Market Integration: France's Grain Markets of the Sixteenth and Seventeenth Centuries.

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Abstract

The present thesis concerns the dynamics behind the integration of French grain markets between the sixteenth and the seventeenth centuries. It is shown that these markets were typically segmented, being oriented towards regional autarchy. During crises, the traditional market system would disintegrate under the strength of urban demand. Using an gross output allocation model, it is shown that the powerful impact on prices following a reduced crop may be linked to the inelasticity of demand with respect to prices as well as the important elasticity of marketed output with respect to yields. Furthermore, it is argued, using a dynamic adjustment model, that the inelastic demand also contributed much to the absence of a rapid adjustment of prices. Finally, using price data recorded during *disettes*, it is demonstrated that apparently, the long run process of creation of a national market was unable, during the sixteenth and seventeenth centuries, to reduce the crises' intensity as measured in deviations of prices from customary levels.

Résumé

Cette thèse étudie les dynamiques qui influencèrent l'intégration des marchés français de grain des XVI[e] et XVII[e] siècles. Ces marchés, alors essentiellement orientés vers l'autarchie régionale présentent l'image d'une structure segmentaire. Lors des grandes crises de subsistances, les réseaux d'échanges se désintègrent sous la force de la demande urbaine. A l'aide d'un modèle d'allocation des récoltes, il est démontré qu'il est possible de relier le puissant impact d'une récolte partiellement réduite sur les prix, à la faible élasticité de la demande par rapport au prix et à la forte élasticité de la quantité offerte sur les marchés par rapport à la récolte brute. De plus, cette inélasticité de la demande se traduit par un ralentissement du retour des prix à la normale lors d'une disette tel que démontré par l'utilisation d'un modèle dynamique d'ajustement. Finalement, l'étude des cours du blé contenus dans les Mercuriales de Paris révèle que le processus à long terme d'intégration des marchés n'a pas contribué, durant la période concernée, à une réduction sensible de l'intensité des disettes telle que mesurée par l'écart des prix par rapport aux niveaux normaux.

Acknowledgments

The completion of this thesis owes much to the patience and dedication of George W. Grantham who directed me expertly through some of the difficult problems encountered in studying French history. His impressive understanding of French institutions has proved to be an inexhaustible source of information. John Galbraith was especially helpful with some of the technical aspects on difference equations. I am also deeply indebted to John McCallum, William Watson, Chris Green and especially to Tom Naylor and Allan Fenichel for their unfaltering support throughout my research and studies at McGill. Finally, financial assistance from the Department of Economics is gratefully acknowledged.

Table of Contents

I- Introduction

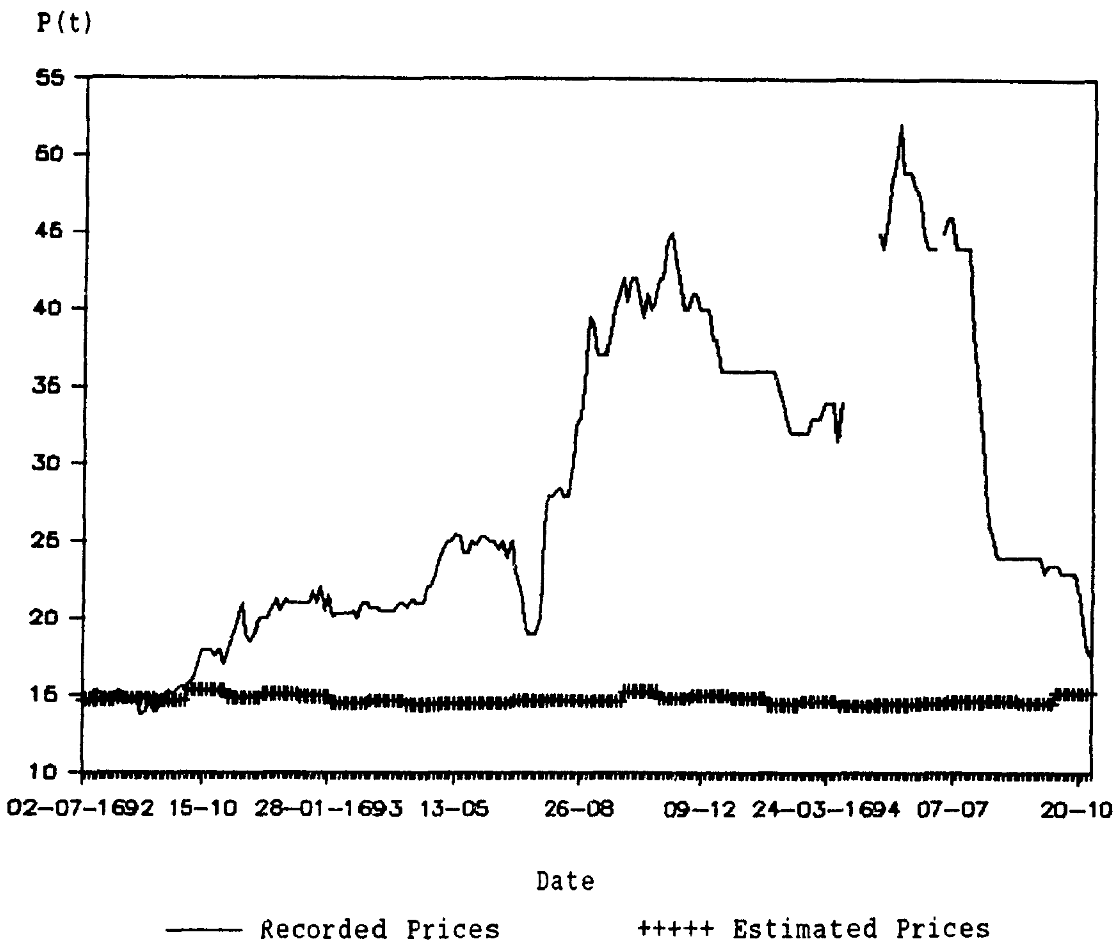
An experienced *Juré Mesureur* observing the grain market of Châlons-sur-Marne, about 100 km east of Paris, in early May of 1693 would have felt it immediately. Looking down from his office, where the official weights were stored, at the deserted marketplace, usually animated with intense activity, his verdict would have been unambiguous; deep in the countryside surrounding his village, as well as in all rural areas of France, another *crise de subsistance* was slowly picking up momentum.

He would know that the local market would be bypassed by Parisian merchants who were now going directly to the sources of grain supply, moving rapidly from farm to farm in desperate efforts to secure grain at any cost. He would be aware that farmers would also share his expectations. They would be waiting nervously for what they would perceive as the maximum price for their reserves of *bled;* almost completely isolated from conditions elsewhere, each farmer trying to decipher the underlying nature of the shortage from the anxious manners of the merchant before him. The preceding winter had been exceptionally difficult; they would also be able to recognize the signs announcing a forthcoming famine.

The market official by experience, might have expected a time path of prices similar to the one displayed in Figure 1. The harsh winter of 1692-93 had been preceded by a wet summer and fall. The excessive rain had delayed the plowing and wasted the seeds insufficiently protected by the superficial turnover of the soil. Prices had responded immediately with a 50% increase.

Following the long and icy winter, the *Juré* would be witness to a cold and wet spring, which surprisingly might have had a minimal effect on the blossoming of the grain, resulting in an optimistic dip of prices. However, when the wet conditions would be prolonged throughout the summer and through the fall, to be followed by what appears to have been another extremely difficult winter in 1693-94, prices would reach more than three times the normal.

Figure 1: Wheat Crisis, 1692-94.



In the spring of 1694, the thaw of water trading routes as well as the opening of many previously impracticable roads giving access to rural grain sources offered some respite, soon to be followed by a speculative peak during the summer preceding the harvest of 1694. During the three or four months starting in May known as the *soudure*, the *Juré-Mesureur* would expect a final impulse to wheat prices as had happened during the thirteen other crises which had hit the sixteenth and the seventeenth centuries. Under the combined effects of speculative hoarding of grain in expectation of another bad year and depleted reserves which had been consumed during the crisis, prices would reach their maximum, three and a half times their normal levels.

Around August, while a generous harvest would begin to take place, prices would come crashing down as the Parisian market would become inundated with supplies which had been kept out just a little too long. The untimely arrival of grain boats which had waited hidden upstream on the Seine, Oise and the Marne rivers for the short-lived peak would precipitate the fall. Still, the definite return to normal conditions would have to wait until a critical date such as the *Fête de la St-Martin* in early November when traditionally, the crop had been threshed, stored, and its extent was fully known. By then, the slow process of expectations adjustment would have accepted the *crise de subsistance* as a thing of the past.

What this Juré could not know, is that this crisis, with the following shock in 1709 would be the last of the great *disettes* which rocked the sixteenth up to the early eighteenth centuries in France. Following this date,the subsequent crises never reproduced the destructive impact reached in the previous centuries. Rather than be allowed to hit with full blow, the shortages of the eighteenth never moved past the stage of latent shocks, to finally disappear completely in the nineteenth century.

The present thesis is an attempt to understand the role of such markets during the crises. It concentrates on how well grain markets diffused information about wants and available resources. The analysis of shocks is particularly interesting in the sense that it helps tracing out the limits of the traditional market system. It will be shown that although the trade apparatus might have performed reasonably well in achieving price stability during normal periods, as can be seen in Figure 1 from the absence of important fluctuations in the first months preceding the impact, the local grain trade system was unable to cope with the increased pressures of concentrated demand as urbanization proceeded at an accelerated pace throughout the sixteenth and seventeenth centuries. During crises, the traditional system would disintegrate with merchants buying directly on the farm, thereby segmenting individual transactions away from market where information on underlying conditions circulated. This probably contributed much to the persistence of the famine by reducing the extent and speed of the adjustment of supply to high price differentials[1].

The study of agricultural markets in the sixteenth and the seventeenth centuries must be placed in the context of the difficult transition from the self-subsistent manor to the market-oriented farm. Following the decline of feudal organization, French agriculture had been essentially oriented towards the autarchy of the producer. The local grain market had therefore been designed to redistribute whatever small surpluses remained to satisfy non-producing local consumption. However, following the great waves of urbanization, this system faced increasing difficulties in dealing with metropolitan demand, and its failure in channeling stable flows of grain supplies was especially evident during crises. Both the agricultural sector and its trade apparatus were slowly evolving in order to meet the new constraints imposed by concentrated demand; this period witnesses the depth and the intensity of the adjustment which had to be undertaken.

The notion of the fragility of the market institutions of the sixteenth and seventeenth centuries was first developed by A.P. Usher. Usher (1913:3-44) insisted on the disruptive influence of the almost perfectly inelastic urban demand on the rural world. In the face of unresponsive supplies, prices would reach maxima during shortages which would only disappear when the next good harvest took place. In the meanwhile, a minimal demand and supply adjustment to the high price differentials would have been observed.

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[1] Usher (1913:196-202)

This argument has been adopted by the two leading French authors for the time period: Ernest Labrousse and Jean Meuvret. Its relevance will be tested using three methods: the analysis of prices at impact, the study of a simple price adjustment model and an analysis of the deviations of observed prices from their usual levels. What this thesis asks, is why did prices fluctuate so much following a reduced crop, did there exist a market mechanism which guaranteed their return back to normal levels and finally, can we recognize a long-run trend in a reduction of the intensity of price fluctuations during crises?

The question of the behavior of prices at impact, i.e. when information on the extent of the crop reduction is held, is addressed through the study of the chain rule of elasticity. It is demonstrated that the impact of reduced yields on prices is directly influenced by the elasticity of marketable output with respect to gross output (crop), while being inversely related to the price elasticity of quantity demanded. Furthermore, certain plausible long-term changes in the parameters which could have had a depressing effect on the powerful link crop-prices are discussed.

The following section will be used to give a better understanding of the various behavioral parameters preventing a rapid adjustment of prices. For this purpose a simple price-adjustment model is introduced which draws heavily on Samuelson's (1939) multiplier-accelerator model translated into a microeconomic context. A simple simulation is used to demonstrate that, in addition to a low degree of price responsiveness of instantaneous relative to lagged supply, a price-inelastic demand might have played an important role in preventing a rapid adjustment of prices back to normal levels. The presence of a time-lagged component to total market supply, a feature recognized in the seventeenth and eighteenth centuries' literature[2], will lead to price-adjustment paths which can be understood using Samuelson's stability conditions.

The purpose of the third approach is to measure the extent of each of fourteen crises by concentrating on the area below the time paths of prices. It will be demonstrated that if we project an estimated normal price over the entire duration of the crisis, the integral defined between actual and normal prices shows a marked tendency to diminish following the 1521-22 crisis up to 1562-63. Following this date, subsequent shocks seem to oscillate around the very high figure obtained in 1521-22, which would indicate that no important reduction in the crises' intensity was felt between the early sixteenth and late seventeenth centuries.

As will be shown, this opinion is also held by Meuvret. and Labrousse as well as Léon and Carrière. In the 80 years preceding the Revolution starting with the last famine in 1709, the crises will never reach their previous destructive force, apparently unable to move past the stage of the *crise larvée.* The *disettes* die out during the nineteenth century when technical progress in transportation, communications and agriculture, notably with the introduction of chemical fertilizers, allows a more efficient allocation of food supplies.

But first, it is perhaps useful to introduce the historical *toile de fond* on which crises are projected. The analysis of food shortages cannot be dissociated from their political, social, economic and climatic context. Their study would be incomplete without reference to the surrounding environment which generates and most often aggravates the *disettes.* The first section briefly reviews the main historical events which marked the sixteenth and seventeenth centuries. A second segment sets the supply-side

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[2]Serres, O.de, (1600), Monceau, D. du (1762)

elements generating the shocks as well as briefly reviews the structural obstacles to adequate supply response to price differentials which would remain in place atleast up to the nineteenth century. These include the states of transportation and communications as well as the attitude towards markets and cash crops. As always in studying distant past, special attention must be given to physical, technical and perhaps most importantly, human constraints on individual decisions. If these are kept in mind, the efficiency with which institutions adapted to their environment is revealed. When this environment is changing, institutions must adapt as well. As is often the case in history, institutional changes are met with fierce resistance.

II- Historical Context

At the beginning of the sixteenth century, France was emerging from a slow renaissance which originated fifty years earlier. Both population and production were painfully recovering from the destruction associated with the second quarter of the fourteenth century which culminated in the great crises of the period 1415-40. Between 1340 and 1560, France's population will go through a formidable *allez-retour* from 17m to 10m and back to 17m inhabitants[3]. Unprecedented and never reproduced thereafter, the impact of this massive transformation of the demographic structure will be felt throughout the subsequent centuries. The plague of 1348 hit the continent via Marseille and marked the start of a decline which will last through the next one hundred years.

The Black Death became endemic, recurring every ten years or so, up to the late seventeenth century. On the political scene, the One Hundred Year War drained population as well as productive capacity through its massive consumption of human lives and the destruction of physical capital it left behind the passage of

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[3]Le Roy Ladurie (1977:494)

troops[4]. In the early fifteenth, a series of bad crops compounded the devastation of the war resulting in the great crises of 1420-40:

"Il faut les horreurs de la guerre et du brigandage, les récoltes brûlées, les fermes et les moulins détruits, les chevaux et les boeufs disparus, les échanges paralysés pour qu'apparaissent les symptômes de la faim effroyable de la période 1420-1440."

LeRoy-Ladurie (1977: 497)

Extreme in their duration and human toll, the crises of 1421, 1432-33 and 1437-39 were probably more intensely felt than their counterparts of the sixteenth and the seventeenth[5]. They offer the image of a severe malthusian adjustment to the decline in per capita consumption.

The recovery took place in the second half of the fifteenth. In addition to the decline in mortality, population growth resumed as the age at marriage was sensibly reduced from 25 or 28 to 21 years[6]. What Le Roy Ladurie (1977) refers to as an effective form of birth-control will play a crucial role in determining population fluctuations throughout the period studied. Under the omnipresent influence of the Church, individuals responded to adverse conditions by postponing marriage plans and reducing family size.

Production finally recovered as witnessed in the increase in tithes entries which will reach their maxima in mid-sixteenth[7]. The relatively peaceful reigns of François 1[er], and Henri II were certainly not unrelated to this recovery. Although subject to

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[4] Le Roy Ladurie (1977: 485)

[5] Le Roy Ladurie (1977:491-92)

[6] Le Roy Ladurie (1977:563-64); and more generally, Goubert (1970a:48-49); Meuvret (1971:277)

[7] Le Roy Ladurie (1977:576-85)

powerful medium-term fluctuations, supplies kept pace with population growth, ensuring a brief respite before the forthcoming *disettes*.

On the technical frontier, no major innovations were introduced for the next three centuries. Agricultural output, over the subsequent period, was entirely dependent on the given capital heritage. Before the major breakthroughs of the mid-nineteenth century in the use of chemical fertilizers and mechanized equipment, output changes were entirely endogenous: better use of the cultivated space, better crop mixes, new land under cultivation, modified land rotation[8].

