value of money."[77] He also sees that during prosperity, "the prices of commodities rise,"[78] because effective demand exceeds effective

supply due to expansion in money and credit.[79] "Crises are usually preceded by a general inflation in prices of articles of capitalist production."[80] Once the crisis erupts, "the prices at which the commodities are then absorbed are ruinous for the producer or merchant."[81] He frequently refers to credit, money, bad debts, speculation and artificial stock values during the crises. There exists, however, no systematic integration of the monetary aspects.

If the effects of inflation can be introduced into the analysis, it can be argued that the rise in general prices allows the less efficient firms to survive during the boom.[82] Inflation plays the role of the IRA in the early stages of the boom by reducing the share of v. However, ultimately the rise in W reverses the pattern and causes the crisis. In the downturn, the less efficient firms are driven out both by the effects of deflation and by the competitive edge of the more progressive firms. One can argue that the displacement effects of technological change during the boom are avoided through inflation.

The clear implication is that if inflation did not occur, the technological displacement effects might even be visible during the boom since the offsetting effects of inflation through: (i) reducing the rate of increase in q (less efficient firms may not be compelled to buy the new machines), and (ii) increasing the share of profits temporarily; would not be operative.

The foregoing discussion on how the labour displacement effects of technological change can be postponed until after the crisis through inflation, which may hinder the adjustment process during the boom, is not part of Marx's analysis. This interpretation is largely derived

from the arguments advanced by E. Lederer in a non-Marxian context.[83] However, Lederer's analysis goes beyond our interpretation of the effects of inflation and technological change. He also indicates that inflation may cause an over-expansion in those firms undertaking technological change. In the downturn, some of these firms may also go bankrupt. The capital values artificially raised due to optimistic expectations and continuing inflation are reduced in the downturn. Moreover, Lederer includes all types of technological change in his analysis. This has been discussed earlier. Given the scanty analysis of monetary factors by Marx, our interpretation must be taken not as a reconstruction of the ideas explicit in Marx, but as an attempt to give meaning to technological unemployment in the context of his cycles.

On the other hand, Marx is much more explicit on the effects of the falling p on the rate of technological change. In other words, instead of considering the postponed effects of technological change during the expansion phase, we can consider the introduction of technological change during the downturn. Marx states: "Improvements, inventions, greater economy in the means of production, etc., are introduced not at times when prices rise above their average level, but when they fall below it, i.e., when profit falls below its normal rate."[84] These improvements are introduced to "create an artificial over-population."[85]

If considered from this perspective, the labour displacing machines will be introduced as the rate of profit falls due to the increase in W. Then, the Marxian technological change should speed up as the crisis erupts. The aggressive capitalists attempt to reduce their costs of production by displacing labour. In this case, the general compensatory

effects of accumulation will not be occurring because the pessimistic expectations will not encourage net accumulation.

We believe that this interpretation is quite consistent with Marx's view of the effects of technological change and with the specific meaning he gives to technological change. It is very likely that the new machines will not be financed through net accumulation during a downturn. It is more likely that amortization funds accumulated or capital from elsewhere in the economy (which was in use previously) will be the source of the capital advanced in the construction of the new machines. The aggregate level of employment may not increase during the period when the machines are built. Upon their adoption, the labour displacement effects will accentuate the general drop in the level of employment caused by the crisis in general.

The secondary effects of these new machines will be felt in other firms which are eliminated either because they cannot adopt the same machines or because the decrease in employment due to technological unemployment reduces the demand for their goods that were purchased by the workers who are now displaced. The general cyclical effects and the effects of technological change become cumulative. Much constant capital lies idle while labour is also unemployed. We will, later in this chapter, see that the idleness of real capital for extended periods can also be related to capital shortage which may become a cause of the subsequent crisis. It is important here to note that the enforced idleness of capital in the present discussion is primarily caused by the decrease in the rate of profit as W increases and not by technological change. The latter follows the crisis and further accentuates it. In other words,

the effect, i.e., the introduction of labour displacing machines in response to rising wages, becomes a secondary cause of unemployment in the downturn. This is in line with Marx's dialectics[86] even though it may raise complications in distinguishing between causes and effects. The Marxian approach, however, cannot be criticized on this basis. Analyzing the cycles in terms of cumulative changes that are interrelated instead of a single cause is commonly accepted by other economists.[87]

The following may be posed against the foregoing analysis:

(a) It may be objected that the introduction of labour displacing machines in a downturn or in a depression is unrealistic because the increased unemployment will push W down and reduce the likelihood of such behavior. This is a source of difficulty in Marx which we have analyzed in detail earlier in this study. Despite his contention that the changes in the IRA will regulate the movements in W,[88] he also argues that the wage rate will not be very flexible downwards when the crisis erupts. "Workers do not allow their wages to be reduced."[89] It could be argued that the stickiness of W is behind the adoption of new machines in the downturn. We have, however, already indicated the ambiguous role of W in the introduction of new machines in Marx. Moreover, it is difficult to salvage his argument by introducing rigid wages in a downturn since he is not consistent on this alleged rigidity.

An alternative interpretation may be that the role of W will be significant if we are talking about the same types of capital goods as before. In that case, a flexible W will gradually lead to a substitution of labour in place of machines. If, on the other hand, the new machines embody a certain type of technology that was previously

unknown, even a flexible W may not stop the introduction of the machines. The reduction in advanced capital for a given level of output through the adoption of the new machines that displace labour and that save a part of the variable capital may offset the cost advantages to be achieved by an increase in the employment of cheaper labour in conjunction with fewer machines of the older type.

We believe that this is a possible interpretation that can be given to the introduction of new machines in a downturn. Even though the relative rigidity of W, particularly in the early stages of the downturn, is a reasonable assumption which can bolster Marx's argument, his argument need not depend on it. The clear implication, then, is that technological change of the Marxian type is the only type that becomes available. If technological change that reduces the constant capital is more predominant, we cannot give a specific meaning to his technological unemployment. Yet, in a downturn even the type of technology which reduces the constant capital may not lead to a reabsorption of labour given the nature of pessimistic expectations that hinder the reinvestment of freed capital. But such unemployment is due to the general atmosphere created by the downturn, and not due to the increase in q which ties up real capital in those firms that adopt the new machines. In this case, technological change can generate compensation in its narrow sense, i.e., it can free sufficient capital to absorb all the workers affected. When q increases, such compensation is not possible according to Marx. The conditions in the downturn also inhibit general compensation, i.e., net accumulation from other sources. Marx need not have limited technological change to the type that increases q. Even other technological changes, that are aimed at reducing the costs of production, can intensify the level of unemployment as long as the savings in costs

are not put back into the circuit. Such a broader view of technological change would have strengthened his analysis of crises. It would have, however, undermined his whole notion of capital shortage as a cause in the long term. Hence, a consistency in his total analysis can be established only if technological change is to be defined in the Marxian terms, i.e., when it increases q in absolute terms.

(b) It may also be objected that the new machines may normally increase the productive capacity of those firms purchasing them and that an expansion in their output in the downturn is hard to defend. Such an objection can much more easily be answered in the Marxian context. In those industries where the new machines are adopted, the adoption process is not simultaneous within the whole industry. The purchasers of the new machines may expand their output at the expense of the other firms which are forced out of the market. This is consistent with a general reduction in output in the industry or economy. As indicated earlier, Marx emphasizes this aspect of competition.