These adaptations were painfully forced upon the rural world by the strength of urban demand. Following the example of other European metropoles, Paris, Lyon, Rouen, Nantes and Toulouse did all experience massive growth[9] which lead to intense pressure on the surrounding countryside forced to specialize in supplying food to the cities:

" .. cette montée des peuplements citadins est l'une des plus difficiles à supporter pour le marché des subsistances, et celà dans la mesure ou elle suppose l'organisation, longtemps déficiente en fait, d'un bon réseau de transports intraregional, ou même interrégional Dans la mesure aussi ou elle déverse, en période de pénurie un pouvoir d'achat urbain qui gonfle les prix, crée du stockage spéculatif, affame telle ou telle zone rurale pauvre d'argent "

LeRoy-Ladurie (1977: 582)

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[8]Labrousse (1970c:418-449)

[9]Le Roy Ladurie (1977:582); deVries (1984:112-114).

Usher (1913) also warns against the danger inherent to the cities' monopsonist position:

"Such a concentration of demand is dangerous as it tends to carry away from the local market more than the actual excess of supply over consumption wants "

Usher (1913: 6)

Urban pressures inevitably affected long-term prices which were on the rise throughout the sixteenth. The disproportionate increases in wheat prices with respect to other products, with the possible exception of wood, reflected the ricardian impact of the introduction of marginal land under cultivation and cannot be solely explained by the massive entries of American bullion throughout the period[10]. Up to 1590, the rise is powerful with prices being multiplied tenfold from 1520 until Morineau (1977:931) observes: "... *le basculement vers l'horizontalité.*". The seventeenth century would experience a stable secular trend around which prices fluctuated madly during crises[11]. Le Roy Ladurie (1977:774-75) estimates that the scale economies following the appearance of large producing rural estates in conjunction with a diminished population pressure were the main elements behind the reaching of a plateau after 1600 [see Figure 2].

The political climate became agitated once again with the beginning of the civil wars in 1560. The religious clashes following the *Reforme* affected mostly the cities with the rural world only marginally influenced. The bad crops of 1585-1595 hurt the Parisian and the South regions where calvinist ideology had its strongholds[12]. The sixteenth ended abruptly with the siege of Paris

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[10]Le Roy Ladurie (1977:584-85); Morineau (1977:937-38); Goubert (1970b:330-346)

[11]Morineau (1977:931-36)

[12]Morineau (1977:911)

by Henri IV where unprecedented price fluctuations were recorded as is demonstrated in the section VII.

A series of plagues in 1626-27, 1631-32 and finally between 1650 and 1670 provided a powerful check on population growth which resumed afterwards during the seventeenth century. The Black Death was slowly eliminated under vigorous urban quarantine policies as well as the possible substitution of the rat specie who carried the virus by a less resistant sort[13]. Famines picked up its role as demographic valve. As in the preceding centuries, internal and external wars also took their toll and aggravated the effects of the food shortages, especially during the troubles of the Fronde in 1648-53 when wheat-producing northern France lost close to 20% of its population[14].

The reverse is also true. Goubert (1970b:360) demonstrates how crises'conditions by reducing tax revenues affected political decisions. Such was the case during the 1693-94 crisis, when the State was forced into retreat in the middle of the war of the Augsburg League. Reduced revenues as well as the inability to requisition food supplies for the troops was translated into a major rethinking of French foreign policy.

The famines of the late sixteenth to the early eighteenth were an essentially climatic phenomena. They corresponded to a brutal fall in temperature which has been associated to a 'miniature ice age'. The study of the growth rings of trees has revealed that northern and western France experienced a prolonged period of excessive rain at the sowing and harvest time as well as extremely

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[13] Goubert (1970a:45)

[14] Le Roy Ladurie (1977:738)

harsh winters throughout the period studied, and especially for the periods 1547-54, 1587-1601, 1614-20, 1635-45 and 1691-1702[15].

The dependence on climatic conditions was complete. The fragility of food production strikes the contemporary mind used to abundance and minimal fluctuations. So many things could go wrong, so many operations postponed when not simply cancelled; the analogy between the time path of prices and a barometric chart is inevitable:

"Il en fallait si peu pour compromettre le respect du calendrier agricole, si peu pour perturber le cycle de la végétation Un été et un automne trop secs ou trop humides retardaient les labours; un froid excessif survenant quand les brins sortaient de terre pouvait les griller, un printemps tardif les empêcher d'épier, juin et juillet pluvieux gâter les blés sur pied Les prix frémissaient à la moindre rencontre météorologique "

Morineau (1977: 942)

Agricultural output, as extrapolated from tithe records, after a promising start at the turn of the century, came to a halt with the advent of the Thirty Years War. A ceiling was reached around 1630. Following this date, certain regions more affected by the war such as the North, the East and the Paris basin experienced a tangible decline in production[16].

Wheat prices follow accordingly. The initial abundance of supplies depressed grain prices up to 1616 at which time, the recovery of urban expansion imparted an upward movement. The strong decline in Parisian demand following the Fronde after 1653 was conjugated with a decline in the gold production of the Potosi

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[15] Le Roy Ladurie (1977:733); Morineau (1977:954-955)

[16] Le Roy Ladurie (1977:765-72)

deposits to depress prices. Partly masked by the devaluation of the *Livres Tournois*, it was felt up to 1726[17].

The eighteenth century was characterized by a long period of rising prices starting in 1726 and continuing to the Revolution. After a timid start, prices pick up momentum after 1763 to reach a ceiling around 1780[18]. The massive entries of silver from Mozambique, followed by gold from Brazil coincided with a Ricardian impulse on prices as the land frontier was expanded under the encouragement of the State. Marginal lands such as marshes were brought under cultivation, involving an increase in operation costs conjugated with depressed output.

Cyclical fluctuations around the positive trend still remained impressive although much less so than their counterparts of the earlier centuries. *Disettes* remained at a latent stage, apparently unable to reach full force. While prices tripled in the preceding era, the fluctuations ranged between 50 and 100% in the eighteenth. Still, crises will have to wait until the next century to disappear completely. Until then, they hit the grain market more precisely in 1725, 1741 and 1771 with a somewhat attenuated but nonetheless impressive force, culminating with a dramatic conclusion in 1789[19].

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[17] Le Roy Ladurie (1977:774-75), Morineau (1977:959-68), Goubert (1970b:330-333)

[18] Labrousse (1970b:384-85)

[19] Labrousse (1970b:386-387)

III- The Anatomy of Crises

III.1 Types of Crises

Studying the parochial records, Pierre Goubert (1970a:39-43) was able to distinguish two types of crises. A first category took place along the agricultural cycle, often starting with wet temperature which disrupted the fall harvests, slowing down in winter when the cold temperatures prevented the rapid propagation of diseases and picking up in spring to finally culminate in summer. The increase in the number of recorded deaths usually coincided with a reduction in marriages and baptisms.

A second type of crisis was restricted to the summer season. Because of its limited duration, births and marriages were most often unchanged. Found everywhere, these shocks were especially frequent in those regions unaffected by *disettes* of the first type, such as Bretagne, Normandie or Provence. Although deaths often reached 20 times the normal figures during summer food shortages, the *crise de subsistance* was essentially a first type crisis. The second category really amounts to an amplification of the *soudure* effect in regions protected by their coastal location which guarantees an easy access to imported grain.

Meuvret (1971:97-104) agrees with Goubert (1970a:49-54) as well as Labrousse (1970b:412-414) that, in general, crises were more severe for the interior than for coastal France. The main element appears to have been the access to international supplies. Any price differential sufficient to cover transportation costs attracted into Marseille wheat from all over the Mediterranean region, from the Baltic as well as from America during the eighteenth[20]. Although fluctuations were somewhat more pronounced along the Atlantic than for Marseille, the damages done by crises

[20] Labrousse (1970b:413)

were still much reduced when compared with the continental interior. Coastal wheat prices were under the stabilizing influence of international market conditions. A region like Bretagne, being a seller on the Lisbon market, saw its prices react to Portuguese movements[21].

Another crucial element seems to have been the relatively elastic demand for grains. Coastal diets with an easy access to the products of the sea as well as a greater reliance on milk and, to a certain extent, meat products, appear to have been much more balanced by contemporary standards than the food habits of the interior:

"A côté de l'équilibre de l'offre, une certaine elasticité de la demande y contribue [à la stabilité des prix] l'alimentation sobre et variée de la région [côtière], les ressources de l'élevage extensif, et la moindre importance -toute relative- du froment dans la ration alimentaire "

Labrousse (1970b:413)

Furthermore, for the interior of France, the situation is worsened by the close correlation between the prices of the various types of grains[22]. Not unlike a tilted ice tray filled with water, high wheat prices forced a readjustment of demand towards the lower quality grains. Individuals who consumed white bread were progressively reduced to eat first *meteil*, then rye, followed by oats. In rural areas this substitution reached more dramatic proportions. Following the digging up of seeds planted in the preceding fall, individuals ate grains still green or tried to cook a bread made of roots, oats and fern when not simply eating bark or grass[23].

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[21]Morineau (1977:920)

[22]Meuvret (1971:123)

[23]Goubert (1970a:43); Usher (1913:208-09)

In addition, the higher proportion of transport costs in final price for the bulkier coarse grains implied greater deviations during crises when low-quality cereals had to be brought in from external sources[24]. The damages imposed by a wheat crisis were thus complete; in addition to the losses directly incurred on the high-quality grain market, high wheat prices, although wheat is consumed by only a fraction of the population, did generate sub-crises via substitution effects in markets for lower-quality grain which may or may not have experienced an absolute reduction in quantity supplied. For these reasons, price fluctuations for coarser grains where much more powerful than for wheat:

"Une série de surcharges et de delestages rendent ainsi plus passionnel encore le marché de la céreale pauvre."

Labrousse (1970b:411)

Conjugated with epidemic diseases, wars and social unrest, the high food prices took a heavy toll on the population. Generally, the first to disappear would be the *éléments fragiles* of the population. The old, the sick were rapidly eliminated with the result that the demographic drop was convex-shaped; rapid at first and slowing down thereafter[25]. Conversely, the massive depopulation through its dramatic reduction of effective demand attenuated the rise in prices[26]. Therefore, the powerful plague of 1630-32 might explain, as will be seen in section VII, the relatively low measure of price fluctuations recorded for this crisis.

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[24] Labrousse (1970b:411)

[25] Meuvret (1971:277), "*On est amené à admettre que la disette provoquait par anticipation des décès qui se seraient produits durant les années suivantes.*"

[26] Morineau (1977:974)

The effect of crises varied however depending on regional conditions. Hence, the overpopulation of the Paris basin region as well as its excessive dependence on wheat cultivation and its strategic location which implied the frequent passage of troops, was translated into a more powerful impact of food shortages than for the rest of France. Furthermore, the proximity of the State apparatus meant that this region faced proportionally heavier and more efficiently collected taxes. By comparison, Haute Bretagne's high birth rate was often associated with a high death rate for children. While this region partially avoided the effects of the shock because of its geographic location and a somewhat more accommodating climate, the different hygiene habits of its inhabitants resulted in a rapid propagation of epidemics[27].

The comparison with Holland or Britain is unfavorable to France and particularly to the French interior. Studying wheat prices in England and France, Meuvret (1971:113-124) notes that the English fluctuations were much less pronounced than their French counterparts, especially after 1660. Once again, the variety of the diet as well as the easy access to international supplies seems to have played the most important role in reducing the fluctuations' amplitude.

III.2 The State of Agricultural Production

The state of French agriculture provided minimal insurance against crises. The British visitor travelling through seventeenth century France would have been struck by the primitive character of food production. As was mentioned earlier, agricultural technology remained virtually unchanged from the Early Middle Ages through the early nineteenth. Whereas Holland with its high-output polder cultivations and England with its large-scale farming resulting

[27] Among others, the deeply entrenched belief that alcohol could cure just about anything. See Goubert (1970a:51)

from the enclosure movement were able to achieve considerable surpluses, French agriculture produced little above subsistence levels. A number of factors may be advanced to explain the importance of French backwardness.

To start with, French agriculture was essentially labor-intensive compared to its British and especially Dutch counterparts. This can be related to the abundance of available rural labor but perhaps more importantly to the massive drain of capital towards the city. Any surplus extracted from the land inevitably took the direction of the metropolis. Tithes, *fermages*, *métayages* and other forms of rent in conjunction with a regressive tax structure aimed at extracting the most from the countryside and the least from the city, left little in excess of bare subsistence to the disposition of the rural world.

This leads to the paradoxical result that, whereas the terms of trade were against towns during crises, which should have caused a massive redistribution of funds from the consuming city to the producing countryside, the impact of taxation was such that the contrary was actually observed. Through the use of a powerful parasitary extraction system, Meuvret (1971:142-145) shows that the urban agglomeration was often able to recover more than the purchasing power that was lost to the rural areas under the form of taxes and various obligations. In addition, this structure was the city's mean of forcing grain out of the granaries and on to the market. The increasing reliance on payments in specie to satisfy urban consumption of manufactured goods meant the necessity for the farmer of exchanging his agricultural output for cash which then took the direction of the city.

In conjunction with the crises' depletion of whatever small rural savings were left once all the charges had been met, the system of taxes, tithes and rent obligations meant that the available funds for expansion and improvement were minimal. The French landed aristocracy seemed unwilling to take up its leadership role as supplier of capital, apparently satisfied with the mediocre surpluses it was able to extract from the land, "... *ne sembl[ant] comprendre ni son rôle, ni son devoir.*".

Goubert (1970a: 158)

As a result, capital equipment was reduced to its simplest expression. The plowing was essentially done with plows and swing plows made for the most part of wood which allowed only a superficial loosening of the soil[28]. Insufficiently protected, with a low degree of permeability to rain, the grain sowed was at the mercy of climatic conditions and was particularly sensible to frost.

In addition to inferior plows, the peasant of the sixteenth and seventeenth centuries had only a limited access to animal traction. Constantly at the mercy of military requisitions, as well as being much more expensive to purchase and in operation costs than oxen, the more efficient horse was almost inexistent in most of the smaller land holdings[29]. Plowing was done with the slower ox, most often borrowed or rented from a rich neighbor which could mean frustrating delays before they became available.

This insufficience of husbandry was also translated in a shortage of manure. In direct competition with the more urbane gardening, as well as orchards and tobacco, which, being great consumer of manure were nonetheless non-producers, agricultural land was rapidly exausted due to the meager fertilizing. Holland had addressed the issue by its efficient use of urban refuse, which had only a limited diffusion in France[30]. The solution to the fertilizer problem will have to wait until much later in the

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[28]Meuvret (1977:103-120), Goubert (1970a:154)

[29]Meuvret (1977:107-110), Goubert (1970a:153-55)

[30]Goubert (1970a:156)

nineteenth century with the development of the beet industry producing phosphoric acid as a by-product[31].

The low yields which resulted implied a rapid exhaustion of the land. The low output / input ratio was translated in the necessity to sow intensively to obtain a desired level of production. The absence of protection from natural plants, leading to the suffocation of the grain appears to have been the main explanation. Meuvret (1977:158) estimates that whereas 2 to 2.5 hectolitres per hectare would have been sufficient, close to 4 were actually sown. As a result, the land had to rest fallow more often leading to an important reduction of potential output. While the fallows had been virtually eliminated in Holland by the late sixteenth[32], French cultivation would be governed by the *assolement triennal* until very late in the nineteenth, whereby one third of agricultural land had to rest uncultivated every year. Not surprisingly, the slow retreat of the *jachère* was followed by a corresponding powerful increase in output[33].

The harvest operation also featured inefficiency and uncaptured opportunities. Rather than use the more efficient scythe which was close to three times faster[34], the reaping was still done using the sickle. In addition to the low quality of the blade, Meuvret (1977:165-173) proposes two reasons justifying this choice. First, a disadvantage of the scythe is that by hitting the straw, the shell of the grain was much more important than with the use of the sickle. Considering that the fallen grains would be lost to the *droits du glanage*, i.e. to the non-producing poor of the village,

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[31]Meuvret (1977:138)

[32]Goubert (1970a:150-152)

[33]Labrousse (1970c:439-440)

[34]Meuvret (1977:174)

the farmer preferred to minimize wheat losses although this implied an increment in labor costs:

"A haute époque, entre le gaspillage de céréales et le gaspillage de main-d'oeuvre, l'agriculture traditionelle n'hésitait pas Tout se passait comme si le temps de travail avait été pour elle d'une considération moindre "

Meuvret (1977: 167)

A second powerful constraint preventing the diffusion of the scythe would be the landed aristocracy's hunting interests. The physical strain imposed by the use of the sickle implied that the straw would not be cut below a certain level. This would guarantee a favorable environment for game. Not surprisingly the prohibition to use the scythe was found in many earlier documents[35].

However, Labrousse (1970c:484-86) implicitely identifies the most important obstacle to an expansion of agricultural output as being the small size of the holdings. Centered on an ideal of self-sufficiency, French agrarian structure had developed following the decline of manorial institutions into a mosaic of small plots cultivated before and above all for the subsistence of the producing household. As will be seen in the next section, the mediocre level of surpluses above family consumption would be the first sacrificed following a crisis. Much later in the eighteenth, the Physiocrats were to look enviously to the British enclosure movement as part of the solution to the problem of food supply. Above all, the rural world had to change its perceptions on markets and on self-subsistence. As is seen next, their skepticism about the ability of market forces to eliminate the *crises de subsistances* was largely justified.

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[35]Meuvret (1977:167)

III.3 Marketing the Grain

The grain merchant of Paris who, stimulated by high prices, would want to secure grain and move it to the metropolis would soon find himself constrained by powerful barriers. First, we already indicated that the time and costs involved in simply localizing the available reserves would be important. Farmers were *a priori* producing for the subsistence of their own family and only secondly for the market. Feeling the panic building up around them, they would be much more reluctant to let go of any portion of the grain when the duration and severity of the approaching famine was unknown.

Another motive for the producer's reluctance to sell might have been the desire to increase the proportion of his stocks reserved as seeds if he expected high prices to be persistent. As will be seen in section VII, this outcome seems however unlikely. Persistent expectations implied that prices, following a crisis would remain above pre-crisis levels, therefore indicating that long-term response to high prices might have been limited at best. The absence of an effective rural capital market probably accounted for much in constraining the opportunity to respond to the price differentials by increasing the area under cultivation.

Still, a final problem facing the merchant would be that the grain trade being considered at the time as part-time work, it would not be surprising to see the farmer already engaged in the process of selling his grain directly on the market without any intermediaries.

If the merchant had been able to purchase any grain at all, it would usually be in small quantities, often insufficient to be truly profitable. Meuvret (1988:152) and (1971:217) estimates that only 1/5 to 1/4 of total output would be marketed, a proportion which, as we will see in the next section, was probably reduced even further during a famine. Therefore, the merchant would have to make his purchases at more than one farm, an obligation greatly increasing transaction costs, including negociating and collecting the stocks, not to mention the expenses of enforcing the contracts in the face of volatile prices.

Still, assuming that the prices still warranted his efforts after all these operations had been performed, there remained the pressing problem of physical movement of the grain to the city which would have to be done by roads or by boat. The preference for grain movement of any importance would have been the ship.

The road network of the period was essentially dictated by geographical constraints. While it would preferably follow the river in plains or valleys, the road tried to follow peaks in mountainous areas. This would imply endless ascent and descent which greatly increased delays[36] as well as risks, considering the absence of an effective braking system on carts loaded to capacity with grain[37].

Not that the maximum load would be significant. Until the breakthroughs in axle technology of the later centuries as well as in the use of macadams starting in 1830, net loads could never exceed 1500 to 4000 kg in the best conditions[38]. The state of roads, namely their insufficient width as well as poor paving and drainage conditions sensibly reduced the maximum weight carried. The preferred combination was usually a one-axle vehicle pulled by a single horse[39], or a mule capable of carrying at most 150 kg which

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[36] Léon and Carrière (1970:166)

[37] Slowing down a running cart was usually done by throwing sticks inside the wheel or by driving with two wheels on the side of the road, see Meuvret (1988:67)

[38] Léon and Carrière (1970:174)

[39] Meuvret (1988:66-67)

was the choice of the smaller merchants like the *blatiers*[40]. Maintenance was under local jurisdiction resulting in large variations in the quality of the road surface. Insufficient budgetary power also resulted in the insufficience of bridges, imposing frustrating detours and portages.

In the absence of a political and fiscal will to ensure proper maintenance and continuity throughout the network and not only on isolated segments, the dependence on climatic conditions increased the delays and uncertainties associated with road transportation. Snow and mud greatly slowed down movements. In fact, from lack of an efficient drainage system, as early as fall, any prolonged rain precipitations would render the roads impracticable. For these reasons, transportation by roads retained its essentially local character throughout the period up to the nineteenth century. On long distance, it could not outcompete the boat. Inside a reduced diameter, usually one or two days walking distance, the cart would be preferred[41]. Accordingly,the legislation of the *Mercuriales* usually identified two sources of supply: local and long-distance as defined as outside a one- or two-days of walking perimeter from the market[42].

Meuvret (1988:81-90) goes into great details in describing the frustrating long delays involved in loading the stocks on and off the ship, the inadequacy of on- and off-ship storage facilities preventing the losses due to humidity, as well as the impact of the absence of an integrated canal system. These costs and risks of untimely arrival to Paris would be compounded during the winter months when the ice would block most waterways.

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[40]Léon and Carrière (1970:175)

[41]Meuvret (1988: 61)

[42]Meuvret (1971:203)

The type of boat used in grain transportation was dictated by the type of river on which they travelled. *Chalands, Sapines, Saint-Rambertes* and *Roannaises* had all adapted to the specific environment on which they operated[43]. Tonnage varied between 25 and 150 t which, although humble by modern standards, meant the mobilization of numerous small sources of supply with corresponding risks and delays.

As with road transportation, river movements were severely constrained by geographic and climatic considerations. Wind, water level, ice and current were all determinants of time and costs of transportation which displayed impressive fluctuations and irregularities. Hence. the journey between Roanne and Briare on the Loire, representing close to 250 km would take between 6 and 20 days depending on the conditions[44]. Probably the single most powerful factor would have been the direction of the current. Exchange through the river was often unilateral, in favor of the downstream destination without a corresponding returning journey. As a result, boats would often be simply dismantled on arrival and the recoverable wood sold[45]. Regions located upstream faced prohibitive transportation costs on returning supplies:

"Ce qui est sûr, du moins, c'est que le fleuve ingrat leur [les régions en amont] restituait chèrement en temps de disette, l'équivalent de ce qu'elles lui avaient confié "

Meuvret (1988: 77)

In addition, regions situated outside the main waterways as well as roads network would be isolated from the major trade channels. Although this implied partial insulation from the intensity of urban demand during crises, it also could mean silent

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[43]Léon and Carrière (1970:175)

[44]Léon and Carrière (1970:176)

[45]Meuvret (1988:77)

extremes of misery. When the long term process of integration finally took off in the late eighteenth and early nineteenth, these areas of highly localized markets such as the sandy plains of Saint-Onge and Angoumois still experienced extremely powerful *disettes*[46]. The impact of the food shortage was particularly intense for those small villages of 15 to 45 families. Their integration inside a national market had to wait until much later and, in some instances, might never have taken place.

To the natural obstacles to river transportation we must add the weight of man-made barriers. Tolls, mills, arbitrary local legislation such as local monopolies were all slowing down the movement of grain to the consuming centers[47]. Probably more important than their direct impact on final price was the increment in the risks of losses due to humidity, the obstacles implied. Although important precautions were taken to ensure that the grain would be isolated from the oozing hull, losses to moisture were inevitable, especially if the wheat had not been bagged[48]. Any prolonged delay compounded the risks of mildew as well as the risks of adverse price fluctuations.

Furthermore, it would only be too tempting for local administrations to immobilize the grain to their own benefit in periods of high prices. As Usher (1913:5) notes, every town and village was acting in a self-centered manner to secure access to a limited food supply at the expense of others. When the expected duration of the crisis was unknown, the rational response would have been to store and hoard as much as possible. In that sense, raids by hungry mobs might have had the tacit agreement of authorities. The grain merchant was often seen as a convenient

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[46]Usher (1913:204)

[47]Léon and Carrière (1970:178); Meuvret (1988:79-80)

[48]Meuvret (1988:81-82)

scapegoat, and to channel popular furor against him, an easy mean to release pressure on local stocks. To put it differently, let us simply say that the complaining merchants might have had difficulty in finding a sympathetic ear from the local governments. The association of hunger with the image of floating granaries filled to capacity and moving slowly in direction of a distant city often implied violent outbreaks which the rural authorities had no intention or power to stop.

Still, assuming that our tenacious merchant had succeeded in going through all the natural and human obstacles mentioned, and that his grain shipment had finally reached one of the few parking spots of the Port de l'École or the Port de Grève in Paris, and assuming that prices were still profitable, his ordeal would not be over yet. The apparently simple operation of selling the grain was in fact complicated by the long list of inhospitable regulations. We already mentioned that one of the objectives of the consuming city would be to try to secure wheat at any cost, even if it implied a long run reduction in supply in retaliation. In the case of Paris, this attitude would be reinforced by its relative monopsonist position especially evident with respect to local suppliers of the Paris basin. This would be translated into severe market legislation essentially aimed at protecting the purchasing interest of the town. To put it simply, regulations tried to force merchant into selling rapidly and at the lowest price.

To begin with, if, as we said earlier the grain had caught humidity during the journey and had to be taken out of the ship, the merchant immediately found himself in the absence of temporary storage facilities. It was explicitly understood that the boats would also serve as showroom and any request to unload, for motives other than final sale, was met with a multiplication of administrative red tape[49]. The absence of overnight storage

[49] Meuvret (1971:205-206)

buildings and equipment was also observed at the Halles market where the grain brought by carts was taken. Unsold stocks had to remain on the open until the subsequent market day occurred which would mean three or four days unprotected from weather, vermine, insects and of course theft[50]. Not surprisingly, the approaching closing hour coincided often with a mad scramble to sell whatever remaining stocks at any price.

The nervous athmosphere thus created contributed greatly to the propagation of panic and to the formation of speculative stocks. These were partly held in check by the explicit resale prohibition. Tolerance was however observed as a flourishing dual market took place outside the regulatory structure[51]. In addition, the impossibility of distinguishing grain bought on the market from grain paid in kind as rents or obligations allowed many landowners to benefit from the high prices by selling directly from their home. Parallel markets and sales *à domicile* provided the necessary safety valves, which were especially important during crises. Yet, certain factors were playing in favor of the parallelism of prices in all markets, whether officially recognized or not.

The proximity of the three main Parisian markets implied an extremely mobile demand which virtually eliminated any possibility of excessive pricing. Markets were competitive as reflected in the evident unity of prices[52] between the Halles, Grève and Ecole markets. As Meuvret (1971:204) argues, this was also ensured by the multitude of small local sellers. These were forced out of the surrounding countryside by the prohibition of purchases, made outside the designated markets, inside a perimeter of 8 to 10 *lieues* around Paris, corresponding to 36 to 45 km.

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[50] Meuvret (1971:205)

[51] Meuvret (1971:209-221)

[52] Meuvret (1971:207)

As can be seen, the position of the consuming city is essentially a mercantilist one where its monopsonist privileges allow a 'beggar thy neighbor' attitude with respect to independent suppliers. Paris set its regulations in order to force the grain inside its walls where it could be sold with explicit reference to urban interests. The increment in costs this implied, was immediately translated in an inward shift of supply. In the face of irreducible demand for grain, despite all the city's efforts to ensure a stable flow, market sale of grain probably did not cover one half and maybe not one third of total consumption[53]. Individuals were relying on other means to ensure their subsistence. Market sources were perceived as irregular and volatile, probably with some justification. Until the Physiocrats in the late eighteenth, these perceptions would greatly hinder the integration of agricultural markets. Market regulations, such as those of Paris, reflected the absence of confidence in laissez-faire. It is shown next that these policies were at least in part dictated by the nature of grain supply. More specifically, the volatility of wheat as well as other grain sources in the face of fluctuating crops, is discussed in the following section.

IV- The Impact

In the next section, a simple model of adjustment to price differentials is introduced to help understand the various interactions between elasticities, or perhaps more precisely the inelasticities of supply and demand and the rate of adjustment. Hopefully, this technique will highlight some of the dynamics behind such situations as the one just described.

[53]Meuvret (1971:208)

However, before discussing the adjustment of prices back to normal levels, we must first study their behavior at the time of the impact. This segment focuses on the relationship between a reduced crop and the price increase it generates. The argument developed by Labrousse (1970d:531-534) and by Meuvret (1971:217); (1977:208-209) and (1988:152) is that a crop failure is followed by a more than proportionate decrease in quantity supplied. In addition, the low price-elasticity of demand will generate powerful price increases if supply shifts inwards.

This point is demonstrated with the help of a simple allocation model and using the chain rule of elasticity. It is shown that when the primary purpose of production is the self-subsistence and reproduction of the producing unit, a shortfall in yields will generate a disproportionate decrease in marketed output. Furthermore, the low elasticity of demand will have a double effect on prices during a crisis: a more important initial increase in prices and, as demonstrated in the subsequent section, it will delay and even compromise the return to usual figures.

The impact on prices following a (partial) crop failure can be decomposed into at least two arguments: the influence of the price-elasticity of demand and the elasticity of marketed output with respect to gross output. More precisely, in equilibrium, the elasticity of prices with respect to gross output is positively related to the gross-yield elasticity of supply and inversely influenced by the price-elasticity of quantity demanded. This is easily observed from the following set of equations where:

$$\eta_{P,Q}$$

is the elasticity of prices with respect to gross output,

$$\eta_{Q^d,P}$$

is the price-elasticity of demand, and

$$\eta_{Q^s,Q}$$

is the gross-output-elasticity of marketed output.

The crop-elasticity of prices is given by the familiar expression of the ratio of the relative change in prices to the relative change in gross output:

$$\eta_{P,Q} = \frac{\frac{dP}{P}}{\frac{dQ}{Q}}$$

If we agree that, in a closed economy with little or no storage, a given percentage decrease in quantity supplied is equal in the short-run and in equilibrium to an identical reduction in consumption (more on this later) then, by the chain rule of elasticity, this measure can also be represented as:

$$\eta_{P,Q} = \frac{\frac{dP}{P}}{\frac{dQ^d}{Q^d}} \times \frac{\frac{dQ^s}{Q^s}}{\frac{dQ}{Q}}$$

which is nothing but:

$$\eta_{P,Q} = \frac{1}{\eta_{Q^d,P}} \times \eta_{Q^s,Q} = \frac{\eta_{Q^s,Q}}{\eta_{Q^d,P}}$$

In other words, if demand for grain, which, being the basic food consumption good, displays a fair degree of price inertia, and if production is orchestrated around largely incompressible self-subsistence, resulting in a disproportionate fall in quantity supplied to the market following a reduced crop, then the corresponding increase in prices will also be out of proportion with the extent of the shortage.

The question of the inelasticity of demand to prices is addressed in the next section where its impact is most powerful. For the time being, let us argue that most chronicles of the time mention the unresponsiveness of demand to prices which is especially evident in urban agglomerations. Rural diets had access to a limited but nonetheless positive set of substitutes, while urban food consumption was essentially based on grain. The extent of the price fluctuations during a crisis is certainly eloquent on the inertia of demand adjustment to high prices.

The impact of a reduced crop on marketed output is perhaps best understood with the use of a simple subsistence model which depicts the various channels of allocation facing gross output. Assume for simplicity that, for a given amount of land under cultivation, the stochastic yields are centered around a mean value and vary under the influence of a random error term as shown in equation (1):

$$(1) \qquad Q_t = E(Q_t) + \varepsilon_t$$

with, $E(\varepsilon_t)=0$.

Then, assume that a fixed proportion s of the average value of the crop must be set aside as seeds in order to maintain a constant intertemporal level of consumption of the producing unit, i.e. the household:

$$(2) \qquad S_t = sE(Q_t)$$

Furthermore, let c represent the incompressible proportion of normal gross output stored for domestic consumption between harvests as in equation (3):

$$(3) \qquad C_t = cE(Q_t)$$

Finally, let T_t constitute the various taxes, tithes and obligations which must be met and which can be separated between a variable segment t_1 which is computed from the actual crop and a fixed component t_2 calculated from the mean yield:

$$(4) \qquad T_t = t_1 Q_t + t_2 E(Q_t)$$

with $0 < s, c, t_1, t_2 < 1$.

Under normal conditions the various allocation channels may be decomposed to determine the marketed residual. With the absence of the error term, the gross output reduces to its average value:

$$(5) \qquad Q_t = E(Q_t)$$

The net output, once seeds provisions have been set aside becomes:

$$\begin{aligned} Q_t^n &= Q_t - sE(Q_t) \\ &= E(Q_t) - sE(Q_t) \\ (6) \qquad Q_t^n &= (1-s)\ E(Q_t) \end{aligned}$$

The marketable ouput, Q_t^s, is then the residual once a consumption (3) and tax (4) reserve has been constituted and is given by equation (7):

$$\begin{aligned} Q_t^s &= Q_t^n - C_t - T_t \\ &= (1-s)E(Q_t) - cE(Q_t) - t_1 Q_t - t_2 E(Q_t) \\ (7) \qquad Q_t^s &= (1-s-c-t_1-t_2)E(Q_t) \end{aligned}$$

During a crisis, gross output deviates from its normal level by the factor ε_t such that:

$$(8) \qquad Q_t = E(Q_t) - \varepsilon_t$$

The net output is reduced by the full amount:

$$\begin{aligned} Q_t^n &= Q_t - sE(Q_t) \\ &= E(Q_t) - \varepsilon_t - sE(Q_t) \\ (9) \qquad Q_t^n &= (1-s)E(Q_t) - \varepsilon_t \end{aligned}$$

Marketed output is reduced in absolute terms by less than ε_t due to the presence of the automatic-stabilizer tax component t_1. In other words, variable taxes fall proportionally to the crop reduction, thereby attenuating somewhat the reduction in supplied output:

$$\begin{aligned} Q_t^s &= Q_t^n - C_t - T_t \\ &= (1-s)E(Q_t) - \varepsilon_t - cE(Q_t) - t_1Q_t - t_2E(Q_t) \\ &= (1-s-c-t_2)E(Q_t) - \varepsilon_t - t_1[E(Q_t) - \varepsilon_t] \end{aligned}$$

$$\text{(10)} \qquad Q_t^s = (1-s-c-t_1-t_2)E(Q_t) - (1-t_1)\varepsilon_t$$

In discrete terms, the measure of the elasticity of marketed output with respect to gross output is simply the relative change in Q_t^s divided by the relative change in Q_t, as shown in the following:

$$\eta_{Q_t^s, Q_t} = \frac{\dfrac{(1-s-c-t_1-t_2)E(Q_t) - [(1-s-c-t_1-t_2)E(Q_t) - (1-t_1)\varepsilon_t]}{(1-s-c-t_1-t_2)E(Q_t)}}{\dfrac{E(Q_t) - [E(Q_t) - \varepsilon_t]}{E(Q_t)}}$$

which reduces to:

$$\text{(11)} \qquad \eta_{Q_t^s, Q_t} = \frac{1-t_1}{1-s-c-t_1-t_2} > 1$$

since $0 < s, c, t_1, t_2 < 1$.