(c) Whether or not the Marxian technological change is the prevalent one, the real objection must be against the contention that significant technological changes characterize the downturn phase. On purely theoretical grounds, it must be argued that significant technological change is generally a characteristic of prosperity and not of downturn. Given the depressed conditions in the downturn, it is very unlikely that the capitalists will seek fundamental changes in technology. The attempts to reduce costs will be through adjustments in the available productive capacity or through rationalizations in terms of saving in labour and constant capital without changing the

nature of the capital goods. Even if Marxian technological change does occur, its magnitude cannot be exaggerated. Given the presence of capital goods inherited from the expansion phase, the loss involved in scrapping these machines must be weighed against the savings to be gained by the introduction of the new machines. Especially if the boom is characterized by the purchases of machines embodying the most recent technology or by additions to the already known types of machines, the new technology to be introduced during the downturn must be of an extremely superior nature if it is to be profitable. The machines may, however, be installed well after the start of the downturn, for example, in the depression. By that time the values of the older machines will have been reduced, bad debts will have been eliminated, and the older machines will have undergone material decay. Then, the introduction of new technology in a depression becomes a possibility. It should be pointed out that the notion of labour displacing technology to be adopted in a depression is not unique to Marx. Spiethoff also emphasizes it.[90] J. M. Clark takes a similar approach when, in reference to the Great Depression, he states: "Improvements in technique have been installed, or stand ready to be installed, which will still further economize labour..."[91] Slichter also argues that if the wage rate is rigid in a downturn, the squeeze on the rate of profit will be accentuated, and that further technological change to displace workers may be sought.[92] On the other hand, it has also been argued that, on the basis of the number of patents received in a downturn or depression, such an argument does not find much support.[93]

(iii) Underconsumption

Whether Marx sees underconsumption as a cause of crisis has been a source of controversy which is still unsettled. M. Bleaney tries to refute the argument that Marx was an underconsumptionist.[94] Sweezy, on the other hand, argues that its role in Marx's writings cannot be ignored.[95] Schumpeter points out that, due to "conflicting evidence," it is not possible "to impute to Marx an underconsumptionist theory of cycles."[96]

There are different versions of the underconsumptionist view. It is beyond the scope of this study to review them.[97] The essential point of the underconsumptionist views is that the consumption power of the working class somehow does not increase in proportion to the productive capacity of the capitalist system. Hence, a relative overproduction of consumption goods occurs and the crisis is precipitated. The argument is based on the unequal distribution of income between the capitalist class and the working class. Even though it is the beginning of later theories on "effective demand", the notion of investment in aggregate demand is absent, and the psychological factors such as those in the Keynesian theory do not exist.

The evidence in the case of Marx is mixed. On the other hand, it is not possible to deny it any role either. One interpretation is that underconsumption may be the effect of the crisis rather than its original cause.[98] As we shall see, such an interpretation is consistent with certain comments by Marx. Yet, one can also trace numerous references to support the view that it is a major cause.

Since we are not trying to discover the only or the "best" cause of

of the crisis but only to relate technological unemployment to the possible types of crises in Marx, we will not be concerned about the controversy. Also, as indicated earlier, if cycles are to be considered not as individual ones but as a series of fluctuations in Marx's long term evolution of capitalism, effects at one time may become causes in the following cycles. Even though we will take such a broad view of the crises in relation to underconsumption, it will be demonstrated that underconsumption as a cause of the crisis is consistent with Marx's view of technological unemployment. This linkage has not been emphasized in the controversy. The most likely reason is that Marx does not synthesize his views.

We will presently cite some of the familiar quotations from Marx that are generally used for refuting the existence of the underconsumptionist view in Marx or for defending it. He states:

> It is sheer tautology to say that crises are caused by the scarcity of effective consumption, or of effective consumers.[99] [He also points out that the crises are generally preceded by a period when the consumption of the workers is at its highest level.[100] In other words, the share of v in net output increases.]
>
> ...[T]he more productiveness develops, the more it finds itself at variance with the narrow basis on which the conditions of consumption rest.[101]
>
> [Consumption power of the working class is] based on antagonistic conditions of distribution, which reduce the consumption of the bulk of society to a minimum varying within more or less limits.[102]
>
> ...[C]onsumption, from the outset is inhibited, since the majority of the population, the working people, can only expand their consumption within very narrow limits, whereas the demand for labour, although it grows absolutely, decreases relatively, to the same extent as capitalism develops.[103]

> The last reason for all real crises always remains the poverty and restricted consumption of the masses as opposed to the drive of capitalist production to develop the productive forces as though only the absolute consuming power of society constituted their limit.[104]

Obviously, the first reference appears to contradict the others and has been the key reference for those who attribute no significance to underconsumption in Marx. The other references cast grave doubt on this view. If underconsumption is not a cause, then the crisis will have to be explained in terms of the falling rate of profit due to the increase in W or in terms of disproportionality. We have already seen that even disproportionality can encompass the underconsumption argument when technological change and capital shortage are integrated into it. However, if one is seeking a simultaneously valid set of causes, the underconsumption argument is not compatible with the falling rate of profit due to increased W. In fact, the first reference supports the rate of profit argument.

J. Strachey sees both the falling rate of profit and underconsumption as simultaneous causes. The wage rate is high enough to reduce the rate of profit but the share of v is not high enough to absorb all the consumption goods.[105] This is an intriguing argument which is also advanced by Sherman.[106] The capitalists are trapped in two ways. If the wage rate goes up even higher, underconsumption may disappear, but then the rate of profit is further depressed, and the crisis erupts. On the other hand, if W does not increase, underconsumption becomes a real source of crisis. There is no escape. This argument must be dependent on some rather special relationships which Strachey does not explain. His analysis remains in general terms. Moreover, he does not distinguish the falling rate of profit due to technological change, i.e., the increase

in q, from the one based on the increase in the wage rate.[107] He uses them simultaneously without explaining how this can be done. Whether such an approach is possible in the analysis of crisis remains doubtful. As we have often indicated, Marx links the increase in q to the secular decrease in p.

In short, Strachey's attempt remains unclear. Its direct relevance to our study is limited. One can, of course, apply Strachey's attempt to our analysis by arguing that Marxian technological change during the expansion period is rapid enough so as not to allow the increase in the wage rate to absorb the increase in the output of consumption goods, but not rapid enough to check the growth in W, which reduces the rate of profit. The falling rate of profit and underconsumption exist simultaneously. Even if such a relationship can be achieved, it must be a special one. We will not elaborate on it.

In the rest of this section, we will try to see how technological change may be related to the elements of underconsumptionist view in Marx independent of the falling rate of profit argument. There are three ways to do this:

(a) We can assume that, in the expansion phase, accumulation continues at a high rate. Even though the wage rate may increase, it may not pose a threat to profitability as long as the productivity of labour is increased in excess of it. In other words, the share of v in s + v may fall even though W increases.[108] Accumulation, accompanied by technological change and the growth in demand for machines, may maintain the total demand growing in balance with the aggregate growth in the productive capacity. In other words, the construction of machines in

the early stages of the expansion may be substantial. Since there is a lag due to the gestation period of the machines, the increase in consumption goods upon the adoption of the new machines is postponed for a period. The slower growth in v does not pose an initial difficulty because it is offset by the capitalists' demand for the machines. Once the new machines are introduced into the consumption goods sector, output of consumption goods increases. Since the growth in v has lagged behind, deflation sets in. Underconsumption becomes a cause that may precipitate the crisis.

This interpretation is rather similar to the arguments of Aftalion and Robertson as we have reviewed earlier. The gestation period plays an important part in it. An obvious criticism of it would be that it fails to explain why v should not grow in a balanced fashion so as to absorb the ultimate increase in consumption goods. An answer can be given to this. Even if v grows in a balanced fashion, the fact that the output of consumption goods will increase in the future creates the possibility that the immediate effects when the machines are constructed will be inflationary. These effects have been underlined also by Hicks.[109] While the machines are still being produced, the expectations of the capitalists would be distorted. They will tend to over-invest in anticipation of even higher prices. The ultimate productive capacity acquired in the consumption goods sector may, then, be in excess of the growth in v. In this case, inflationary forces and a lack of foresight due to long gestation period compound each other. Even though underconsumption can be integrated into this analysis, it is not a primary cause. At best it is a result of these other forces. Over-investment in capital goods due to inflationary pressures in consumption goods

felt during the gestation period and the distortion of expectations eventually lead to a state of underconsumption. This is probably why Aftalion does not use the concept of underconsumption. Also, since the concept of gestation and the significance of expectations due to inflation are not explicitly dealt with by Marx, our interpretation is a rather liberal one.