What equation (11) implies is that a given percentage reduction in yields will generate a disproportionate decrease in quantity supplied to the market. The rationale behind this argument is that with production being undertaken primarily for irreducible household consumption and reproduction and, with a fixed component in the payment of taxes and obligations, the amount being marketed will be the first sacrificed whenever a shortfall is experienced.

Hence, for example, following a 10% reduction in gross output, quantity supplied would fall by as much as 40% or 50%[54] which made Meuvret (1971:217) remark that any change in gross output "...*se répercutait singulièrement amplifié dans les quantites offertes.*" Conversely, a generous yield will lead to a flooding of the market, particularly in the face of rudimentary storage facilities. As a result of a greater than unity value of the crop-elasticity of supply and a price-elasticity of demand which is most probably lower than unity, prices will tend to fluctuate more than proportionally with the fluctuations in gross output.

It should be noted that equation (11) somewhat overstates the extent of the drop in marketed output following a reduced crop. For one thing, many obligations, including crop-inelastic ones were redeemable in specie thereby forcing the farmer to the market. Furthermore, tax or rent payments made in kind could be and often were sold on the market. Two factors were playing in this direction namely the privileged location of the landlord who, by residing in the city had access to profitable market information as well as the limited storage possibilities. Great concentration of grain while being difficult to realize would also involve great risks of popular furor in times of scarcity. Not surprisingly, market regulations explicitly allowed sales at home even outside official market hours[55].

Still, a great proportion of wheat paid in taxes, rent or tithes would never reach the market. Taxes levied in kind often served to supply the armies in times of war while tithes usually were distributed for charity purposes as well as being consumed by clerical members and their personnel[56]. Notice finally that the

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[54] Meuvret (1988:152)

[55] Meuvret (1971:214)

[56] Meuvret (1988:28-36), Labrousse (1970d:532)

existence of an active market for seeds indicates that some elasticity was probably present in their provision. Farmers could always purchase or borrow seeds to be planted if their stocks were insufficient. This however might imply that crops had been so low that setting aside seeds was impossible. At this point, individuals would no longer be concerned about next year, but only intent on surviving the current year.

Perhaps more than standard cobweb rationales, studying the allocation channels explains the importance of the cyclical fluctuations encountered throughout the period studied. Although cobweb phenomenoms were most probably also at stake, deviations were a direct result of the character of production.

A circular relation is immediately apparent. In the face of the inability of the market to provide stable access to food, local and especially individual autarchy were promoted among the masses as the social ideal. In turn, this reliance on one's own means of subsistence resulted in increased fluctuations in output and prices as the peasant's status on the wheat market oscillated between buyer and seller:

"Lorsque la météorologie avait été moins favorable, il [le paysan] n'avait plus rien à vendre, lorsqu'elle avait été franchement mauvaise et que les prix s'élevaient, il devenait acheteur "

Meuvret (1971: 20)

Perhaps even more crucially, the later integration of markets depended on a profound change in the attitude towards them. Individuals had to be convinced that the market would be able to guarantee that their consumption needs would be addressed. Although the cities were taking aggressive steps to ensure that their price signals were heard, the conversion in the rural areas was much more painful. The image of intense urban demand destroying the complex set of rural surplus distribution channels was certainly not helping in promoting the attractiveness of free markets. Not surprisingly, the resistance was passionate, and for a long time extremely effective. Crises were seen as an act of God, unpredictable, most importantly unavoidable and even perhaps necessary as Usher (1913) remarkably understands:

"The man sat down calmly to meet his fate If it pleased God to smite him with famine, so be it The idea that these troubles can or should be avoided is a strictly modern idea."

Usher (1913: 220)

The sixteenth and seventeenth centuries' literature is filled with citations which describe the positive influence of *disettes* on obedience and ardor at work. In the face of rigidly set nominal wages, the multiplier impact of such an important reduction in purchasing power was extensive. The emerging manufacturing, mining and construction industries were all affected, although at diverse degrees, by the increase in prices. As was said earlier, a wheat crisis is a general crisis. To the increase in 'industrial' unemployment must be added the massive influx of agricultural workers liberated by the absence of crops to be harvested, collected, cleaned, transported and stored. Not surprisingly, employers found themselves in a buyer's market.

Still, over the long run, a number of factors were slowly beginning to dissolve the adverse relation between the agrarian organization and the stability of markets. More precisely, exogenous changes in the composition of diets as well as a climatic respite in the eighteenth accompanied by a long period of high prices changed profoundly the character of production. France was slowly evolving towards large-scale farming, and this implied inevitable changes in market organization.

We might expect that the amplitude of quantity and price variations would have a tendency to diminish in the subsequent centuries as the expansion in output as well as the change in the variety of the diet led to a lower percentage of gross output reserved for auto-consumption (c). Furthermore, agricultural improvements, particularly in the use of fertilizers and weed-killers as well as the development of sturdier specie of wheat will have a depressing effect on the seed/yield ratio (s), also contributing to a reduction of the elasticity of marketable output with respect to gross output. Finally, much later, the adoption of a proportional, and to a certain extent progressive, tax structure instead of fixed obligations will help in reducing amplitude.

Despite these changes, the return of prices back to normal levels remained painfully slow. The next section reviews some of the rationales, in addition to those outlined in section III, preventing a rapid adjustment to the price differentials.

V- A Model of Price Adjustment.

As was discussed earlier, integrated markets imply that changes in relative prices between two or more geographically distinct areas that are above normal transactions (including transportation) costs will lead to arbitraging movements of goods until the price differentials are eroded. The intensity of this adjustment, in other words the speed with which relative prices are brought back to their initial levels will depend on factors which will determine the shape of the adjustment path. Hence, the introduction of lags in the model will lead to an oscillatory pattern of price movements which can be either divergent, convergent or stable.

The model used here is a variation of the inventory and cobweb models that were developed in Alpha Chiang's (1984:561-85) treatment of first- and second- order difference equations. Certain amendments have been introduced to account for the specific characteristics of the Parisian grain markets of the sixteenth and seventeenth centuries.

As is well known, difference as well as differential equations are solved using the sum of a particular integral which represents the intertemporal equilibrium level and a complementary function which is viewed as the deviation from this equilibrium. It should be noted that the intertemporal equilibrium can either be static or expressed as a function of time for such factors as exogenous shifts in demand due to population growth.

The purpose of using difference equations is to obtain an equation of the form: $P_t = [P_0 - P^*_0] (b)^t + P^*_t$,where P_t is the time path of actual prices and P_0 may be seen as the impact price, i.e. the price observed when the full extent of the crisis-inducing factor has been assessed. One example of the crisis price might be the price quoted on the *Fête de la St-Martin* in early November when, traditionally, the autumn crop had been stored and the full extent of the year's yield known. Another might be the prices recorded in early May when the wheat first blossomed and offered information on the forthcoming crop. Corresponding to this period, P^*_0 is the normal price usually recorded on this date and reflecting normal conditions. P^*_t is the intertemporal equilibrium price associated with usual supply and demand conditions. Notice that more elaborate versions of this equilibrium will take into account such factors as seasonality, resulting in a non-linear concave-shaped equilibrium time path. Furthermore, we generally expect that a new higher P^*_t will emerge during crises corresponding to the inward shift of the supply curve following a reduced crop. However, for simplicity, we assume a constant equilibrium throughout the shock.

What the difference equation implies is that at the critical time period t=0, if the price observed P_0 is equal to its normal value P^*_0, then, the expression under the brackets collapses and price is simply equal to its intertemporal equilibrium value P^*_t. However, if we observe an inequality at t=0, a path for P_t is generated, the pattern of which is dependent on b. The factor b is the variable of interest and can be seen as the adjustment factor which will be expressed as a function of the various parameters entering in the demand and supply schedules, such as the relative shares of instantaneous and time-lagged supplies[57].

By simulating changes in the parameters that are reflected in b, it is possible to observe the resulting pattern of price movements. These may yield useful information on the spectrum of adjustment processes. Hence, for instance, the modern wheat markets with high-tech storage facilities, futures contracts and telecommunications equipment should display an almost instantaneous adjustment path to moderate shocks reflected in a very low positive value for b which will imply that price differentials above usual transaction costs will not be persistent. However, for an economy with tremendous barriers to the flow of information and resources as well as limited storage capacity the range of possible values for b becomes much more extended. Thus, if b is close to 1, the price impact is perpetuated over long periods of time. For values of b that are greater than 1, the pattern of prices is then divergent from equilibrium and this situation will be prolonged until definite news about the forthcoming harvest becomes available without any supply response in the meanwhile.

To help understand the adjustment parameter, we introduce the following demand and supply specifications. Quantity demanded at time t, Q^d_t, is as follows:

$$(12) \qquad Q^d_t = \alpha - \beta P_t$$

[57]The time path of prices as a function of b is as follows:
$|b| < 1$, convergent to equilibrium;
$|b| > 1$, explosive;
$b < 0$, oscillatory;
$b > 0$, non-oscillatory.
Notice that rational expectations are not reconciled with equilibrium path. Instead, Muth (1961) uses serially correlated disturbances. As a result of independently and identically distributed disturbances, most rational expectations models focus directly on equilibrium without studying the adjustment path, see Cyert and DeGroot (1974:523).

It should be noted that (12) refers to flow demand only. In other words, the quantity demanded is for immediate consumption purposes and stock (speculative) demand is not considered at this stage. The supply of wheat, Q_t^s, is assumed to come from two sources, local, Q_t^{sl}, and foreign, Q_t^{sf}, where:

$$(13a) \qquad Q_t^{sl} = -\gamma_l + \delta_l P_t$$

$$(13b) \qquad Q_t^{sf} = -D\gamma_f + \delta_f P_{t-1}$$

$$(13c) \qquad Q_t^{s} = Q_t^{sl} + Q_t^{sf}$$

$$(13) \qquad Q_t^{s} = -\gamma_l - D\gamma_f + \delta_l P_t + \delta_f P_{t-1}$$

with, $\gamma_f > \gamma_l$.

Notice that the boundary separating local from foreign may be understood in the sixteenth century sense i.e. local is defined as inside a one or two days walking distance perimeter around the city. The specification that foreign fixed costs are greater than local expenses is reflecting the poor state of transportation. However, it should be expected that this comparative disadvantage of foreign supply sources will probably be eroded much later in the nineteenth century when improvements in communication and transportation will be observed. For the same reasons, it is probable that $\delta_l > \delta_f$ where foreign suppliers faced with long delays in the marketing process would be less responsive to short-term fluctuations due to the risk of untimely deliveries to the market. The addition of the dummy variable D is an attempt to account for the increment in barriers to trade during the winter months when ice and mud would render most road and river channels impracticable. Therefore:

$$D = \begin{cases} 1, & \text{during summer months} \\ \pi, & \text{during winter months, with } \pi > 1. \end{cases}$$

Finally, lagged prices have been substituted to current prices facing foreign supply to reflect delays in information flows, supply collection and transportation/distribution of the grain. Although, for simplicity, a value of 1 has been used to represent the lag involved in organizing a supply response when grain is not held in readily available supplies, it is possible to imagine more sophisticated lag functions such as P_{t-lag}, where:

$$lag = (t - t_0) + \tau_1(d) + \tau_0$$

In this equation, the period elapsed before the time-lagged segment of total supply appears on the market, is a function of the number of days $(t-t_0)$ before the forthcoming harvest is available for commercial purpose, a positive function of the distance, $\tau_1(d)$, and finally, a fixed component, τ_0, representing the time needed to localize the supplies and organize their transfer.

The last equation needed to close the system is a discrete-time price transmission mechanism where fluctuations in inventories will cause price movements:

$$(14) \qquad P_{t+1} = P_t - \sigma[Q_t^s - Q_t^d]$$

with, α, β, σ, δ_1, δ_f, γ_1, γ_f, >0.

We assumed earlier that only flow demand was to be analyzed in the model. The reason for this is that this assumption allows for some simplification in the study of the adjustment parameters. More specifically, it becomes possible to simulate results for the characteristic roots using three arguments which greatly simplifies the presentation. Although unrealistic, the assumption of no speculative demand is not completely implausible.

Given the poor state of storage facilities which, for the most part were built in adobe[58] allowing an important proportion of the stocks to be lost to humidity, vermin and weevil[59], the severe anti-hoarding laws as well as the hungry mobs raiding anyone believed to hoard grain, the desire to hold stocks for speculative purposes would have been constrained by the mobilization of important sources of capital. The maximum amount of grain stored could not exceed two thirds of total storage surface[60].The necessity to leave free a given maneuvering space as well as the obligation to avoid contact of the grain with walls to minimize losses to humidity meant important storage costs constraining the formation of truly profitable stocks.

When we consider the minimal reserves of credit which were for the most part already engaged in other activities such as commerce or forestry[61], it becomes clear that grain hoarding was not open to everyone. This is not to say that speculative formation of grain stocks did not exist as evidenced in the frequent immobilization of grain boats close to the metropolis whenever it was believed that prices had not reached a maximum. But the financial strength this operation supposed was usually found elsewhere such as in the long distance trade and not in the domestic food industry. However, there remains the possibility of marginal hoarding undertaken at a small scale with which we shall deal later. For the moment, let us assume that stock demand is sufficiently small to have but a minimal impact on market conditions.

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[58]Le Roy Ladurie (1977:583)

[59]Meuvret (1977:31)

[60]Meuvret (1988:17-19)

[61]Léon and Carrière (1970:207-215)

It should be noted that studying the Parisian wheat market implies that wheat being a necessity, demand is likely to display price-inelasticity, implying a low value for β. Furthermore, since the demand for bread is fairly predictable[62], we may assume that movements in prices during a crisis will reflect supply shifts tracing out demand. In other words, the assumption of no stock demand implies that demand is not shifting out when the first signs of the forthcoming *disette* are heard. For this reason, we can say that:

$$(15) \qquad -\sigma = \frac{P_{t+1} - P_t}{Q_t^s - Q_t^d}$$

where Q_t^s is the quantity available for consumption after the shock has been felt, i.e. $Q_t^s = Q_{t+1}^d$. In other words, since consumption is ultimately constrained by crisis supplies, the inward supply shift is tracing out demand such that we may say that:

$$(16) \qquad \sigma = \frac{-[P_{t+1} - P_t]}{[Q_{t+1}^d - Q_t^d]} = \frac{-\Delta P_t}{\Delta Q_t^d} = \frac{-1}{-\beta} = \frac{1}{\beta}$$

Equation (16) simply reproduces the traditional inverse relation between price-responsiveness of demand and price changes.

Substitution of equations (12) and (13) in (14) will yield the following second-order difference equation:

$$(17) \qquad P_{t+2} - [1 - \sigma(\delta_1 + \beta)]P_{t+1} + \sigma\delta_f P_t = \sigma(\gamma_1 + D\gamma_f + \alpha)$$

which is referred to as the fundamental dynamic equation.

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[62] The assumption of stability of demand i.e. stationary and non-stochastic is from Newberry and Stiglitz (1982) who used it in a model of competitive stockpiling rules applied to food production.

V.1- The Particular Integral

As was mentioned above, the solution to (17) will contain the particular integral which is the intertemporal equilibrium price and a complementary function which is the deviation from that equilibrium. Since (17) is of the form $Y_{t+2} + a_1 Y_{t+1} + a_2 Y_t = C$, the particular integral is:

$$Y = \frac{C}{1 + a_1 + a_2}$$

or, in the present context:

$$(18) \qquad P^* = \frac{\sigma(\gamma_1 + D\gamma_f + \alpha)}{1 - [1 - \sigma(\delta_1 + \beta)] + \sigma\delta_f} = \frac{\gamma_1 + D\gamma_f + \alpha}{\delta_1 + \beta + \delta_f}$$

It should be noted that this static equilibrium, whose existence is guaranteed by the assumption that all parameters involved are strictly positive, can be easily modified to account for dynamic influences such as changes in tastes following urbanization.

Another modification yielding interesting results is also available if we are allowed to backstep a little. We said earlier that we assumed that no stock demand was recorded in our model. Recall that the reasoning behind this restriction was motivated by the desire to simplify the analysis of the complementary function. However, these complications are not present at the stage of the particular integral which, it will be remembered, is nothing but the intertemporal equilibrium price P^*. Therefore, let us assume that flow demand, Q_t^{df}, retains its familiar expression in equation (12a) while the motives behind speculative demand Q_t^{ds} can be represented in equation (12b):

$$(12a) \qquad Q_t^{df} = \alpha_f - \beta_f P_t$$

$$(12b) \qquad Q_t^{ds} = \alpha_s + \beta_s (P_t - P_{t-1})$$

with all the parameters strictly positive.