(b) A more Marxian interpretation can be given to underconsumption. This is not only compatible with the previous chapters but is also strongly evident in some of the quotations cited earlier. If the Marxian technological change is rapid in the expansion phase, the growth in absolute demand for labour will be slow. Also, given an ample supply of unemployed labour at the beginning of the expansion phase, the upward pressure on W will be reduced. As a result, the increase in the productive capacity of the consumption goods may exceed the growth in v. Technological change of the Marxian type can lead to underconsumption, relative to the increase in the productive capacity in consumption goods. Technological change, then, plays a double role. It limits the growth in v while simultaneously increasing productivity. It becomes a double-edged knife. Capital increases output and productivity but also decreases the workers' "exchange capacity".[110] This interpretation is the simplest way to relate underconsumption to technological change. Underconsumption is brought about by the antagonistic effects of technological change on income distribution and on growth in output.

Since we have assumed a rapid rate of technological change, a decrease in the rate of profit due to excessive increases in W does not appear as a cause of the crisis. The implication is that the boom will come to an

end well before full employment is achieved. It is not the labour scarcity that precipitates the crisis by depressing the rate of profit. Underconsumption as a cause of the crisis due to technological change is also defended by Löwe. It is significant to note that Löwe discusses this aspect in conjunction with his review of Marx. We believe that his analysis fits in Marx's conceptual framework and integrates many points that we have studied up to now. The following quote from Löwe underlines this. He states:

> ...[W]ith growing capital intensity, that is, increasing capital per capita, the bottleneck of capital formation can be overcome only by a steadily increasing rate of saving or, more likely, by the continuous lengthening of the adjustment period required. In the interval technological unemployment persists and exerts pressure on the wage level and on aggregate consumption. Such a fall in demand for mass consumption goods will in the end affect also investment unfavourably. Instead of gradual compensation we have to expect what today we would call a cumulative deflation and cyclical downswing.[11] [It is important to note that Löwe synthesizes capital shortage and underconsumption as a cause of the crisis.]

The logic of our argument is that the reductions in per unit costs will be more than offset by the deflation following the relative overproduction of the consumer goods. The rate of profit will fall as a consequence of underconsumption because realization cannot take place at the expected prices.

Another way of looking at the same process would be that the introduction of the new machines in the expansion phase enables the capitalists to realize the relative savings in v even before the consumption goods are on the market. In other words, their advanced capital for any

given level of output decreases before the output is even produced. But once the goods come on the market, the deflation process eliminates the initial gains. The rate of profit falls.

The essential ideas in our interpretation are clear. However, such an explanation of underconsumption encounters many of the familiar difficulties that we have cited throughout the study. The most important one is the employment creation aspect in the construction of the new machines. Even if the adoption of the new machines may displace labour, the initial net investment in machine construction may have to be substantial. The initial increase in employment and income may be substantial enough to reduce the possibility of underconsumption in the future. If the case is such, not underconsumption but the increase in W due to investments associated with the construction of the new machines may precipitate the crisis.

A second difficulty is that since the prosperity period may not only be characterized by technological change of the Marxian type but also by expansion on the basis of a given q, it is not obvious why the demand for labour could not grow adequately so that all available labour is employed and v increases in balance with the increase in the output of consumer goods.

Finally, given the absence of emphasis on the part of Marx with respect to labour displacing technological change in the expansion phase, it may be argued that technological change and underconsumption cannot even be depicted as a cause in Marx.

Even though we cannot counter these possible criticisms by any

specific references to Marx, our contention is that if underconsumption is to be seen as a primary cause of the crisis in Marx, then labour displacing technological change in prosperity must be the fundamental explanatory element. Otherwise, underconsumption as a cause has to be discarded.

(c) A third way to relate underconsumption to crises would be to see it not as a cause of the crisis, but as an effect of it. Then, it can be argued that in the expansion phase, accumulation in general far exceeds the growth in q and exhausts the supply of labour. The resulting shift in the income distribution in favour of the working class due to the larger increase in W relative to the increase in productivity reduces the rate of profit. In the downturn, even more sophisticated machines are introduced. The displacement of labour reduces the share of v in s + v faster than the decrease in net output.[112] Then, underconsumption becomes an accentuating influence. This is essentially the same type of argument followed in the discussion of the effects of the falling rate of profit. In this case, underconsumption and technological change are not primary causes of the crisis. They become effective after the crisis, and they intensify the downward spiral.

In summary, underconsumption as a cause of crisis can be derived from Marx's analysis of the effects of technological change. It can also be seen as an effect of the crisis which, in turn, aggravates the contraction in employment and output.

7. Technological Change and Recovery

In this section, we will analyze the significance of Marxian technology in bringing the depression to an end and starting the recovery. We have already indicated that in Marx, there is no chronic state of underutilized capacity, i.e., chronic depression. F. Engels, in the preface to the English edition of Capital states: "The decennial cycle of stagnation, prosperity, over-production and crisis, ever recurrent from 1825 to 1867, seems indeed to have run its course, but only to land us in the slough of despond of a permanent and chronic depression."[113] This is a view which cannot be attributed to Marx.

The depression in Marx is a phase of adjustment which restores profitability and prepares the conditions for the subsequent expansion.[114] The main emphasis is on the role of capital destruction in a depression. This requires some clarification.[115]

Some machinery and equipment remain idle and undergo material decay. Depending on the length of the depression, they may be completely lost to the economy.[116] Also capital goods in general become devalued due to deflation and low rates of return.[117] Many firms, unable to recover their capital at the old values, go bankrupt. In fact, Marx sees this as the main form of capital destruction.[118] This is intensified by the fact that debts were incurred on the basis of pre-crisis expectations. He says: "The fixed charges -interest, rent - which were based on the anticipation of a constant rate of profit and exploitation of labour, remain the same and in part cannot be paid."[119]

Marx also sees the roots of expansionary forces in these phenomena. "Ultimately, the depreciation of the elements of constant capital would itself tend to raise the rate of profit."[120] Bad debts are eliminated. He also argues that the rentier class will benefit and may be "more enterprising than" those who are now bankrupt.[121] The rapid fall in the prices of raw materials helps restore profitability. We can also introduce centralization and concentration as an influence. As the less efficient firms get eliminated, the more efficient ones capture their markets. "The old capitalists go bankrupt."[122] Normal capacity and profitability are achieved by the remaining firms. As idle machinery and equipment undergo material decay, eventually the demand for replacement will be revived. Even though Marx does not emphasize replacement on the basis of given technology, he clearly argues that new machines will be introduced.[123]

The role of the wage rate is not clear in this process. If it is assumed that the workers do not accept significant cuts in the wage rate, this avenue to restore profitability is blocked. As we have seen, Marx is not consistent on this aspect even though he, at one point, argues that "the reduction of wages below the average" will be a factor in returning profitability.[124] On the other hand, the stickiness of the wage rate has also been interpreted as a source of eventual recovery.[125] The argument is that the consumption demand does not fall as fast as the contraction in output and eventually arrests the downward spiral. If this is a reason for recovery, it must be seen in conjunction with other factors such as centralization, reduction in the prices of capital goods and raw materials, and the elimination of debts. We have not found any clear evidence in Marx for supporting the view that the consumption

demand is a cause of the recovery process. What is implicit in this view is that there is a symmetry between the forces that may cause or intensify the crisis and the forces that end the depression. According to this argument, if underconsumption is a force contributing to the crisis, then recovery must be due to the elimination of underconsumption as a negative force. Given Marx's emphasis on the rapidity of labour saving technology in a depression, it is doubtful that consumption demand can be shown as a factor in revival. This point will be elaborated upon later in the present section.

The foregoing brief summary of the comments made by Marx in reference to recovery are general in scope. The reason for it lies in the fact that Marx's comments on the forces bringing about the recovery are even less coherent or synthesized than his comments on the possible sources of the crises. Since our objective is not to study the forces behind the recovery per se but to see the significance of Marx's technological change in this process, we will not attempt to give interpretations to all the possible sources of recovery.

Marx emphasizes the introduction of labour displacing machines in a depression. We have already examined the theoretical strength of this contention. Assuming that Marx is correct, it would, then, appear that such technological change can hardly be a factor behind recovery within the logic of the Marxian analysis. Stated differently, the direct effects of technological change, i.e., its effects through spending and employment in machine construction, and displacement of workers upon installing the machines should be negative.

According to this, the construction of the new machines will not

increase the aggregate level of employment. They will be financed through the diversion of money and real capital from their other uses in the economy. Only a reallocation of existing capital will take place, not a net accumulation. Upon the adoption of the new machines, the aggregate level of employment will fall because of the displacement effect. Such interpretation is clearly consistent with Marx's view of technological change. It also shows that even if W is rigid, a relative increase in consumption as a possible source of recovery may not materialize because the displacement of workers may offset the effect of a rigid W and still reduce the total variable capital advanced.

Such technological change will also have secondary effects. Since the Marxian technological change reduces per unit cost of production, further deflationary pressures can lead to more bankruptcies and enforced idleness of real capital in those firms competing with the ones that install the new machines.

The negative effects of such technological change in the methods of production in a depression have also been indicated by other economists.[126] The implications of Marxian technology in a depression have a certain logic that is tenable if one accepts the premise that labour displacing technological change is significant in a depression. Then, the primary motivation of capitalists will be to reduce the costs of production without increasing the level of output. It will be very unlikely that there will be compensation in its broad sense due to net accumulation, given the depressed conditions.

Moreover, temporary shut downs and dismissal of workers by those firms planning to buy the new machines are more likely. In other words,

the displacement of workers may precede the construction of the new machines. Then, the conversion of v to C will precede the adoption of the machines. In the absence of crisis it was difficult, as frequently pointed out in the earlier chapters, to give meaning to this process. Under normal conditions, it is more realistic to assume that the firms which purchase the new machines continue to operate while the machines are built. The depression conditions, however, raise the possibility that this may not occur. The firms may not even be able to cover their running costs when they use their older machines and choose to shut down until the new machines are built.

The foregoing analysis implies that the Marxian technological change is primarily a negative force in a depression. Its contribution to recovery is not clear. At best, its positive effect is through the restoration of profitability in some industries that introduce the new machines and the effects of this on the expectations of capitalists. We need not seek all possible indirect ways through which Marxian technology may hasten recovery. By far the most important effect appears to be negative. One possible source of recovery due to such technological change would be net accumulation in the economy due to widespread demand for the machines. In a depression this is not likely given the pessimistic expectations on the part of the capitalists.

In summary, the recovery in Marx cannot be explained through his technological change. Other stimuli to accumulation must be sought. Marx lists stimuli such as "new markets", and new "social wants."[127] He does not, however, link labour displacing technology to them. Whatever positive effects it may have, for example, through centralization,

capturing markets and faster obsolescence which may lead to increased demand for capital goods elsewhere, its direct effects on employment are primarily negative. This would have to be the result if these machines do not call forth net accumulation, i.e., if they can be constructed through the diversion of money and real capital in use elsewhere.

On the other hand, if technological change induces net investment, then Marx's technological change can also lead to recovery. This change in the premise would, however, undermine much of Marx's analysis because it would not be consistent with his general view that technological change occurs mainly through the conversion of v in use to C. This view can hardly explain the increase in accumulation which is necessary for a recovery. In short, given the totality of our analysis in this study, Marx's limited view on technological change cannot explain the expansionary forces leading to a recovery in terms of labour displacing machines. Our interpretation differs significantly from that which is advanced by Samir Amin. He does not specifically refer to Marx in this context. However, his analysis is clearly along the Marxian lines. He sees the recovery arising from "the sudden investment called for by the construction of the new machines."[128] The implicit assumption is that there will be a net accumulation associated with these new machines. Given our earlier analysis in Chapters III and IV, we find it difficult to attribute such an interpretation to the introduction of labour displacing machines in the Marxian context.

8. General Evaluation of Some Important Issues

In this section, we will analyze and evaluate some questions that were raised at the beginning of this chapter as well as some issues that were referred to but not fully developed. We will undertake the evaluation of the following: (i) Relationship of capital shortage to cycles; (ii) Unemployment in depression and long term unemployment; (iii) Frequency of cycles and technological change. It must be underlined that our discussion will only emphasize those aspects directly relevant to our study.

(i) Relationship of Capital Shortage to Cycles

One important question raised at the beginning of this chapter concerns the role of real capital shortage in cycles and the reconciliation of the long term model based on this concept with cycles. The discussion of crises can be used to give some meaning to Marx's prediction on the secular tendency of the aggregate level of employment. It may be argued that depressions may lead to a capital shortage in the long term. When we analyzed the crisis-free long term accumulation, the implicit assumption was that the old capital in existence was fully recovered. In other words, premature scrapping of the old machines or material decay of a part of the existing capital stock because of underutilization did not take place. In a depression, however, these possibilities become real. The longer the depression, the more likely an actual physical destruction of real capital will be. Machinery and equipment which would have been used to employ labour under normal conditions may eventually be lost to the economy.

Also, the possible introduction of even more sophisticated new machines by some capitalists to reduce their costs of production by displacing workers is hastened by the cut-throat competition in a depression.[129] The older machines, which would have been in use under normal conditions when such competitive pressures were not as severe, are forced to permanent or temporary idleness. In the former case, the machines may not be profitable enough to be put into operation even if recovery starts. This is equivalent to an actual destruction through material decay. In the second case, the increasing demand during the recovery may bring the machines back into operation.[130] One cannot, of course, say which will be the predominant outcome. This depends not only on the duration of the depression and the strength of recovery, but also on the competitive edge gained through the introduction of the new machines. In short, the depression phase may be a phase of actual destruction of real capital and, hence, the destruction of the means to equip workers in the subsequent recovery, regardless of how such recovery starts.

In this framework, the depression period serves like wars or natural calamities which can reduce the quantity of real capital. Technological change in the depression intensifies the magnitude of such destruction if it takes place on a significant scale. Marx clearly sees this to be a significant force. He says: "...[C]ompetition compels the replacement of the old instruments of labour by new ones before the expiration of their natural life, especially when decisive changes occur. Such premature renewals of factory equipment on a rather large social scale are mainly enforced by catastrophes or crises."[131] The rate of adoption

which would, under normal conditions, be determined by the comparison of the gains due to the acquisition of new machines with the losses involved in scrapping the old machines is no longer determined solely by such considerations. The low rates of profit or even partial losses in recovering constant capital in a depression lead to premature obsolescence and can lead to actual destruction of capital. Economic calculations may be distorted by the general effects of the depression and uncertainty.

If such actual capital destruction intensified by Marxian technological change is significant, the economy will have to produce an equivalent amount of constant capital to replace that which has suffered material extinction. This is the only meaning that can be given to destruction of real capital in a depression. Under normal conditions, if the existing machines are not brought back into operation because of the competitive edge gained by the introduction of the new machines, the productivity gains should normally offset the loss of the real capital.[132] Clearly, this calculation is complicated by the effects of the depression.

The implication of actual capital destruction through material decay is that the labour absorption in the recovery will be rendered more difficult. This will also be accentuated by the fact that each successive depression will accelerate the rate of increase in q. Thus, the destroyed capital must not only be replaced but also its magnitude must grow if an equivalent amount of labour is to be absorbed.

The foregoing interpretation, which is nowhere explicitly stated by Marx, is, we believe, compatible with his view of technological change in a depression. We can use this interpretation in order to reduce the

dependency of Marx's long term capital shortage model on the falling rate of profit because of technological change. Similarly, if the depression phase is characterized by the Marxian technological change, the rapid rate of growth in q acquires a clearer meaning. Each successive depression accelerates the growth in q due to competitive pressures. The recovery and expansion phases may encounter a limit, based on the increased requirements for advanced capital. Then, real accumulation in equivalent periods during successive recovery phases will have to be greater and greater if the same number of workers are to be absorbed. The stimulus to introduce labour displacing machines, which appears to be much weaker under the crisis-free conditions, is strengthened by the competitive pressures in a depression.

This analysis also reduces the dependency of the Marxian long term prediction on excessive rates of growth in population. It shifts the emphasis to rapid rates of growth in q and capital destruction in the depression. Capital shortage rather than excessive growth in population becomes the underlying cause of the long term unemployment.