Notice that speculative demand is no longer a function of the actual price level only, but now depends on the change in P_t. This assumption is important in the sense that it allows speculative demand to be reduced to a constant (the intercept) in periods of steady state, i.e. when $P_t = P_{t-1} = \ldots = P_{t-n}$, and to be active only in periods of price instability. This restriction appears to be consistent with the sixteenth and seventeenth centuries' reality when some entry in the grain trade was witnessed in periods of crises; undertaken more as a marginal activity than a principal occupation and with a minimal capital mobilization, becoming a *blatier* often constituted an appreciable addition to farm income.

Then, if total demand, Q_t^d, is simply the sum of (12a) and (12b), the expression is reduced to:

$$(12c) \qquad Q_t^d = (\alpha_f + \alpha_s) + (\beta_s - \beta_f)P_t - \beta_s P_{t-1}$$

It follows that by solving the reduced form as in the no-stock-demand case, and expressing the result in a fundamental dynamic equation similar in many respects to equation (17), the particular integral is given by:

$$(18a) \qquad P^* = \frac{\gamma_1 + D\gamma_f + \alpha_f + \alpha_s}{\delta_1 + \beta_f + \delta_f}$$

A number of observations immediately flow from (18a) which is identical to (18) with the addition of the stock demand schedule intercept in the numerator.

1° It will be noted that the subscript t has been dropped from the expression of normal price P^*. The reason for this is that we are dealing here with an intertemporal equilibrium which will be prevalent over all time periods. Because no provision for secular influences have been introduced, this equilibrium is assumed to be constant. As was mentioned earlier, more sophisticated models could take account of long term trends by combining continuous with discrete time analysis[63]. However, for our analytical purposes, the additional benefits of fancier modelling may be slight; we are dealing here with a relatively short span of time (i.e.1-2 years) for which we may assume that secular influences are weak. The seasonal element is partially addressed with the dummy variable D which will operate on equilibrium during winter by raising the price by the increment in fixed costs incurred during the cold season. The cyclical component is studied in the next section.

ii° Also referring to stock demand, we note that in steady state, the equilibrium prices are unaffected by the stock demand's price responsiveness parameter β_s which have cancelled out in the denominator. The reason is of course that steady state implies that $P_t = P_{t-1} = \ldots = P_{t-n}$, such that in effect, only the irreducible intercept of stock demand, α_s, enters in the computation of P^*. Therefore, although its short-term effects on prices may have been and indeed probably were de-stabilizing, equilibrium prices are not affected by the elasticity of speculative demand in the long-run.

iii° The equilibrium price is however positively related to the intercept of stock demand, α_s, which, as the price-insensitive component of speculation, may be seen as the purely expectations-generated element of the demand for stocks. This implies that if we assume that stock demand is minimal following long stretches of price stability, at the end of a crisis the equilibrium price may remain temporarily higher than its pre-shock level until expectations have adjusted and accepted that the crisis is over. This characteristic is often found in markets where expectations following a *disette* display a powerful degree of

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[63] Chiang (1984:ch.18)

inertia. Prices remain at supra-normal levels even though the yields have been good:

> "Lorsque la crise s'étale sur plusieurs années, il arrive souvent que le minimum auquel on revient, une fois la crise passée, est supérieur à celui d'où l'on était parti "
>
> Morineau (1977:944)

This probably also reflects a seller's market for seeds reserves which were often either consumed or sold during the famine. Once expectations have adjusted, we should expect an inward shift of the stock demand schedule thereby bringing back prices to their initial levels.

iv° Over the long-run, the fixed costs parameters for the local and foreign supply sources, γ_l and γ_f, will be lowered as advances in transportation and communications technology are introduced on the wheat market, thereby reducing the equilibrium prices. For the same reasons, D the external supply seasonal disadvantage should be reduced as public funds are injected in road and canals development and maintenance. These crucial improvements had to wait well into the mid-eighteenth century under administrators such as Orry and Trudaine when changes in road construction technology, notably in the utilization of wheather-resistant substructure and efficient drainage system were finally introduced[64]. Only then did the fixed costs differentials between local and distant supply begin their slow erosion.

v° As food substitutes (notably corn and potatoes) become available and diets adapt accordingly, the relative importance of grains as the primary food source will decline. This will be translated into a lower value for the consumption intercept, α_f, as well as an increase in price responsiveness β_f both contributing to

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[64] Léon and Carrière (1970:171)

a reduction of P^*. This however may be counterbalanced in the case of wheat, by an increase in exogenous demand for white bread under the combined influence of accelerated urbanization and population growth. Traditionally, rural regimes favored a coarser bread made of rye while urban diets were centered around white flour.

vi° Both supply price-responsiveness parameters, δ_1 and δ_r, were probably increased over the long-run, thereby reducing P^*. As communications improved, the amount of white noise contained in price signals were certainly reduced thereby benefitting in terms of a prompter supply response and a better understanding of underlying conditions. When we keep in mind that a letter from Bordeaux to Lyon had to transit through Paris, taking eight days to reach its destination[65] during which prices may have fluctuated, we appreciate the reluctance of the grain merchant to organize grain transportation and communications technology are introduced on the wheat market, thereby reducing the equilibrium prices. For the same reasons, D the external supply seasonal disadvantage should be reduced as public funds are injected in road and canals development and maintenance. These crucial improvements had to wait well into the mid-eighteenth century under administrators such as Orry and Trudaine when changes in road construction technology, notably in the utilization of wheather-resistant substructure and efficient drainage system were finally introduced[66]. Only then did the fixed costs differentials between local and distant supply begin their slow erosion.

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V. 2- The Complementary Function

The complementary function P_c will give us a measure of the adjustment parameter b. This component is interpreted as the deviation of a time path from its intertemporal equilibrium. The convergence towards or divergence away from equilibrium is then

[67] Léon and Carrière (1970:178)

determined by the adjustment parameter b whose solution is given by the characteristic roots, b_1 and b_2, where:

$$b_1, b_2 = \frac{-a_1 \pm \sqrt{a_1^2 - 4a_2}}{2}$$

which become:

$$(19) \qquad b_1, b_2 = \frac{1 - \sigma(\delta_l + \beta) \pm \sqrt{[-1 + \sigma(\delta_l + \beta)]^2 - 4\sigma\delta_f}}{2}$$

These two b's which can be distinct (if the term under the root is positive), repeated (if the term is equal to 0), or complex (if it is negative), are those reflecting the adjustment pattern in:

$$P_t = [P_0 - P_0^*](b)^t + P^*$$

The following Table 1 simulates some of the results for b by allowing certain parameters to change. Notice that our earlier assumption from equation (16) which implied that price changes are inversely related to the price-responsiveness of demand allows us to considerably simplify the presentation of the results for (19). Indeed, we may now report the values of the adjustment parameters corresponding to three levels of price-elasticity of demand for various levels of local and foreign supply responsiveness to prices.

Table 1: Values of the Adjustment Parameters.

1- Low Elasticity of Demand: σ = 20, β = 0.05

$\delta_l \backslash \delta_f$	0.05	0.25	0.5	1.0
0.05	R = 1	R = 2.24	R = 3.16	R = 4.47
0.25	-.21/-4.79	-1.38/-3.62	R = 3.16	R = 4.47
0.50	-.10/-9.90	-.53/-9.47	-1.13/-8.87	-2.76/-7.24
1.00	-.05/-19.95	-.25/-19.75	-.51/-19.49	-1.06/-18.9

2- Average Elasticity of Demand: σ = 2, β = 0.5

$\delta_l \backslash \delta_f$	0.05	0.25	0.5	1.0
0.05	R = .32	R = .71	R = 1	R = 1.41
0.25	R = .32	R = .71	R = 1	R = 1.41
0.50	-.11/-.89	R = .71	R = 1	R = 1.41
1.00	-.05 -1.95	-.29/-1.71	-.1/-1.9	R = 1.41

3- High Elasticity of Demand: σ = 1.11, β = 0.9

$\delta_l \backslash \delta_f$	0.05	0.25	0.5	1.0
0.05	R = .24	R = .53	R = .74	R = 1.05
0.25	R = .24	R = .53	R = .74	R = 1.05
0.50	-.13/-.42	R = .53	R = .74	R = 1.05
1.00	-.05/-1.06	-.38/-.73	R = .74	R = 1.05

Table 1 presents the values of the characteristic roots for three different levels of demand price-elasticity, corresponding to β = 0.05, 0.50, 0.90, which are obtained when various levels of local and foreign supply responsiveness are fed in equation (19). Two results are reported whenever the figure under the square root is positive. These must be interpreted by noting that if both are greater than 1 in absolute value, then, the resulting time path is clearly divergent. In other words, a shock will tend to lead to an explosive situation where price increases over the entire duration of the crisis. For values of b that are less than -1, this divergence will be accompanied by an oscillation.

For the case where b_1 is not equal to b_2, and one of the b's is less than 1, the b with the highest absolute value will tend to dominate the other and lead to divergence if greater than 1 in absolute value. Once again, negative figures imply oscillatory movements.

If the term under the square root in (19) is negative, we are faced with the problem of complex roots where:

$$P_c = R^t(A_1\cos\theta_t + A_2\sin\theta_t)$$

and A_1 and A_2 are arbitrary constants. The time path displayed here is that of a stepped fluctuation i.e. a non-smooth sine-shaped function. The variable of interest is then R where:

$$R = \sqrt{\sigma\delta_f}$$

which will determine convergence (if R<1) or divergence (if R>1).

The first comment on Table 1 is that, not surprisingly, because of the presence of a time-lagged component in total supply, all time paths display oscillations which are more pronounced as the responsiveness of lagged supply, δ_f, is increased. Following a shock, as we move to the right of Table 1, we obtain values for R which are increasingly different from 0 which would correspond to an instantaneous adjustment to a localized shock. Hence, in the third case, where the equilibrium price is stable for foreign supply responsiveness values that are less than 1, as we move to the right, the speed of the adjustment is reduced and the fluctuations more pronounced.

This last result is perhaps better understood if we consider the 'locked-in' nature of lagged supplies in our model. Once a price signal is heard, supplies are engaged in an irreversible process. In the meanwhile, local (from available stocks) response will have taken place, unless completely immobilized (e.g. between harvests) driving down prices so that the untimely arrival of long-term shipments will have a disruptive effect on the adjustment of prices. Rather than helping restore normal conditions, lagged supplies will initiate a wave of fluctuations which will be the greater, the more responsive supply is.

This also applies to readily available stocks which will tend to have a more powerful disruptive impact as we move to the bottom of each table. The more responsive instantaneous supply is, the sharper the drop in prices in the first round. Hence, we obtain the paradoxical two results for b where local supplies are very effective in driving down prices, i.e. b is close to 0 in the first stage but, with the arrival of lagged supplies in the second round, a pronounced set of shock waves is brought in.

In a world of imperfect information channels and long delays, this hypothesis is certainly not implausible and we may perhaps better appreciate the risks involved facing both sets of suppliers in determinig the quantity to be shipped to the city or the amount to be sown for next fall's harvest:

"Quel prix trouverait-on lors de l'arrivée à destination? S'il fallait, pour obtenir des taux de vente acceptables, prolonger le trajet, faire retour en arrière ou ent.eposer, comment calculer dépenses et profits?"

Meuvret (1971: 218)

Not surprisingly, lagged-supply response would have been extremely cautious in responding to the demands of Paris. Therefore, severe crises where local stocks would be depleted would be persistent, with price signals unheard of, or perhaps more probably, unanswered.

What can also be seen from Table 1 is that another factor preventing the rapid restoration of equilibrium is the inelasticity of demand. The low responsiveness of demand to the shock leads to large swings in prices even for minor shifts in supply. As soon as demand elasticity is increased (case III), we observe price convergence to equilibrium. The reason for this is that substitution effects will facilitate the rapid adjustment of prices to their initial levels. Changes in relative prices will lead to substitution to grains other than wheat such as rye and oats or other non-grain food such as roots or chestnuts. These would provide partial insulation against high wheat prices whose impact would be reduced accordingly. As Grantham (forthcoming) shows however, while rural wheat consumption may have been responsive to high prices, urban diets were probably more firmly set.

Further evidence of low urban price elasticity of wheat consumption is to be found in Usher's (1913:6) account of the disruptive effects on rural markets of massive purchases by city agents which would not be reluctant to double or even triple usual prices in order to secure the grain. These merchants in times of famine would tend to bypass local markets and go directly to farmers thereby worsening the already imperfect state of price information channels. The ensuing disruptions of normal market operations would further impair rapid adjustment to a crisis by effectively segmenting individual transactions away from the market. Indeed, even readily available grain stored in granaries would have a tendency to disappear from public markets as the rational response of farmers could be to hide the grain and wait for whoever they felt was offering them the best price. As Usher argues, the most distinguishing feature of sixteenth and seventeenth centuries' institutions is probably their vulnerability to even moderate shocks:

> "Heresy was dreaded with a fear that to us seems unreasoning simply because the unusual was so powerfully associated in medieval thought with social disintegration."
>
> Usher (1913:12).

Finally, the image of avid merchants storming the countryside in search for whatever grain they could lay their hands on raises the possibility of man-made crises. In this sense, the following large swings in price might bear little relation to the initial impact. As agents and *blatiers* would run from farm to farm, spreading panic and affecting expectations, any shock or even fear of shock for instance due to political incertainty could have the potential to trigger a full-scale crisis. The concept of the marble sitting on top rather than inside the bowl might be more appropriate for this period than the Neoclassical stability dogmas.

The subsequent improvements in transportation, communications and market operations which would occur in the nineteenth century could thus have had a positive impact on the reduction of the intensity and frequency of the crises at least as important as the agricultural developments in the use of chemical fertilizers and mechanized equipment. However, the diffusion of these changes was met with much skepticism, the weight of traditional farming imposing an impressive degree of inertia:

"Il eût fallu maîtriser le ciel, augmenter les rendements ou mettre en culture de nouvelles terres Or, les techniques agricoles demeurent ce qu'elles furent et bien cultiver sa terre c'est la cultiver comme la cultivaient ses pères "

Gascon (1977:258)

Perhaps even more crucial in this difficult transition from a feudal to a market-oriented agrarian structure was the development of a new attitude toward markets and marketable crops. French agriculture, under pressure from emerging cities to supply stable flows of food, was slowly moving away from subsistence farming and towards cash crops. This is not to say that marketable crops were inexistent but rather that their relative importance in total farm output had been so low that the development of market institutions past the traditional system had never been warranted.

This system was simply unable to sustain the tensions imposed by the development of important urban centers and its failures were especially evident during the crises. The towns would not content themselves with unpredictable supplies undertaken more as a marginal activity than a principal occupation. Their first response was to regulate. Intervention was undertaken at three levels, a control of the markets, a control of demand (mainly the bakers) and finally, regulation of merchants. When the first two failed miserably during crises, a series of subsidies and non-pecuniary rewards were introduced to attract supplies but were also met with little success[68]. Direct purchases had a somewhat better fate, especially in Lyon where the *Chambre d'Abondance* succeeded in exporting famine outside the city limits, at the price of a systematic starvation of the surrounding countryside[69].

However, the urban authorities rapidly realized that the root of the problem was more deeply entrenched. The intensity of urban demand forced the internalization of agricultural markets within the city walls. Rather than having to dive to the supply source, the monopsonist position of the city would help it force supplies out of the *campagne* in an unified location where information could be more easily diffused. The challenge facing market integration in the sixteenth and seventeenth centuries was therefore not to integrate with some distant market but rather to integrate surrounding sources into stable flows from the producing countryside to the consuming city. However, as is shown next, the price stability it implied would not be felt until late in the eighteenth.

VI- The Measurement of Integration

The traditional method for measuring the degree of market integration is straightforward. A given set of markets is said to be integrated if prices of one or more commodities traded in these markets tend to display unison in movements. In other words, as a corollary to the law of one price, any price differential between two or more markets that is in excess of normal transportation and

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[68]Gascon (1977:258-60)

[69]Usher (1913:180-202)

other transaction costs will tend to be eroded through arbitrage such that in effect, a single price can be said to be prevalent for all integrated markets. Hence, localized scarcity resulting in a change in relative prices should not persist any longer than the time needed for the price signal to be heard, supplies to be collected and moved to the wanting region[70].

Econometric tests of integration therefore involve the use of static price correlations where prices in different markets are regressed one against the other(s) and resulting correlation coefficients matrices serve as indicators of integration[71]. Market integration is reflected in low variance and therefore high values of the correlation coefficients with prices displaying unison in movements.

This raises the immediate question of how high is high enough? The dividing line between integrated and segmented markets then becomes arbitrary and, apart from dynamic interpretations such as comparing the regression coefficients over different time periods, definite statements about the degree of integration are hazardous.

A second problem raised by Ravallion (1987) is that two markets with infinite transportation costs between them but sharing similar climatic conditions might display an important degree of parallelism in periods of varying climate which could be mistaken for integration. This outcome must be seriously considered in studying sixteenth and seventeenth centuries' markets when the crises of the period were sometimes induced by weather affecting

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[70]A fall in income, in rural areas, might break the link between scarcity and high food prices through its impact on effective demand, see Sen (1981a).