We believe that the long term accumulation model as analyzed in the last chapter becomes more coherent if it is modified through these effects of crises. Marx offers the elements of such a reconciliation, but he does not perform this task. Consequently, his crisis-free long term accumulation model remains weak. If such a synthesis of the cyclical effects with Marx's long term accumulation model is accepted, then the capital destruction effects of the depression may be large enough to offset some of the subsequent increases in productivity, arising from technological change, which will absorb labour when advanced as capital. These periodic destructions, in addition to rapid increases

in q, will reduce the rate of secular increase in the absolute demand for labour. Increasing levels of unemployment even with low rates of growth in population, will be possible in the long term.

Even though our interpretation does not violate the Marxian logic, the familiar objections can still be raised, for example, the validity of the Marxian premise that such technological change will be widespread in a depression. In addition, real capital destruction in a depression will largely depend on the duration of this phase. The role of the premature obsolescence of the old machines as an element in this destruction should not be exaggerated.

The question of the role of capital shortage leading to subsequent crisis is more complicated and, once again, not discussed by Marx. We can undertake a rather speculative approach to it without analyzing all of the complexities. This is essentially a restatement of our interpretation of the disproportionality argument in terms of capital shortage. It can be argued that in the upswing, the output and surplus do not grow rapidly enough because of prior capital destruction and that the shortage of real capital, not of money, precipitates the crisis. The disproportionality argument as discussed earlier should be integrated into this. The crisis can erupt well before full employment is achieved. The economy will not possess sufficient capital to maintain its earlier rates of expansion. The crisis will be preceded by increases in the prices of raw materials and machines, and the rate of profit will fall.

(ii) Unemployment in Depression and Long Term Unemployment

Many of the points that should properly belong to this section have

been referred to earlier in conjunction with capital shortage. One important point is that Marx's secular unemployment must be understood as one which is chronic. Our discussion of long term accumulation illustrated the substance of this point. If the Marxian unemployment is to be seen only in depressions, then this secular argument has no meaning. Limiting unemployment to depressions only is not consistent with a permanent reserve army as capitalism develops. Then, the economy would fluctuate between periods of full employment during booms and unemployment during crises. It is our interpretation that Marx's unemployment is not of this type. A consistent interpretation should be that the level of unemployment will become higher and higher when it is measured during the successive periods preceding the crises, i.e., during the peak prosperity periods. It cannot be claimed that Marx is clear on this point. Hence, a definite judgment cannot be made.

The explanation of the crisis in terms of the falling rate of profit caused by the increase in W tends to give support to the interpretation that Marx's growth model is a series of periods characterized by more or less full employment and also by periods of depression with high levels of unemployment. This could still be consistent with secular increases in unemployment if the average level of unemployment during the totality of each cycle is used as the index. This is not, however, consistent with the treatment of technological change and relative scarcity of capital which constitute the main message of Marx's long term prediction. One would, then, have to explain how the shortage of capital is overcome so that the boom periods can offset the levels of unemployment caused by crises. In effect, the capital shortage argument would have to be discarded.

The Marxian technological unemployment, if it is to have any significance in his analysis, must also be sought in prosperity periods. Obviously, most of our historical experience disproves this.[133] Whether the recent experiences, which indicate high levels of unemployment even in prosperity, are proof that Marx's prediction is being realized is a question that requires empirical studies. In "Capital Accumulation and Unemployment in Postwar Italy,"[134] Pierluigi Profumieri argues that, due to the increase in q, unemployment has been observed even in prosperity periods. He points out that each cycle started with a higher q. Moreover, he does not see the rigid wage as the cause of the increase in q.[135] Our objective is only to present the logic of Marx's analysis, not to test its empirical validity.

The falling rate of profit as a cause of the crisis does not appear to fit our interpretation. If our interpretation of Marx is correct, as capitalism develops, the causes of crises should be explained less and less in terms of the scarcity of labour. Disproportionality, underconsumption and capital shortage must be the elements behind these crises. On the other hand, it can also be argued that crises due to the wage rate, i.e., the falling rate of profit, need not imply that the boom period is associated with more or less full employment. Such an explanation would have to depend on monopolistic elements, for example, on union strength, or other factors such as dual markets and immobility of labour. Even though we have, at times, incorporated the role of class struggle and the rigidity of W in the downturn into our analysis, we have, for the most part, used a competitive model. A thorough study of these elements would take us into areas which are beyond the objectives of this study.

A final but important point still remains in relation to capital

shortage. If the Marxian long term model is characterized by capital shortage, one may ask whether the Marxian cycles will be of increasing amplitude over time. In fact, given the limited growth in capital, one would expect that output would rise at slower and slower rates. Hence, crises due to relative over-production should be less frequent. As Bernice Shoul points out, prosperity and depression should become less distinguishable.[136] If this interpretation is accepted, then our long term accumulation model, as analyzed in Chapter IV, can be studied without crises. If crises can be ignored, then our previous criticisms will still hold. Yet, Marx clearly sees cycles of increasing amplitude, which occur more frequently as new machines are introduced.[137] However, he does not explain why this should be the case.

(iii) Frequency of Cycles and Technological Change

We have pointed out that the Marxian decennial cycle based on the replacement of constant capital is not consistent with his emphasis on continuous technological change which not only changes the physical durability of the machines but also the rate of obsolescence. He argues that the new machines will have a longer physical life span but also that competition, through further technological change, will force faster rates of obsolescence.[138] Given the alleged rapidity of the increase in q, the latter effect appears to be the dominant one. In other words, the advanced constant capital would have to be recovered in shorter and shorter periods while its size grows in absolute terms. In this sense, the disruptive effects of technological change will be more frequent. They can cause or accentuate the crisis. This rapidity of technological change must be behind his contention that the cycles will be more

frequent.[139] He does not, however, elaborate on it.

This argument can be related to his claim that the tendency to over-produce is inherent in capitalism. Due to the possibility of further technological change, the capitalists try to recover their advanced constant capital in the shortest possible time. They adjust their output to their production capacity and not directly to demand.[140] They tend to operate their plants at near full capacity by devising methods to intensify the work effort, by trying to extend the work day, or by having extra shifts through the utilization of the same workers. Each capitalist thinks that he can sell his output without difficulty.[141] Thus, imbalance between demand and output can lead to crises. Such imbalance or disproportionality need not occur in all industries. "For a crisis (and therefore also for over-production) to be general, it suffices for it to affect the principal commercial goods."[142] The important point is that Marx sees the effect of the increase in constant capital on the behaviour of capitalists when the latter are constantly threatened by technological change that may subject their capital to "moral depreciation."[143] Continuity of production to recover the advanced capital in the shortest possible time becomes an objective necessity. Hence, over-production becomes an inherent tendency. We have, however, pointed out that his capital shortage argument would tend to weaken this tendency in the long term. Nevertheless, a relative over-production with respect to consumption power of the working class is still possible even though the total output may tend to grow at lower rates.

NOTES TO CHAPTER V

1. Mattick, "Value Theory", p.47.

2. Gourvitch, p.42.

3. Sweezy, Capitalist Development, p.133; J. D. Wilson, "A Note on Marx and the Trade Cycle", RES V (1938), 107.

4. Schumpeter, History, p.1131.

5. The literature on the Marxian crises is extensive. Some of the brief treatments include H. J. Sherman, "Marxist Models of Cyclical Growth", History of Political Economy 3 (Spring 1971); H. Smith "Marx and the Trade Cycle", RES IV (1937). Sherman also reviews the interpretations by Sweezy, Kalecki, Dobb, and Strachey. In "Marx and the Business Cycle", Science and Society XXXI (1967), he points out that technological change, by reducing the wage rate, can be a cause of underconsumption.

6. Sweezy, Capitalist Development,pp.133-84.

7. Schumpeter, History, p.1131.

8. G. Haberler, Prosperity and Depression (Cambridge: Harvard University Press, 1958).

9. Hansen, Business-Cycle Theory (Boston: Ginn and Company, 1927).

10. Schumpeter, History.

11. Haberler, Depression,pp.15-24. Also see J. Tinbergen, "Critical Remarks on Some Business Cycle Theories", Econometrica X (April 1942), for an elaboration of Haberler's classifications. In another article, Tinbergen and P. de Wolff present a statistical study for the U.S. between 1910 - 1932 to specify the causation of technological unemployment. In their model, which abstracts from cycles, they conclude that the increase in productivity was unfavourable to employment, particularly when technological change was not accompanied by additional investment. Hence, they argue that price flexibility and income effects have not served as compensatory influences. "A Simplified Model of the Causation of Technological Unemployment", Econometrica VII (July 1937).