[71]Because the direction of the dependence betw n prices of two (or more) markets is often difficult to determine, Latham and Neal (1983) proceed with a second regression after interchanging the dependent and independent variables. What they obtain is the lower and upper bound of the true slope term whose critical value is 1.

all France if not all Europe. Therefore, the conclusion that two or more distant markets were integrated simply because their prices tended to display similar fluctuations during crises, must be taken with caution[72]. Still, despite its shortfalls, static bi- or multi-variate analysis of price movements remains a conventional and relatively easy way of measuring integration provided of course that data is available for the markets which are studied.

However the problem with the application of this technique to the sixteenth and seventeenth period lies precisely in the difficulty of gathering sufficient data to proceed with the analysis. Apart from big urban centers for which data has been collected, regional price figures are either inexistent or too incomplete to study. Therefore other methods had to be considered which could be applied to single market price series. The techniques chosen will be more concerned with the dynamic aspects of market integration than static considerations.

VII- Integrals and Integration

The third method proposed refers to the definition of integrated markets mentioned earlier where it was argued that price differentials that are persisting over long periods of time could be reflecting segmentation. This can be understood diagrammatically by observing that, on Figure 1, following a shock, the area under the time path of prices reflects departures from normal pricing. A given impulse, such as a reduced crop following a harsh winter and/or unexpected massive purchases by the armies, will generate a pattern which may differ greatly from the one displaved in Figure 1

[72]Other causes of spurious correlation in addition to climate are seasonality or the presence of a third good traded in both markets, see Ravallion (1987), Blyn (1973), and Harris (1979). Furthermore, Granger and Newbold (1974) demonstrated the use of a static model on non-stationary time series will imply serial dependence of the residuals which significantly reduce the validity of conclusions on integration, see Ravallion (1987).

depending on the underlying conditions. By projecting estimated normal prices (henceforth P_t^*), over the entire duration of the crisis (usually 1-2 years), we can subtract actual from normal prices, multiply by a corresponding time duration and sum over all observations once normalized for inflation to obtain a measure of crisis intensity in terms of deviations from normal conditions.

We may assume that over the long run, a higher degree of market integration resulting from improvements in transportation and communications will generally help in stabilizing price fluctuations by facilitating the arbitrage operations, thereby reducing the value of the computed integrals[73]. Then, by comparing two areas during identified crises, we should be able to provide an indication of the direction of long-term integration processes.

VII. 1 Choice of Data

Price figures used in the present thesis are from Baulant and Meuvret's *Prix des Ceréales Extraits de la Mercuriale de Paris, (1520-1698)*. This remarkable work presents the definite advantage of unification in measures and values. The prices are for a *setier* corresponding to 1.56 hectolitre, about 250 lbs of grain, and they are quoted in *Livres Tournois* corrected to decimal format.

The Parisian market was, not surprisingly, the first in importance in France during the sixteenth and seventeenth centuries both in volume and value. Its food consumption mobilized close to 12 departments. By comparison, the second market in importance,

[73] Notice that market integration does not necessarily imply a Pareto-optimal allocation. Newberry and Stiglitz (1982) identify 4 conditions which are to be met for a Pareto-efficient competitive equilibrium:

1) Risk-neutrality,
2) Rational expectations,
3) Common beliefs about price distribution over different states,
4) Access to perfect capital markets.

Lyon only required between 6 and 8[74]. The supply sources were mainly local although wheat imports were often brought in during crises. The Beauce, Brie, Ile-de-France, Picardie and Vexin regions were the main granaries of Paris.

To the extent that this study focuses on market integration, the commodity chosen is wheat which is the most marketable of all cash crops at the time. The rationale behind this is imposed by the nature of the test. Since wheat, as the grain of highest mercantile value, was the most desirable on the Parisian market, and, as such the most marketable, it should have displayed the highest degree of market integration[75]. All other grains, including oats and rye should point to lesser levels of integration as is reflected in their much more powerful fluctuations.

For similar reasons, the Halles were chosen over other markets, its importance reflected in the excellent quality of its price series. In addition to the Halles which concentrated all the grain transported by road from the *banlieue* of Paris, the Port de l'Ecole and Port de Grève markets specialized in stocks moved by boats. Located close to the Louvres, the Ecole market was opened to the larger boats operating on the Oise river through which gave access to the granaries of Picardie, and via Rouen and The Havre, to the Atlantic. The Port de Grève was situated close to city hall and accommodated the smaller boats from Brie, Valois and Tardenois. When the high crises' prices covered the transportation costs, the grains of Lorraine and those of the Loire basin via the Briare canal entered through the Grève harbor[76].

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[74]Gascon, (1977:257)

[75]Baulant and Meuvret (1960: 17).

[76]Meuvret (1971:200-202)

For wheat as well as for other grains, the authors propose two columns of prices: maxima and minima which correspond roughly to differences in the quality of the products. Wheat quality was principally varied through the addition of rye in the wheat sowed which was incorporated to obtain a more resistant straw[77]. The presence of rye however reduced the value of the grain by altering the flour which would be coarser and less white, a definite disadvantage to urban palates. Therefore, the maximum prices quoted in the *Mercuriales* correspond to the purest wheat, i.e. the wheat with the least proportion of rye.These prices were chosen as referring to a more or less homogeneous product, although it is recognized that the definition of 'purest' grain may vary through time, especially during shocks.

The desired approach in the face of stochastic variations in the quality of the grain would have been to take the expected value of the various quantity-weighted price/quality categories as a measure of expected revenue facing the supplier. Expected return would thus be represented by:

$$E(R) = \sum_{i=1}^{m} P_i Q_i$$

where P_i and Q_i are respectively the price and relative quantity of quality 'i' grain whose product is summed over the m different quality types found on the market at the time of their recording in the *Mercuriales*.

However, because no corresponding quantities were available, the unweighted arithmetic average had to be considered instead of the more desirable weighted mean. This measure was rejected primarily for its reduced representative value. It was felt that it would be more profitable to concentrate on one wheat quality,

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[77]Meuvret (1977:148-150)

namely the one corresponding to the maximum price instead of trying to define an elusive average quality. As Meuvret aptly prescribes:

"Si le ble 'bon et loyal' est aussi le ble 'marchand', le 'meilleur ne sera-t-il pas aussi le 'plus marchand'? La qualité maxima a plus de chances d'être bien définie que toute autre et son haut prix en fait une céréale d'exportation Il nous apparaît pour des raisons analogues à celles qui nous font exclure le méteil qu'on peut se dispenser de chercher à définir une qualite moyenne Si nous avions en regard de chaque prix la quantité vendue, il en serait autrement "

Meuvret (1971:74).

Finally, it should be noted that prices recorded in the *Mercuriales* were usually entered once a week corresponding to the Saturday visit of the officials from the *Police des Grains*. However, in periods of rapid price movements the *Jures Mesureurs* also quoted prices on Wednesdays, the only other day on which the grain market was held. The reason for this close watch is fiscal; a sales tax being imposed on the grain while the price of bread was severely regulated, their records were essential to determine the profit margin of the bakers. According to Meuvret (1971:49), the conflicting interests of the bakers and the market authorities were (at least in principle) sufficiently acute to ensure that the prices entered in the *registres* were accurate descriptions of market activity.

In computing the areas under the price curves, a time weight of 1 was used whenever the quotations were recorded weekly, and .5 when only 3-4 days had elapsed between the entries.

VII. 2 The Estimation of Normal Price $\hat{P}_t$.

The definition of what is a normal price is open to numerous interpretations. Should we use the prices recorded immediately before and after the crisis as reflective of a normal environment as Meuvret (1971:106) and (1988:180) does with his use of *médianes mobiles*? But then, how far back do we go: one, five, ten years? If autocorrelation is suspected such that a given crisis is (at least in part) the result of past conditions (e.g. depleted seed reserves caused by a series of rainy autumns) then, past prices will translate individuals' expectations on the imminence of a shock rather than normal trading conditions. Then, any measure of the deviations of prices from customary levels based on an expectations-inflated normal price will tend to introduce bias by understating the extent of the fluctuations. By comparison, a *disette* which would have been completely unexpected would have been reflected in low pre-crisis prices and therefore yield a high measure of deviations. Another option is to use the entire series and to smooth out the crises.

To the choice of modern smoothing techniques, such as spectral analysis, is often confronted simpler processing like the unqualified use of moving medians or moving averages. The decision about which one is preferable is most of the time dependent on the objectives pursued, with the result that recognized sophisticated apparatus, such as the Census II method of seasonal adjustment, are not immune from disquietingly *ad hoc* measures[78]. The perennial problem with smoothing is how smooth is smooth enough? For instance, when using centered or exponential ing averages, the choice of the interval's length is crucial in the determination of the degree of smoothing achieved. When dealing with well-behaved phenomena occurring at more or less regular time intervals and lasting a constant amount of time, this decision, without being trivial, is nevertheless much facilitated. However when studying sixteenth and seventeenth centuries' grain crises, the difficulties are immediately apparent.

To start with, the problem of expectations again arises and simply increasing the interval will often be insufficient as a corrective measure particularly if crises are occurring at a close interval one from another, such as the 1562-63 and 1565-66 crises.

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[78]Pyndick and Rubinfeld (1981:488)

Then, a centered moving average with an interval greater than 5 will capture crisis prices and be translated into an overstated P_t^*. The result is that the deviations measure will be biased against relatively isolated *disettes* such as 1630-32, which occurred after almost 40 years of uninterrupted calm and which was followed by 10 years before the next crisis happened. The estimated normal prices projected over 1630-32 will obviously be lower and while its effects were mainly felt in the Midi, this crisis will be overstated.

Closely related is the fact that unusually long shocks will tend to inflate the moving average unless the interval is varied accordingly. This is especially evident during long crises such as 1648-53 where the normal prices computed using moving averages were overstated unless the interval became grotesquely long. The solution of a case by case adaptation of the interval length is clearly unacceptable, depriving the test of its validity.

A third problem raised in Meuvret (1971:86) is that the peaks obtained during shocks are so much out of proportion with usual prices that their influence might be excessive. Hence, an annual average of almost 40 *Livres Tournois* obtained in 1590 when the usual should have been closer to 8.8 is the direct result of short-lived peaks of 90 at the height of the siege of Paris. This figure which reflects the closing of trade routes for the strategic purpose of starving the city obviously cannot be used in computing normal price levels.

Thus, because of the specific problems encountered in computing P_t^*, the moving averages whether centered, exponential, double exponential or two-parameters exponential were all rejected in favor of other alternatives. Crudely put, what was done was to reconstitute P_t^* *as if* the crisis had not occured.

A time series y_t can be thought of as being composed of the product of four components: $y_t = L \times C \times S \times I$ where L is the long-term trend, C is the cyclical or medium-term component, S, the seasonal element and finally, I represents the irregular influences[79]. The smoothing procedure which was applied was therefore to eliminate I from the price series while taking special steps to ensure that the other components remained present.

The long-run element L was estimated by first taking out all designated 14 crises-years from the annual averages (August to July) between 1520 and 1698 computed by Baulant and Meuvret (1960) which is obviously the most direct way of removing the irregular element, provided one is willing to accept the broader association of 'irregular' with 'crisis'. Then, in order to obtain some measure of the underlying long-term trend, a second-order exponential equation of the type:

$$\ln P_t = \beta_0 + \beta_1 t + \beta_2 t^2 + \varepsilon_t$$

was estimated for which the following output was obtained:

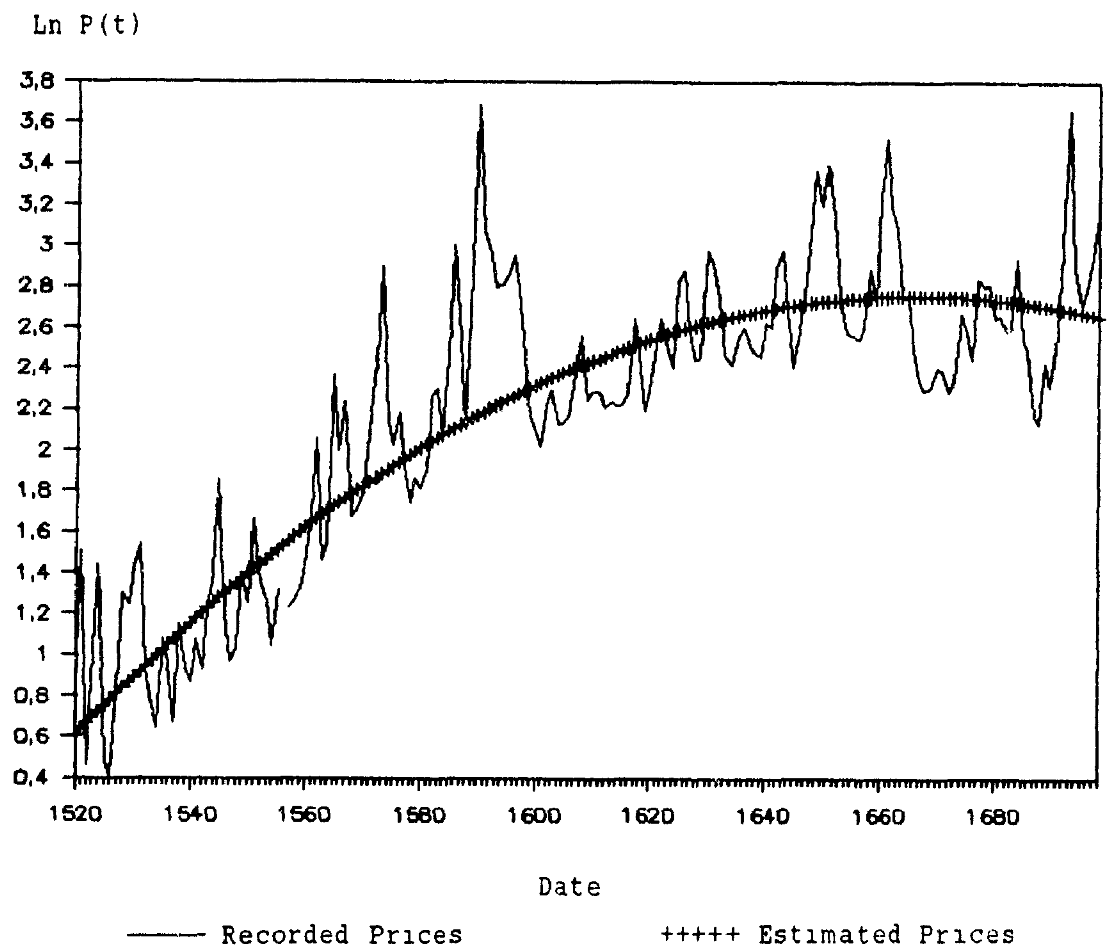
Constant: $\beta_0 = 0.609671$
Standard Error of the Estimate: 0.267725
R-Squared: 0.824916
Nb. Observations: 142
Degs. Freedom: 139
X Coefficients: $\beta_1 = 0.029307$, $\beta_2 = -0.00010$
Std. Err. of Coef.: 0.001776, 0.000009

The negative coefficient of t^2 accounts for the slower growth of prices after 1600 which, as was mentioned earlier, reflects a break in the inflationary pressures which followed a decline in the massive imports of Spanish American precious metals. This can be seen from Figure 2 where the time path of the annual averages as well as the estimated P_t^* are pictured. We also mentioned earlier

[79] Pyndick and Rubinfeld (1981:488). Notice that an alternative is to see a time series as a sum of various influences, see Granger and Elliott (1967).

that other factors included an attenuated population growth, as well as economies of scale obtained through the increase in farm size. The presence of such an important break in the trend imposed the use of the Chow test to determine whether data segmentation might be preferable to a unique regression[80]. As demonstrated in Appendix 1, the results of the test did not warrant the use of two separate regressions but instead pointed in favor of the single polynomial. The series obtained with the above regression is thus the annual averages, which can be projected over crisis years, deprived of their cyclical, seasonal as well as irregular components, the first two which then have to be reintroduced.

Figure 2: Annual Wheat Prices, logarithmic scale



[80] Chow (1960)

Figure 2 depicts the cyclical fluctuations which rocked the Parisian wheat market throughout the sixteenth and the seventeenth, as well as the projected secular trend for the period. We can see with Morineau (1977:931) that following the cyclical storm between 1520 and 1533, a relatively calm rise will take us through 1560. Then, with the beginning of the religious wars, another period of important fluctuations is apparent culminating in the early 1590's. A second respite is recorded until 1640 at which point the troubles of the Fronde and Après-Fronde witness a series of powerful deviations from secular trend. The Colbert administration is characterized by a relative calm until the early 1690's at which point, the wave of shocks corresponding to the last years of the reign of Louis XIV hits the metropolis.

What is immediately apparent from Figure 2 is that even in relatively peaceful years, important 'normal' fluctuations are recorded. The presence of such deviations in agricultural sectors is recognized even today and state intervention on commodity markets usually concentrates on the definition of a 'band width rule' along which prices fluctuations are considered normal and not warranting any stabilizing action[81]. A measure of normal price which does not address this problem will therefore lead to an overestimation of the fluctuations during a food shortage. More specifically, price movements which would otherwise have been characterized as customary will be entered as crisis fluctuations in the computation of the area under the time path of prices.