12. Hansen, Business-Cycle,pp.1-9.

13. J. M. Clark, Strategic Factors in Business Cycles, (New York: National Bureau of Economic Research, 1949).

14. Clark, p.164. He uses the term "reserve army" and argues that technological change will worsen the depression.pp.123,132.

15. Schumpeter, History, p.1135.

16. Ibid., p.1127.

17. Hansen, Business-Cycle,pp.3-5.

18. Ibid., p.4.

19. Ibid.

20. Marx, Capital I, 115.

21. Ibid. Also see TSV II, 499-505, 507-17, where he criticizes Ricardo and Say's Law by integrating money into market exchange.

22. Marx, Capital I, 115.

23. Marx, Capital III, 220.

24. Ibid., p.254; Capital I, 137-8.

25. Marx, Capital III, 260.

26. See Sweezy, Capitalist Development,po.195-7.

27. Marx says: "The superficiality of Political Economy shows itself in the fact that it looks upon the expansion and contraction of credit, which is a mere symptom of the periodic changes in the industrial cycle, as their cause." Capital I, 593. Also see Capital III, 254, 441, 446-8, 450, 483.

28. A. Aftalion, "The Theory of Economic Cycles Based on the Capitalistic Technique of Production", Review of Economic Statistics IX (1927).

29. G. Garvy, "Kondratieff's Theory of Long Cycles", Review of Economic Statistics XXV (Nov. 1943).

30. D. H. Robertson, A Study of Industrial Fluctuation (London: D. S. King and Son, 1915).

31. Aftalion,pp.165-66.

32. Ibid., p.167.

33. Belfer, p.166.

34. Marx, Capital I, 592-3. He says that these decennial cycles are "interrupted by smaller oscillations." Ibid., p.596. He also states: "One may assume that in the essential branches of industry this life-cycle now averages ten years. However, we are not concerned with the exact figure. This much is evident: the cycle of interconnected

turnovers embracing a number of years... furnishes a material basis for the periodic crises." Capital II, 188-9.

35. Garvy, pp.207-8.

36. Marx, Capital II, 188.

37. Robertson, pp.13-4.

38. Ibid., p.31.

39. Ibid., p.36.

40. Ibid., pp.170-71.

41. N. Cobeljic and R. Stojanovic, The Theory of Investment in a Socialist Economy (White Plains, New York: International Arts and Sciences Press, 1969).

42. Ibid., pp.92-3.

43. E. Mandel, Late Capitalism, trans. J. De Bres (London: Humanities Press, 1975), pp.184-247. Mandel indicates some of the possible contradictions. However, he does not show how technological displacement can be related to crises.

44. Fellner, "'Modernised' Interpretation", p.23.

45. A. Kähler, "The Problem of Verifying the Theory of Technological Unemployment", Social Research III (Nov. 1935), 440.

46. Ibid., p.443.

47. Marx, Capital I, 29.

48. Marx, TSV II, 497.

49. Marx, Capital I, 427.

50. Marx, Capital II, 225.

51. Marx, Grundrisse, p.749.

52. Ibid., p.750.

53. Marx, Capital III, 250.

54. Smith, p.204.

55. Marx, Capital III, 254-6, 258-9. For a discussion on the effects of the falling rate of profit on concentration, centralization and accumulation see Capital I, 241-2.

56. Marx. Capital III, 250.

57. Marx. TSV II, 484-5.

58. Marx says: "...[E]ach capitalist does demand that his workers should save, but only his own, because they stand towards him as workers, but by no means the remaining world of workers, for those stand towards him as consumers." Grundrisse, p.287.

59. Marx, Capital III, 256.

60. Sweezy, Capitalist Development, pp.147-89. On underconsumption and disproportionality see E. Mandel, Marxist Economic Theory I, trans. B. Pearce (New York Monthly Review, 1970), pp.361-73.

61. Marx, Grundrisse, p.311.

62. Marx, Capital II, 26-34, 58-9.

63. Ibid., p.399.

64. Marx, Capital I, 303.

65. For Marx's discussion on the simple and extended reproduction models see Capital II, 396-527.

66. Marx, Capital III, 406.

67. See S. Koshimura, Theory of Capital Reproduction and Accumulation, J. G. Schwartz, ed. (Kitchener, Ontario: DPG Publishing Company, 1975); A. B. Razgoner, "The Separation of Simple Reproduction from Expanded Reproduction in Karl Marx's Schemes of Reproduction and Circulation", Matekon XII (Fall 1975).

68. Sweezy, Capitalist Development, p.158.

69. Marx, Capital I, 413.

70. Ibid. He also points out that a natural shortage in raw materials may reduce that part of the total capital which is to be advanced as v. Moreover, a part of the existing fixed capital may be impossible to utilize, owing to such shortage. He sees this as a possible cause of crises. TSV II, 515-6.

71. Marx, Capital III, 251-2.

72. Marx, Capital I, 580-81.

73. Ibid., p.580.

74. Clark says: "First, we should understand that there are no causes that are aboriginal in the sense that they have not themselves causes; but there are some that may be treated as originating forces for our purposes." p.14. Marx clearly rejects any attempt to explain the crises in terms of a single cause. TSV II, p.510.

75. Haberler, Depression, pp.5-6.

76. Marx indicates the effects of the deflation process without relating them to the new machines. TSV II, 494.

77. Marx, Capital I, 581.

78. Marx, Capital II, 414.

79. Ibid., p.319.

80. Marx, TSV II, 505. Also see Capital III, 254, on deflation and credit.

81. Marx, TSV II, 505.

82. Strachey incorporates the expansion in the supply of money and credit into his analysis in order to show that a disproportion between output and consumption may occur, owing to the over-optimistic expectations caused by inflation. pp.309-21. He does not, however, relate this discussion to technological change.

83. Lederer, "Technical Progress." Also see S. H. Slichter who argues that labour saving devices may not show their effects during the boom, but only when the boom ends. The level of employment falls "more than it otherwise would." "Lines of Action, Adaptation and Control", AER, Supplement, XXII (March 1932), 42.

84. Marx, TSV II, 27.

85. Marx, Capital III, 255.

86. Marx, Capital I, 593.

87. Clark, p.18.

88. Marx, Capital I, 596.

89. Marx, TSV III, 312.

90. Gourvitch, p.175.

91. Clark, p.123. He also states that the cyclical fall in employment was "all the more serious", owing to the fact that "the seemingly abnormal increase of capital equipment had not been employing many workers." p.108.

92. Slichter, p.44. In his comments on Slichter, Clague points out that technological change may be so rapid that unemployed labour and idle capital may co-exist simultaneously. In this case, wage flexibility adds nothing to the system. "Discussion", AER, Supplement, XXII (March 1932), 48, 55.

93. E. Graue, "Inventions and Production", Review of Economic Statistics XXV (Nov. 1943).

94. M. Bleaney, Underconsumption Theories (London: Lawrence and Wishart, 1976), pp.110-19.

95. Sweezy, Capitalist Development, p.151.

96. Schumpeter, History, p.1132.

97. See Bleaney for a comprehensive review and evaluation.

98. Sweezy, Capitalist Development, p.155.

99. Marx, Capital II, 414.

100. Ibid., p.415.

101. Marx, Capital III, 245.

102. Ibid., p.244.

103. Marx, TSV II, 492. Also see p.563, where he relates the displacement of labour to reduction in v and deflation.

104. Marx, Capital III, 484.

105. J. Strachey, The Nature of Capitalist Crisis (New York: Covici Friede Publishers, 1935), pp.259, 336.

106. Sherman, "Marx and Business Cycle", p. 497.

107. Strachey, p.250.

108. Sherman, "Marx and Business Cycle", p.491.

109. Hicks, Value and Capital, p.286.

110. Marx, Grundrisse, p.422.

111. Löwe, p.235.

112. Sherman, "Marx and Business Cycle", p.491.

113. Marx, Capital I, 17.

114. Marx, Capital III, 249.

115. Marx, TSV II, 495-6. He says: "...[T]he equilibrium would be restored under all circumstances through the withdrawal or even the destruction of capital." Capital III, 253.

116. Ibid., pp.253-54.

117. Ibid.,pp.252-3.

118. Ibid., p.254.

119. Marx, TSV II, 516.

120. Marx, Capital III, 255.

121. Marx, TSV II, 496.

122. Ibid.

123. Marx, Capital III, 255-6.

124. Ibid.,pp.254-6.

125. Sherman, "Marx and Business Cycle", p.491.

126. Kähler says: "Mechanization therefore brings about unemployment during depressions not only through increased productivity of labour but also because it forces the discarding of capital equipment and a contraction of productive activities." p.458. On Spiethoff see Belfer,p.176. Lederer also makes a similar point. "Technical Progress", p.38.

127. Marx, Capital I, 575.

128. S. Amin, Accumulation on a World Scale 2, trans. B. Pearce (New York: Monthly Review, 1974), 497.

129. Marx, Capital III, 252, 255.

130. Ibid., p.255.

131. Marx, Capital II, 174.

132. Bouniatian, pp. 342-3.

133. However, Lowe cites D. Weintraub to show that even during the prosperity period preceding the Great Depression, the level of unemployment never fell below 10%. p.249. He attributes this to massive technological change during this period.

134. P. Profumeri, "Capital Accumulation and Employment in Postwar Italy", JEI 4 (Dec. 1971).

135. Ibid.,pp.75-88.

136. Shoul, p.293.

137. Marx, Capital III, 121, where he seems to agree with the English Factory Reports which he cites.

138. Marx, Capital II, 188. Also see pp.172-3. It is important to note that S. Kuznets also emphasizes the obsolescence factor as a characteristic of "modern epoch." Population, Capital, and Growth: Selected Essays (New York: W. W. Norton, 1973), p.156.

139. See note 137.

140. Marx points out that due to the growth in fixed capital, the "continuity of the production process" becomes "a compelling condition." Grundrisse, p.703. Also see Capital III, 256; TSV II, 468, 484.

141. Marx, Grundrisse, p.521.

142. Marx, TSV II, 505.

143. Marx, Capital III, 188.

CHAPTER VI

CONCLUSIONS

Since we have stated many conclusions throughout the study, we will not repeat all of them. We will limit the present chapter to a brief summary of the more fundamental conclusions that can be derived from Marx's analysis.

Marx's approach to technological labour displacement is most clear in his short term model which excludes accumulation. The construction and adoption of the machines are financed through the restructuring of capital which is already in use. This process involves an increase in constant capital at the expense of variable capital. Hence, there is an absolute diminution in the amount of variable capital advanced. With a given wage rate, the absolute level of employment decreases relative to the periods preceding the construction and adoption of the new machines. Even though there are some differences such as the role of constant capital, the model is very similar to the one advanced by Ricardo.

The long term crisis-free model incorporating simultaneous accumulation and technological change is the basis of Marx's argument that

the absolute level of unemployment will increase in the long term even though the absolute level of employment will also increase. This model depicts the Marxian race between the labour displacement effects of technological change and the labour absorption effects of net accumulation. Repeated statements by Marx indicate that he believed that the rate of accumulation would exceed the rate of increase in C with respect to v. Consequently, the absolute level of employment increases. Marx's choice for the increase in the absolute level of employment does not, however, necessarily follow from his analysis.

He could also have argued that the organic composition of advanced capital will increase faster than the total increase in capital. Then, the absolute level of employment would fall over time. We will return to this aspect shortly.

Marx's long term crisis-free model is based on a relative capital shortage with respect to the available supply of labour, i.e., the growth in the stock of capital will not be large enough to absorb the additional entrants into the labour force. This relative shortage, according to him, is caused by two factors. Firstly, the rapid rates of increase in the organic composition of capital increase the amount of commodities that must be used as constant capital to equip the additional workers. Hence, the rate of growth in total capital may not be sufficient to perform this task. Obviously, the rigidity of capital-labour coefficients lies behind the argument that there will be unemployed workers. Secondly, he introduces the concept of the falling rate of profit as a secular tendency to argue that the rate of accumulation will decrease over time.

We have called the first explanation behind the alleged relative capital shortage the direct effect of technological change. The second effect, i.e., the effect of an increase in the organic composition of capital on subsequent accumulation, was called the indirect effect. We have seen that this indirect effect is untenable. Marx fails to show why technological change will reduce the average rate of profit in the long term.

Our analysis of the Marxian crises with respect to technological change and technological unemployment was a speculative attempt to synthesize the long term unemployment, when Say's Law holds, with cyclical unemployment, when the capital stock is underutilized.

The relationship of technological unemployment to crises in Marx is not a clear one. We have advanced alternative interpretations. The most clear argument linking the two is in terms of the underconsumptionist view in Marx. Technological displacement depresses the rate of growth in v below the rate at which the output of consumption goods increases. Hence, a disproportion occurs. If such disproportion characterizes many industries, the crisis may start. Alternatively, underconsumption caused by displacement may be an accentuating factor in a depression even though it may not be a factor in starting the crisis. This argument can be related to the adoption of labour displacing machines after the crisis starts.

The falling rate of profit, caused by the increase in the wage rate during the boom, can also be seen as an explanation for the crisis. This clearly is not consistent with the argument based on underconsumption. In this case, technological displacement is not

sufficient to check the growth in the share of v during the boom. Accumulation exceeds the rate of Marxian technological change and exhausts the available labour supply. The new machines are introduced in the downturn or depression in order to reduce costs and to gain a competitive edge. In this way, technological unemployment can accentuate a crisis which is initially caused by the falling rate of profit. In the downturn or depression, general compensation due to net accumulation may not take place, given the business conditions. We have also seen that the disproportionality argument as a possible cause of crises can also be related to technological change and unemployment in a much more complicated manner.

One can make two important observations about the relation of technological change to crises in Marx. Firstly, even though the role of technological change as a primary causal factor or an accentuating force in crises can only be speculated upon, one can assert much more forcefully that Marx's technological change cannot play an important part in starting the recovery. The totality of our analysis indicates that Marx's technological change, assuming that it is widespread in a depression as he claims, cannot be seen as an expansionary force. In fact, the conversion of variable capital already in use to constant capital would worsen the depression in terms of unemployment, without necessarily leading to a net expansion in output. Such technological change would only enable some capitalists to survive by driving others out of the market. Only in an indirect fashion such a competitive edge may encourage net accumulation on the part of the innovative capitalists who were able to raise their rate of profit. However, even then, it is not clear

why such a recovery in the rate of profit by some capitalists should lead to a net accumulation in the economy as a whole. The result may simply be a process of centralization. Since Marx does not see net accumulation as a prerequisite for the introduction of the new machines, his technological change cannot be used to explain the forces behind net accumulation which may start the recovery.

A second observation with respect to crises is that, if one is to achieve a consistency between Marx's long term technological unemployment and unemployment during crises, one must, somehow, introduce the alleged capital shortage into the analysis of crises as well. The long term argument, as we have seen, is dependent on this alleged shortage. Since the crises are but phases in the long term growth process, capital shortage must also be related to them. We have shown that, if one accepts the Marxian argument that labour displacing technological change is widespread during the crisis, one can then attach some meaning to capital destruction in a crisis and also to the alleged rapidity of the increase in q. The crises will be reinforcing the secular tendency. Such an attempt to reach a consistency would, however, also imply that, in the long term, crises should, for the most part, be caused by underconsumption and other types of disproportionalities, but not by the periodic increases in the wage rate due to the elimination of the industrial reserve army. In other words, even the prosperity periods should be characterized by high levels of unemployment, i.e., by workers who cannot be absorbed because the available capital is not sufficient. During the crises when Say's Law does not hold, the level of unemployment further increases. However, even if the crisis does not occur, there will be long term technological unemployment.