The cyclical element was indirectly accounted for by defining a buffer zone around the estimated annual average, the argument being that prices in non-crisis years will tend to move around a secular trend, subject to medium-term impulses which are (at least directly) unrelated to crises, a 'normal' fluctuations interval

[81] Newberry and Stiglitz (1982)

around P_t^* was built. This buffer zone accounts for the marketed-output phenomena described in section IV which were common over the medium-time period. Obviously, these are the direct heritage of the structural elements of sixteenth and seventeenth centuries' agriculture (as well as being present in contemporary agricultural markets) such as the irreversible character of production and cannot be considered 'irregulars'. Therefore, in the following computations of the integral below the time-path of prices, the program rejected any deviations below a critical value as 'normal' and instead assigned a 0 in the calculation of total area under the curve. This was done by computing the average relative deviations (in absolute value) from estimated prices in non-crisis years only. The resulting critical value is: 0.228. In other words, any deviations less than 22.8%, in absolute value, from the estimated P_t^* was not entered in the integral. This figure appears reasonable. Meuvret (1971:108) obtained similar results for wheat between 1597 and 1697 for the majority of years[82]

The seasonal component was reintroduced by 'seasonalizing' the annual averages, i.e. by multiplying the means by 12 monthly indices which were computed by using the technique outlined in Pyndick and Rubinfeld (1981:488-489), and detailed in Appendix 2. Two sets of indices were computed using the monthly data in Baulant and Meuvret where the prices recorded on the first market of each month are reported for the entire period 1520-1698. The results are reported in Table 2 and are shown in Figure 3 where seasonal indices in crisis years and non-crisis years are given.

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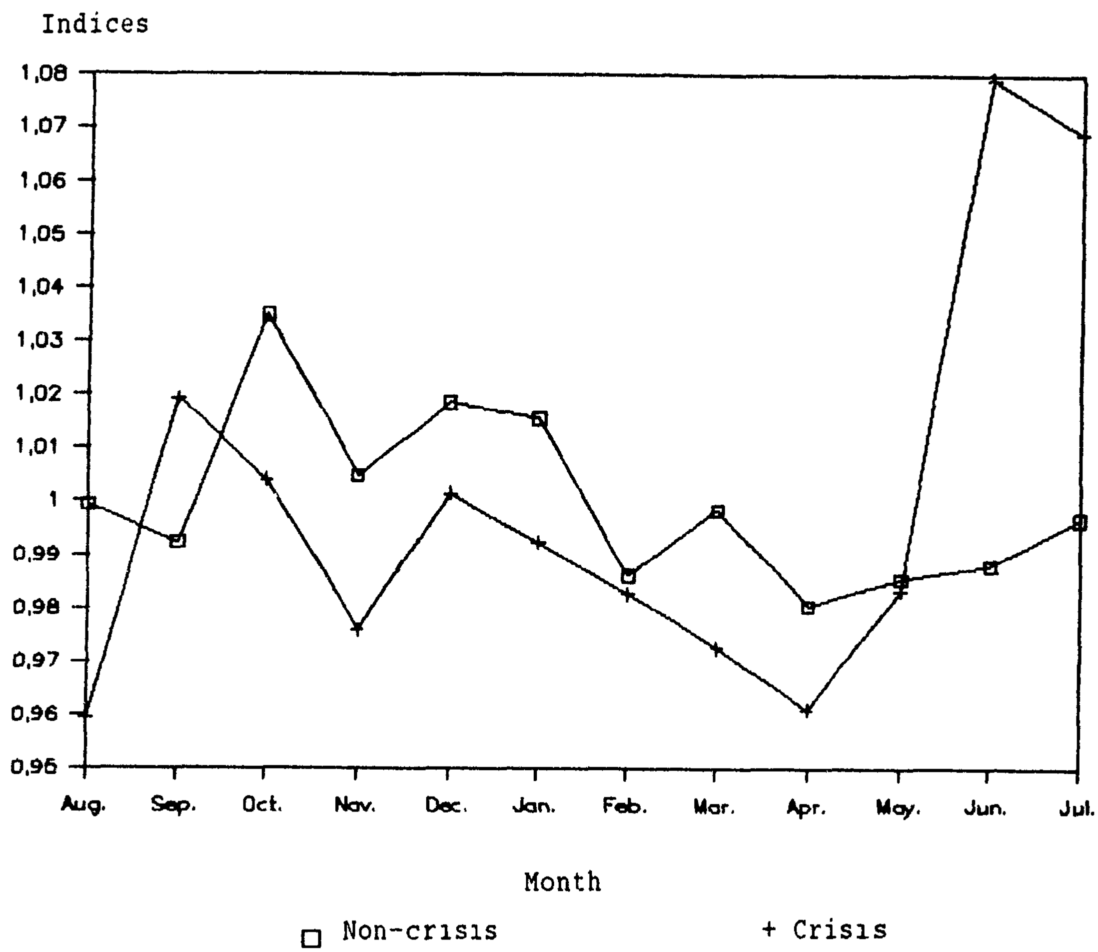
[82]The variance of these fluctuations remains however impressive and differs across regions and varieties of grain, see Meuvret (1971:105-111).

Table 2: Seasonal indices, maximum wheat prices (1520-1698)

Month	Crises	Non-Crises	Month	Crises	Non-Crises
Aug	.959	.999	Feb	.983	.986
Sept	1.019	.992	Mar	.973	.998
Oct	1.004	1.035	Apr	.961	.980
Nov	.976	1.005	May	.983	.985
Dec	1.001	1.019	June	1.079	.998
Jan	.992	1.016	July	1.069	.997

Figure 3: Seasonal Indices, wheat prices



The first impression from the seasonal indices in Table 2 refers to their minimal amplitude. Both crises and non-crises indices represent seasonal movements of reduced importance when compared to others. Hence, by comparison, the US indices of housing starts will range from a low of 0.55 in January to a high of 1.26

in June[83]. Agricultural prices, varied minimally as a result of seasonality, which says much on the price stability achieved during normal times. This could be an indication of adequate storage or of a seasonal shift in diets. Hence, individuals might have substituted coarser grains in place of wheat during the peaks of the *soudure* which went from April/May to July/August, therefore limiting the price increases as indicated by the greater seasonal volatility of the lower-quality grains[84].

The impact of storage explains much of the smooth decline from January to April. McCloskey and Nash (1984) argued that storage costs, as reflected in terminal prices, will be high at the outset and fall gradually as risks premiums fall continuously when definite news on the forthcoming harvest become more precise. Therefore, following a critical date like the *Saint-Martin* in early November, storage costs will peak in December or January to fall thereafter. As can be seen from Figure 3, this decline is more pronounced in crisis years which could reflect the greater effort used in monitoring the blossoming and evolution of the grain.

A third comment also refers to the difference between crisis and non-crisis years. Seasonal fluctuations during a food shortage are much more passionate, especially during the *soudure*. This period corresponds to the time of the year when the reserves would be depleted. As Taub (1987) showed, production and consumption decisions were taken as to minimize the stocks left immediately before a harvest. We saw earlier that agricultural production was undertaken primarily for the subsistence of the household. Any remaining residual once provisions for taxes, rent, tithes and consumption between the harvests had been set aside, would be sold on the market. This implied that a wealth-maximizing producer would

[83]Pindyck and Rubinfeld (1981:490)

[84]Labrousse (1970b:410)

have tried to reduce his stocks in excess of incompressible needs to a minimum. The slow increase of prices in non-crisis years might therefore be explained by some degree of error in the calculation of the required amount in storage to cover annual needs, which would force a certain number of producers on the market as consumers. In periods of crisis, the small residual would become negative i.e. producers would enter the grain market *en masse* as consumers, being unable to accommodate the needs of their household.

As demonstrated in Appendix 3, McCloskey and Nash (1984) used the normal probability distribution to compute the average 'waiting time' between famines corresponding to various carryover levels. Their results for medieval England show that by setting the starvation level at 50 with respect to an average output of 100 units, a 5% carryover above consumption needs would have implied an average waiting time of 22 years between famines. However, the actual time elapsed between shocks was on average 10 to 15 years. By pursuing their analysis one step further, we can easily show that this would imply a carryover of 2.5% corresponding to 15 years and of -5.2% for 10 years waiting time (see Appendix 3). In other words, the residual above usual needs which could be made available for sale would be minimal at best or negative, i.e. producers became consumers, at worst.

Meuvret (1971) recognized that the seasonal influences, while generally weak in normal periods, would become more pronounced during crises:

"A l' intérieur du cadre tracé par l'année de récolte, le mouvement saisonnier qui, aux yeux des marchands n'était jamais négligeable, demeurait cependant assez moderé en temps ordinaire Mais il était extrêmement marqué durant les années de hausse "

Meuvret (1971:218-19).

The relative stability of prices in non-crisis years speaks against the McCloskey and Nash (1984) argument on the inadequacy of storage as reflected in the frequency of famines. Their argument rested on the fact that in equilibrium, storage which is considered as a deliberate decision must earn its opportunity cost, i.e. the interest rate, just like any other type of investment. Through various methods, they estimate the rate of return to oscillate around 30 to 35% which would prohibit storage as a profitable activity unless returns to stored grains were at least as high. This is only part of the story. Without rejecting the profit motive, Meuvret (1988:ch.1) shows that the primary objective of storage would have been the fear of hunger, and as a result, stocks would have been held as to minimize consumption variance in between crops. This would have been reflected into seasonal stability of prices, as inadequate storage would have forced to the market a number of producers as consumers, especially through the *soudure*. The seasonal indices computed above show that at least inside the annual context, storage achieved admirable price stability in normal years. Its insufficiency is reflected during the crises only.

Section IV demonstrated that an alternative view to storage as a deliberate investment decision was to consider crops as a stochastic phenomenon. If, in the absence of efficient capital and grain markets, production is orchestrated around self-subsistence, carryover or sold grain becomes a residual subject to the random influences. We saw that this opinion was shared by leading French authors such as Meuvret and Labrousse. Rather than the complex dynamic programming apparatus which Taub (1987) assumes to be reflecting production, consumption and storage decisions, the carryover, as its name reflects, could be better explained as a stochastic quantity in excess of basic needs over which the producers had little or no control. This assumption is consistent with observed cyclical volatility and seasonal calm during normal years, with a more powerful seasonal influence during crises. If we keep these in mind, the amplitude of the deviations from normal pricing which are described next are perhaps better understood.

VII.3 The Area Under the Curve

The next operation in computing the area below the time path of prices was to normalize the difference between observed and normal prices by dividing by the estimated figure in order to provide a correction for inflation. Monetary manipulations were not unknown to the royal authorities. In addition, part of the massive entries of American gold and later silver into Europe through the Carrera were captured by France through her wheat and, to a lesser extent, manufactured exports to Spain, not to mention *la course*, a romantic name for what is better known as piracy. The impact on prices, although some authors question its importance, was nonetheless significant especially during the sixteenth and the later half of the seventeenth, peaking in the years 1501-05, 1536-40, 1551-55 and 1591-95[85]:

> "Sachons simplement que les prix les plus élevés-ceux des disettes-ont certainement eté réalisés sur les marchés en monnaie surévaluées par rapport à leur valeur intrinsèque les crêtes de l'argent à la fin du XVI^{e} siècle sont partculièrement factices."
>
> Morineau (1977:938)

Therefore, some provision for monetary inflation had to be considered. The advantage of normalizing resides in the fact that the deflators applied to P_t^* and P_t cancel out by expressing the deviations in percentage terms, thereby eliminating the need for hazardous transformations in hard numéraire such as grams of fine silver.

The next operation was to weight this relative deviation by the duration of the differential (f_t = 0.5 for 3-4 days, 1 for a week) for all observations in each of the 14 crises identified by Baulant and Meuvret. Furthermore, the weighted deviation was squared to reduce the relative weight given to small fluctuations over more

[85] Morineau (1977:956-72)

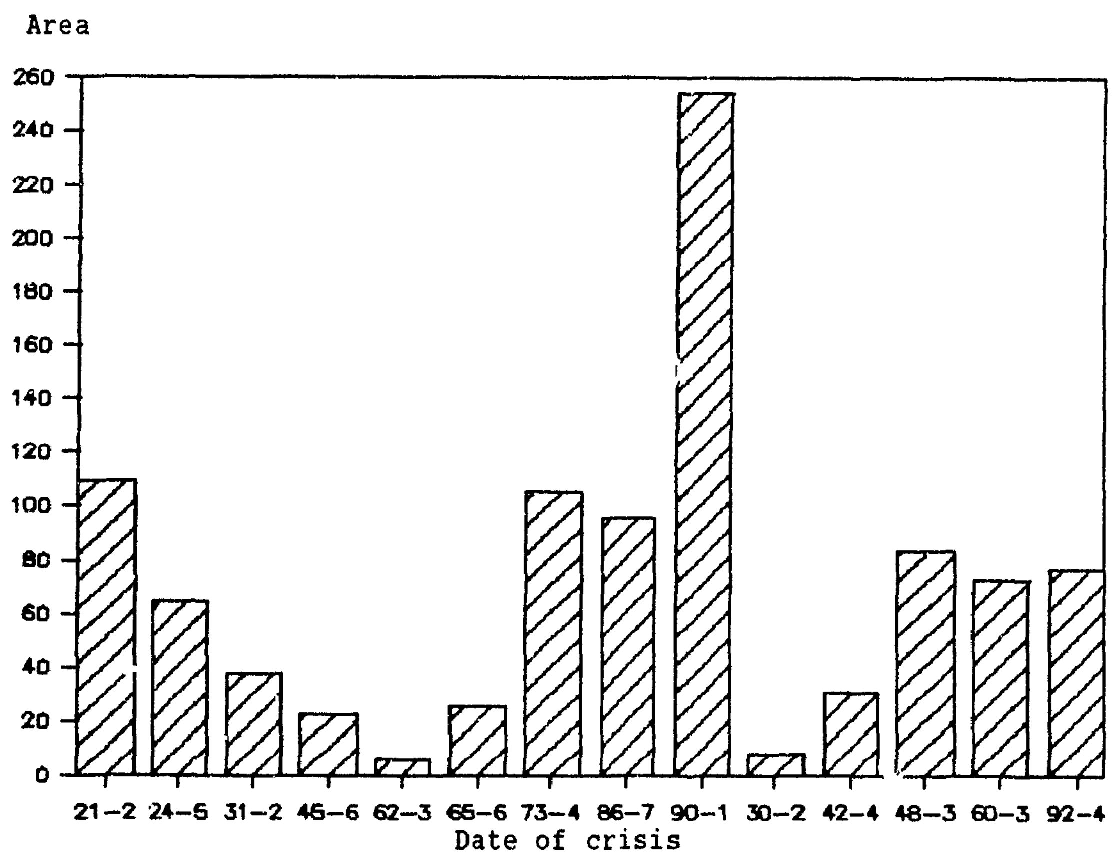
powerful ones, a standard operation tributary to the analysis of variance. Finally, the result was summed over all n observations which started in July of the year preceding the shock and up to the end of October when prices reached their normal levels. Therefore, the measure of area, reported in Table 3 and Figure 4, is given by:

$$Ar. = \sum_{t=1}^{n} \left[\frac{(P_t - P_t^*) f_t}{P_t^*} \right]^2$$

Table 3: Area under the time path of wheat prices during crises.

1521-22	109.4	1585-87	95.9
1524-25	64.3	1590-91	254.2
1531-32	37.5	1631-32	8.2
1545-46	22.9	1642-44	30.9
1562-63	6.2	1648-53	83.4
1565-66	25.7	1660-63	72.4
1573-74	105.6	1692-94	76.9

Figure 4: Area under the time path of wheat prices during crises



The first impression from Table 3 and Figure 4 is that the intensity of the crises was markedly reduced between 1520 and 1565, while subsequent shocks appear to have been much more powerful, with the exception of 1630-32. These figures certainly go a long way in shattering any belief that some underlying long-run integration process could have helped in reducing the severity of crises between the early sixteenth and late seventeenth. This opinion is also shared by Léon and Carrière (1970:166-80), Labrousse (1970b:415-16); (1970d:562-63) and (1970e:694-95) and Meuvret (1971:275) and (1988:180-87) who believe that the long and painful process of the creation of a national market would have to wait until the late eighteenth and more importantly the nineteenth century. In the meanwhile, crises did not appear to diminish in intensity. If any trend is to be inferred from these integrals, it rather points toward an intensification of the deviations from normal pricing following a period of declining fluctuations in the first half of the sixteenth, if we set aside the troubled times of the Religious Wars of the late sixteenth century.

Secondly, two crises immediately stand out of the distribution as extremes: 1590-91 immediately followed by 1630-32. The crisis of 1590-91, as the most intense, must be analyzed in its proper historical context. This period corresponds to the troubled times of the *Guerre des Trois Henri*, also known as the *Guerre de la Ligue*. The siege of Paris by Henri IV must be taken into consideration in assessing the relative importance of this crisis. Because of the closing of normal channels of communications and supply for strategic purposes, this computed area cannot be used as a valid measure of market segmentation. Still, we are struck by the magnitude of the deviations with integrals more than two and a half times the figures of other important shocks. The inelasticity of demand for wheat is also apparent with average prices reaching more than four and a half times their pre-crisis levels.