Marx's analysis can be criticized on several grounds. One can question the assumed rigidity in the production coefficients involving labour and means of production. One can criticize the alleged technological bias which always increases the organic composition of advanced capital. From our perspective, a more fundamental criticism can be raised without going outside the Marxian framework. This criticism, which we have often referred to, is directed against the relationship of technological change to net accumulation in Marx. Even though Marx, unlike many economists, sees that technological change will normally involve an increase in constant capital, i.e., technological change is not free, he does not see net accumulation as being necessary in this process. The conversion of v to C appears to be the primary source of finance in bringing about technological change. Stated more correctly, the amortization funds recovered plus the already advanced variable capital are the major vehicle to increase the organic composition of capital. This line of thought underlies Marx's short term analysis and is the most explicit one in his writings, particularly in the first volume of Capital. Obviously, in a hypothetical economy which does not experience net accumulation, such technological change would ultimately be checked because most of the available variable capital would have been converted to C. Even though Marx's long term model incorporates net accumulation and, thus, enables a growth in C with respect to v while v also increases in absolute terms, there is no clear evidence in his writings that he sees high rates of net accumulation as being necessary for his technological change. A clear impression one gets from his writings is that the rate of accumulation will exceed the rate of technological change, which is reflected through the increase in the ratio of C to v. In

this sense, the absolute level of employment will increase. Yet, given the logic of his short term analysis where technological change primarily involves the conversion of v to C, one could also argue that, in Marx, technological change could be faster than the rate of accumulation. Then one could expect a secular decrease in the absolute level of employment. In short, Marx's long term model shows general compensation due to net accumulation, but the logic of his analysis does not necessarily lead to this result. The most pessimistic result, i.e., a secular decrease in the absolute level of employment, is also consistent with his approach. This ambiguity in Marx is clearly related to his limited view of technological change. In the real world, his view is possible. Technological change can be introduced at the expense of v by restructuring the existing capital. It is, however, also likely that revolutionary technological change of any type will normally require net accumulation in the economy as a whole. In this case, Marx's short term analysis will have to be discarded. Then, technological change will usually be accompanied by an immediate increase in both C and v. An increase in the ratio of C to v will be accompanied by a simultaneous increase in the absolute level of employment. It is, of course, still possible that the rate of accumulation necessary for the introduction of new technology may be less than the rate of increase in the ratio of C to v, i.e., technological change involves a conversion of previously advanced v to C. Yet, such an outcome is not necessarily determined in advance. Marx's analysis, on the other hand, necessitates the immediate displacement by ruling out net accumulation in the short term. In his case, the only source to increase C is the capital which was previously advanced as wages. Long term accumulation involves technological change, but technological change does not appear to be the engine behind

this growth. In fact, as we have seen in Chapter IV, the rise in the organic composition of capital indirectly reduces the rate of accumulation by reducing the average rate of profit in the long term. It appears that the logic of Marx's short term analysis should ultimately become applicable once again, i.e., given the low rate of accumulation, technological change should be financed mainly through the conversion of v. This outcome in the long term is consistent with his approach even though he tries to show that his analysis supports the correct observation that the absolute level of employment has increased over time.

Our conclusions, so far, have indicated the weaknesses and incompleteness of Marx's specific analysis. We must, however, note that Marx's general theoretical approach to the study of the question of technological unemployment can still be defended, in spite of the fact that his conclusions are based on special assumptions. His methodology is primarily an attempt to identify the essentials from the non-essentials in this area. He specifies not only the type of technology he is concerned about, but also the types of changes that can normally be associated with it. He seeks the possible forms of compensation only in those changes that are directly or indirectly caused by such technological change. He rules out other changes and sources of compensation which are independent of the particular technological change under consideration. It is very clear that the associated changes which he specifies are not complete. He ignores, for example, the adjustments in the capital-labour coefficients that may occur as a consequence of the relative cheapening of labour upon displacement. Nevertheless, he is very careful about not introducing changes which have little to do with the particular technological change. One very good example for this is that he does not consider the additional capital,

which arises from independent sources, as a compensatory factor which can legitimately be included in the analysis of technological unemployment. If one traces the source of compensation to net accumulation, one has to establish the necessary links between such accumulation and the technological change whose employment effects are being considered. This can be done in two ways. Firstly, one can argue that significant technological change usually requires net accumulation. Then, the question of technological unemployment may cease to be a practical concern because net accumulation will normally be associated with increases in the level of employment. As we have already seen, Marx does not adopt this approach. Secondly, one can argue that technological change will increase the surplus sufficiently so that the workers who may have been displaced upon the adoption of the machines will be reabsorbed through subsequent accumulation. Obviously, neither argument can be proven on purely theoretical grounds. Yet, both arguments are theoretically sound because they do not introduce independent sources of compensation. Since Marx tends to ignore the first argument, one could say that he does not consider all possible forms of change. He limits himself to the refutation of the second argument. His conclusion, as it has been discussed at length, is that the surplus generated through the particular technological change will not be sufficient for full compensation.

If additional surplus becomes available from other sources, and all of the displaced workers are reabsorbed, one can only say that the growth process has caused general compensation. This approach, however, does not specify the theoretical boundaries of the problem. As we have seen throughout the present study, many of the current and classical arguments make this error. The supply of capital is assumed to be readily forth-

coming. Even though this might be the case in some economies, this fact does not mean that the theoretical problem concerning technological unemployment has been resolved. At best, this approach is based on a belief which happens to have been reinforced by historical observations. In modern thought, the Keynesian emphasis on the demand aspect tends to support the belief that the availability of capital is not a source of concern. It is beyond the scope of this study to consider the controversies in this area. The important point is that the Keynesian approach does not even define the question of technological unemployment. General compensation is inherent in this approach as long as aggregate demand is not deficient. Then, any possible displacement of labour can only be temporary, given adequate demand manipulation.

It is important to note that the neo-classical approach has, in some ways, much more in common with the Marxian approach in this area. It constitutes an attempt to specify the changes that can be associated with the particular technological change. Despite the fact that the neo-classical technological change, as it is discussed in relation to labour displacement, strictly speaking, is pure mechanization along a production isoquant and does not involve the introduction of previously unknown methods of production, this approach, at least, tries to trace out the subsequent changes caused by the initial labour displacement. In this case, compensation occurs through the adjustments in the production techniques in response to the changes in relative input prices. Thus, the introduction of machines is slowed down or even reversed, given the subsequent movements in the prices of capital and labour. We have discussed at length how these compensation mechanisms differ from Marx's analysis, which does not emphasize them. We cannot, however, exaggerate the similarities. With a

few exceptions, the neo-classical economists do not deal with the question of technological unemployment. Given the conviction that flexible prices will ultimately resolve the problem, there is no concern about a possible shortage of capital. Obviously, the Marxian concern is very much a result of the fact that this conviction is not mutual. It should also be indicated that the neo-classical approach to the question of technological unemployment often shares the same weakness that exists in the Keynesian approach. Demand for commodities is usually shown as a compensatory mechanism. The reabsorption of displaced labour is sought in demand elasticities for the cheaper products and in shifts in demand after technological change. We have shown at length that there is serious confusion in this area. The origin of the supply of capital necessary for an expansion in total output and employment is left unexplained. Once again, as in the Keynesian case, capital is assumed to be readily available.

In summary, our study of Marx shows that Marx's general theoretical approach offers many useful insights on the compensation controversy even though he can easily be criticized for presenting a limited view of technological change. Moreover, he makes some special assumptions concerning technological bias and forms of finance. By way of comparison, we have also shown that classical and current approaches are not adequate to refute Marx. It was not the objective of this student to study how or whether modern theory could be modified so that it could deal with the question of technological unemployment. We believe that our study of Marx offers some insights that may be useful in other studies in this area. Given that the public's concern about technological labour displacement is very much alive, the economics profession cannot afford to be complacent. Despite its weaknesses, the Marxian analysis deals with such concern. One cannot refute it without offering a rigorous analysis of the question.

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LIST OF ABBREVIATIONS

AER:	American Economic Review
EJ :	Economic Journal
ILR:	International Labour Review
JEI:	Journal of Economic Issues
JPE:	Journal of Political Economy
QJE:	Quarterly Journal of Economics
RES:	Review of Economic Studies