The following crisis of 1630-32 also strikes one as extreme when compared to others following the earlier decline in intensity which had ended in mid-sixteenth. We said in the second section that this shock had been associated with Black Death which had started in 1628 and lasted through 1632. The extensive toll in population might explain the relatively low figure obtained for the corresponding *disette* which struck two years after the beginning of the plague. The intense reduction of effective demand the plague implied as well as the start of quarantine measures by the city which meant a closing of its walls to the mass of rural poor who usually flowed inside when prices started to augment, could have had an attenuating effect on the rise in prices in the Parisian market.

A second explanation might have been the over-estimation of normal price P_t^* . The use of the quadratic meant to capture the deceleration of the growth in prices of the seventeenth following their impressive ascent in the preceding century. It is possible that the attenuating influence of the negative value of the t^2 parameter might not have been felt sufficiently in the computed P_t^* corresponding to 1630 through 1632. As a result, the strong trend of the sixteenth would have been over-represented leading to a low value of the integral computed for this period.

The third comment refers to the relationship between positive and negative deviations. A second program was constructed whereby observations where actual P_t was lower than P_t^* have been entered negatively in the sum of total area. The logic behind this operation is that the area was computed without discrimination between positive and negative deviations ($P_t < P_t^*$) when the weighted deviation was squared. Therefore the integrals might have tended to overstate the absence of an adjustment to price differentials if prices had fallen below normal levels. As is well known from cobweb theory, in a market structure where important lags are involved, it is likely that errors in price expectation will result in the untimely arrival of supplies on the market, thereby driving prices below normal levels, especially if demand is inelastic. Subnormal prices might have been observed toward the end of the harvest period which could indicate untimely arrivals of grain on the Halles market as well as excessive supply responses in wheat sown. Therefore, important differences between the first and the second columns could be an indication that excessive supply response was observed.

However, results for the second program were that with the exception of the 1524-25, 1531-32 and 1565-66 crises, no difference between the first and second integrals were recorded. Expressed in percentage of the first those differences for the three crises mentioned were minimal: respectively 9.2%, 4.8% and 7.4%. In other words, for 11 crises out of 14, prices did not fall significantly below their actual levels, and the remaining three display small negative deviations indicating that cobweb phenomena were probably weak or not observed at all within a time period of two years, used for each shocks.

Two explanations may be advanced to explain this apparent paradox. First, the creation of a buffer zone of close to 23% around normal price would absorb most short and medium range deviations from usual levels. As was explained, this figure corresponds to the average amplitude of the fluctuations in non-crisis years and would incorporate most cobweb influences which might have been found in an economy where time lags were important. Therefore, deviations that would have been less than 22.8% of normal price would not have been entered into the sum, being considered as normal.

Secondly, we already noted in sections IV and V that long term response to high prices would have been minimal. The absence of an effective rural capital market as well as the risks involved in the face of meager financial strength would have prohibited investment in expanded grain production. The temporary character of crises did not justify the long run immobilization of rare funds associated with an increase in cultivated area. As a result, prices remained persistently above customary levels throughout the *disette* and did not return to normal until the slow process of expectations adjustment had been completed.

Yet, for all its shortcomings, the traditional market system appears to have offered relative stability with prices firmly set at customary levels. In a period of fixed nominal wages, this feature was seen as a necessity. Apart from crop failures, food prices displayed strong inertia and only slow adjustment to such disturbances such as monetary manipulations, would have been allowed:

" seul un déficit effectif de la production pourrait justifier une augmentation des prix et cette augmentation des prix était un grand malheur pour tous En dehors de la, il n'y avait guère de place que pour l'enrichissement malhonnête aux dépens d'autrui "

Meuvret (1977: 39)

However, whenever it was felt that a crisis was on its way, the old system would collapse under the intensity of urban demand. At this time of madly fluctuating prices, when panic was on the verge of breaking loose, and hungry mobs would terrorize the countryside, supplies had a tendency to disappear from the markets as grain movements became increasingly risky. *Blatiers* and merchants' agents would have to literally dig out the grain from its hidden storage facilities, therefore contributing to the general confusion:

" The merchants themselves are as much in the dark as the people Each knows the extent of his own dealings, none can have any idea, however crude of the extent of other's purchases A panic is essentially unreasoning fear, but under these circumstances, it is hardly surprising that reasonable men became panic-stricken "

Usher (1913: 202).

VIII- Conclusion

The purpose of this thesis being to measure the extent and dynamics of market integration in the Parisian periphery of the sixteenth and seventeenth centuries , it was argued that, by using crises' data and the adjustment of prices to normal levels as criteria, grain markets were typically not integrated during the period studied. Furthermore, we cannot observe any signs that a long-run integration process was effectively helping in reducing the intensity of the food shortages over the two centuries. If, by long-term integration we understand the creation of a national market through the introduction of the various producing and consuming regions into a unified communications and trade network, then we may not infer from the price data of the *Mercuriales* that the wheat market was integrated or moving towards greater integration over the period studied.

To be more precise, a national market did exist for certain specific products with a high value to bulk ratio such as almonds, nuts, saffron, pastel and other non-perishable luxuries[86] but the specific character of grain supply and demand played against its integration. A set of small local network would be found throughout France but the link between them would be minimal.

Each region reacted to the market failure to ensure food supply stability by closing-in on itself, i.e. by developing local redistribution channels, independent of external disruptive influences. In the same way that individual autarchy was idealized, local or regional isolation and self-subsistence were believed to be the key to survival.

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[86] Morineau (1977:895-97)

It would seem that traditional trade channels and apparatus usually performed reasonably well in achieving this goal during normal periods[87] and, to a certain extent, in moderate crises. Still, during full-scale shocks, the grain markets were unable to bring prices back to customary levels as local grain markets disintegrated under the pressures imposed by urban demand.

We saw that the beginning of the sixteenth marked the end of the painful recuperation which had started 60 years earlier following the great decline originating in the middle of the fourteenth. French agriculture's recovery was achieved however at the expense of progress and, unlike its rapidly advancing Dutch or English counterparts, French food production was basically back to its starting point. Techniques and equipment had remained as they were in the two preceding centuries and were to remain unchanged for the forthcoming three hundred years. Population, mainly urban, growth was beginning to put intense pressure on agriculture and its main cash crop, grain. The great waves of urbanization of the sixteenth and seventeenth demanded a more stable access to food which the traditional system was unable to guarantee.

The inevitable confrontation between inelastic urban demand and inelastic rural food production resulted in episodic crises which, as we saw, took dramatic proportions through extensive substitution and multiplier effects on the still-young French manufacturing, construction and mining industries. The long term effects although difficult to measure, probably played an important role in accounting for French 'retard' in entering into the modern era compared to its perennial competitors England and Holland.

We saw furthermore that French farmers, partly as a response to instability of food markets, had chosen self-sufficiency as leitmotiv. The implications of this choice were reviewed in the

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[87] Usher (1913:11-12)

fourth section where it was argued that the impact on prices of a reduced crop would be disproportionate to the extent of the reduction. The first allocation model showed that the elasticity of prices with respect to gross output could be represented as an inverse function of the price-responsiveness of demand and positively influenced by the gross-output-elasticity of marketed supply. Because of the significant auto-consumption entailed in an essentially autarchic economy, the marketed residual remaining once taxes, rent and tithes had been paid and once a sufficient seeds and annual consumption reserves had been set aside, would be disproportionately affected by fluctuations in yields. The grain supplied to the market would be the first sacrificed whenever crops were reduced. Furthermore the low price-elasticity of demand would entail powerful price repercussions following a food shortage.

The low responsiveness of quantity demanded to prices also influenced adversely the speed of the adjustment of prices back to normal levels. We saw in the following section that in a model of price adjustment where time lags are introduced, at low levels of demand elasticity, a given shock will cause prices to fluctuate away from pre-crisis equilibrium or to remain permanently higher. As a result of the unpredictable fluctuations associated with grain prices, supply response, especially long-term would be associated with a high risk premium. With an inelastic demand implying impressive fluctuations in prices following supply response beyond an unknown critical point, the apparent inertia of price is perhaps better understood. This is not to say that both long- and short-run supply responses were completely unable to curb prices. However, observation of the time paths of prices at various crises seems to point out to b's which would be approaching or greater than 1, an indication of minimal price-stabilizing supply shifts and demand substitution.

For these reasons, a moderate crisis where crops in the surrounding area had been only partially affected would imply an important degree of price-adjustment inertia, reflecting the high costs of grain movements to the city as well as the limited extent of the producing farmer's response. However, a full-scale catastrophe would require long-distance response which could be even more hazardous considering the time needed, in addition to the repetition of all the delays mentioned in section III, for the information to simply reach the region. Not surprisingly, those crises implied an almost complete disintegration of the grain trade.

The final section attempted to find a measure of the intensity of each crisis by concentratring on the area below the time path of prices. It was argued that as a corollary to the law of one price, increased long-term market integration should be reflected in a lower value of the deviations of prices from normal levels. This result would have been obtained from the process of the creation of a national market which should have allowed more efficient leveling of regional differences in supply and demand conditions. We saw however that this change demanding a massive transformation of the transportation and communications infrastructure was inoperative in the sixteenth and seventeenth. Not until the late eighteenth and early nineteenth did integration begin to take a modern significance. Until then, integration concerned the more immediate problem of internalization of markets i.e. of digging out rural supply and forcing it onto the urban market.

Conditions were slowly evolving to allow the progressive integration of markets to take place. We mentioned briefly the positive incidence of changes in diets allowed by the increased availability of substitutes to grain. By increasing the elasticity of demand with respect to prices and by liberating the portion of income tied to grain purchases, they would allow grain markets to progressively become less passionate. As Labrousse (1970b:416) understands, wheat was an economic prisoner of its specific supply and demand characteristics, "*Et gardé sur place par des foules anxieuses, pire que des geôliers. Il reste l'aliment de vie, disputé avec fureur.*". For markets to become efficient, grain had to be deprived of its extraordinary nature and to become a 'good', traded just like any other. The only way to achieve this goal was to progressively introduce subsistutes: maize. potatoes, nuts and much later dairy and meat products. Only then would grain markets cease to be viewed with suspicion.

On the supply side as well, in-depth adjustments had to take place to eliminate crises and the first amendment had to concern prices. As Boisguillebert, Quesnay and the other Physiocrats of the late eighteenth understood well, high wheat prices sufficient to cover large-scale production costs and to warrant the installation of a national infrastructure would give the true impetus to market integration. But first, the idea of high prices had to be dissociated from the image of the *disette*[88]. In a world of rigid nominal wages and powerful guilds preventing a rapid adjustment, this concept of fighting fire with fire was difficult to accept. The solution had to go through the productivity increases associated with the great waves of industrialization of the late eighteenth. The (not always) welcomed new opportunities mainly in textile facilitated the reintegration of the mass of small producers which, being forced out by the debts contracted during the great crises were displaced by the implantation of large-scale farming.

This century saw the emergence of a powerful upward trend in prices which finally justified the massive changes required by French agriculture. The progressive reduction followed by elimination of the cycles which had characterized the two previous centuries stands witness to positive impact of high prices. Production progressed slowly but progressed nonetheless. Accelerated clearing after 1760 gave access to new land[89]. Perhaps

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[88]Labrousse (1970b:368)

[89]Labrousse (1970c:418-434)

more importantly, the proportion of land resting fallow was diminishing allowing a more efficient utilization of existing areas. As a result, output was finally beginning to win the race with population growth, marking the end of the brutal malthusian adjustments.

Market integration also meant the installation of trade channels facilitating exchange. A first notable reduction in crises' intensity was immediately observed following the big wave of road development after 1750. The construction, initially for strategic purposes of the *route royale* contributed much to the reduction of delays involved[90]. Somewhat less favored by State attention, the building of canals unifying the various waterways also played a major role. However, the single most powerful impact would be obtained with the introduction of the railroad during the nineteenth[91]. The victory on climatic and geographic conditions it implied meant the true integration of the wheat market. Through its reduction of freight costs, 'foreign' sources were finally incorporated into a unified national system of exchanges. By the last quarter of the nineteenth century, the fluctuations of wheat prices had at last taken a modern amplitude.

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[90]Labrousse (1970e:695); Léon and Carrière (1970:176-178)

[91]Labrousse (1970e:695) and for an account of the Indian experience, see Hurd (1975).

Appendix 1: The Chow Test.

The use of the Chow test is warranted whenever it is suspected that two or more definite trends or influences are present in the data. In other words, whenever we want to know whether a single model can be applied to apparently different data sets. Hence, for instance, the test is particularly useful to determine whether we may pool time series with cross-section data[92].

The application is straightforward. It boils down to testing the null hypothesis that the two (or more) regressions are identical in which case a single model may be used instead of data segmentation. Therefore, the annual (non-crisis) average prices series was separated into two series: 1) 1520-1600 covering 62 observations and, 2) from 1601 to 1698 with 80 observations. Then, the following equations were fitted:

1) $\ln P_{t1} = \beta_{01} + \beta_{11} t1 + \beta_{21} t1^2 + \mu_{t1}$,
with t1 corresponding to 1520-1600

2) $\ln P_{t2} = \beta_{02} + \beta_{12} t2 + \beta_{22} t2^2 + \mu_{t2}$,
with t2 corresponding to 1601-1698

yielding the corresponding sum of squares of the residual: $ESS_1 = 0.0735$ and $ESS_2 = 0.0399$ which may be summed to give the unrestricted sum: $ESS_{ur} = ESS_1 + ESS_2 = 0.1124$

The restricted sum of squares ESS_r is simply the sum obtained from the estimation of the single polynomial $\ln P_t = \beta_0 + \beta_1 t + \beta_2 t^2 + \mu_t$ with data covering the entire period 1520 to 1698 and which was found to be equal to 0.0717.

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[92] Pindyck and Rubinfeld (1981:123-24 and ch.9)

The final step is simply to compute the F statistic to determine the significance of the difference between the two sum of squares. The F statistic with 3 parameters and (62+80)-(2*3) degrees of freedom is given by:

$$F_{3,136} = \frac{(ESS_r - ESS_{ur})/3}{ESS_{ur}/136}$$

which, in the present case, gave a negative value equal to -16.46. This figure being less than the critical value $F_{3,136} = 3.0$ at the 5% significance level, we cannot reject the null hypothesis that the two regressions are identical. Therefore the use of a single regression is warranted.

Appendix 2: Seasonal Adjustment.

The seasonal indices used in this thesis were computed using the technique outlined in Pindyck and Rubinfeld (1981: 487-89), a simplified version of the Census II method from the Bureau of the Census of the U.S. Department of Commerce which , as of 1981, was the standard seasonal adjustment used in the U.S..

Using the monthly data found in Baulant and Meuvret (1960) corresponding to the prices recorded on the first market of each month in the *Mercuriales*, a twelve-month centered moving average was applied to remove the irregular component remaining in the non-crisis years data. The use of this horizontal smoothing also eliminates the seasonal element and leaves the data with only its long-term secular trend and cyclical components. Therefore, by dividing the original monthly figures by the smoothed observations, or:

$$\frac{L \times C \times S \times I}{L \times C} = S \times I = Z_t$$

we are left with Z_t a measure corresponding to the seasonal and irregular elements S x I.

Then, with data regrouped by months, we take the mean value of S x I to eliminate finally the irregular component. We obtain 12 average values of Z_t which will sum to 12 if no secular trend is still present in the data. To eliminate any remaining long-term influences, we simply normalize by dividing each seasonal index by the sum obtained and by multiplying by 12.

Appendix 3: Size of the Carryover.

McCloskey and Nash (1984) estimated that, assuming that the distribution of (gross) output is normal with an average value of 100 and a standard deviation of 35, we may calculate the average waiting time between famines to be 22 years, if we set the starvation level at 50 and a carryover of only 5%. Therefore, the medieval England levels of carryovers would have to be less than this figure as evidenced by the frequence of food shortages which occurred every 10 to 15 years.

What was done was therefore to follow the inverse sequence and to compute the average size of the carryover corresponding to a 15 and 10 years waiting time. Hence, in the case of the 15 years interval, we may say that:

$$1/15 = 0.0667 = \text{prob}(Q_t \leq 50)$$

where Q_t is the level of production. To the starvation level of 50 correspond the average level of output, the size of the carryover as well as the standard deviation of 35 such that:

$$\begin{aligned} 0.0667 &= \text{prob}(Q_t \leq [E(Q_t) + E(\text{car.})] - \sigma_Q \times Z = 50) \\ &= \text{prob}(Q_t \leq 100 + E(\text{car.}) - 35 \times Z = 50) \end{aligned}$$

Associated to the probability of 1/15, we observe a critical value Z of 1.5 for which we then find that the average size of the carryover corresponding to a level of production of 100 and a waiting time of 15 years is given by:

$$\begin{aligned} E(\text{car.}) &= [(35 \times 1.5) + 50] - 100 \\ &= 102.5 - 100 = 2.5\% \end{aligned}$$

Similarly, for a waiting period of 10 years, the average carryover is equal to -5.2% which represents the average annual deficiency over consumption needs to be accommodated by purchases on the grain markets.

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