Essays on Trade Liberalisation and Resource Misallocation in Indian Manufacturing

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Abstract

This thesis is composed of three empirical studies that provide novel insights and explanations to understand the effect of trade liberalisation on resource misallocation in the Indian manufacturing.

The first essay explores whether the pro-competitive effects of trade improve resource allocation in an economy with underlying domestic distortions. In the 1990s, India significantly reduced trade restrictions but maintained substantial factor market distortions, like effective input subsidies to some exporters. Using plant-level cross-sectional data, I find that the decline in output tariffs generally improved within-industry resource allocation. However, in the most distorted industries, persistent distortions weakened the positive impact of liberalisation. This adverse outcome indicates that trade reforms faced a second-best environment, wherein pre-reform trade protection-induced distortions counteracted the negative effects of underlying factor market distortions. I conclude that removing such distortions via trade liberalisation can be detrimental to allocative efficiency without commensurate factor market reforms. While the first essay does not differentiate between continuing and exiting plants, the second essay conducts a longitudinal analysis of continuing plants to examine the asymmetric effects of trade reforms on plant efficiency and size. By comparing plants with varying levels of pre-reform trade protection-induced distortions, I find that trade liberalisation increased input utilisation and output for plants that are relatively undersized due to these distortions. This indicates that trade reforms primarily stimulated growth in initially undersized plants, thereby improving allocation and productivity. The third essay extends this analysis by focusing on exiting plants within the same longitudinal sample, evaluating the impact of trade reforms on plant exit and resource misallocation. I find that plants tending to be oversized due to trade protection-induced distortions are more likely to exit post-reform. Further analysis suggests that this exit potentially reduces the dispersion of distortions, thereby improving resource allocation within the industry.

Abrégé

Cette thèse est composée de trois études empiriques qui fournissent de nouvelles informations et explications pour comprendre l'effet de la libéralisation du commerce sur la mauvaise allocation des ressources dans le secteur manufacturier indien.

Le premier essai explore si les effets pro-concurrentiels du commerce améliorent l'allocation des ressources dans une économie marquée par des distorsions internes sous-jacentes. Dans les années 1990, l'Inde a considérablement réduit ses restrictions commerciales, mais a maintenu d'importantes distorsions du marché des facteurs, comme des subventions effectives aux intrants accordées à certains exportateurs. En utilisant des données transversales au niveau des usines, je constate que la baisse des tarifs de production a généralement amélioré l'allocation des ressources au sein de l'industrie. Toutefois, dans les secteurs les plus touchés, des distorsions persistantes ont affaibli l'impact positif de la libéralisation. Ce résultat défavorable indique que les réformes commerciales ont été confrontées à un environnement de second choix, dans lequel les distorsions induites par la protection commerciale avant la réforme ont neutralisé les effets négatifs des distorsions sous-jacentes du marché des facteurs. Je conclus que la suppression de ces distorsions via la libéralisation des échanges peut être préjudiciable à l'efficacité de la répartition des ressources sans réformes du marché à facteurs proportionnels. Bien que le premier essai ne fasse pas de distinction entre les usines en activité et celles qui le quittent, le deuxième essai effectue une analyse longitudinale des usines en activité pour examiner les effets asymétriques des réformes commerciales sur l'efficacité et la taille des usines. En comparant les usines présentant différents niveaux de distorsions induites par la protection commerciale avant la réforme, je constate que la libéralisation des échanges a accru l'utilisation des intrants et la production des usines qui sont relativement sous-dimensionnées en raison de ces distorsions. Cela indique que les réformes commerciales ont principalement stimulé

la croissance dans des usines initialement sous-dimensionnées, améliorant ainsi l'allocation et la productivité. Le troisième essai étend cette analyse en se concentrant sur les usines qui quittent l'usine au sein du même échantillon longitudinal, évaluant l'impact des réformes commerciales sur la sortie d'usines et la mauvaise allocation des ressources. Je trouve que les usines qui ont tendance à être surdimensionnées en raison des distorsions induites par la protection commerciale sont plus susceptibles de disparaître après la réforme. Une analyse plus approfondie suggère que cette sortie réduit potentiellement la dispersion des distorsions, améliorant ainsi l'allocation des ressources au sein du secteur.

Contribution of Author

This thesis contains three essays and I am the sole author of all essays.

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Contribution to Original Knowledge

Critics of trade liberalisation argue that opening up to international trade might not necessarily improve resource allocation in developing economies plagued by other underlying distortions, such as subsidies and market inefficiencies. This skepticism is illustrated by India's experience in the 1990s. Despite significant economic reforms that reduced trade barriers and increased global integration, there was minimal improvement in input allocation across plants. Persistent domestic distortions, such as subsidies that artificially lower input costs for some plants or regulatory barriers that hinder market entry, continue to influence resource allocation. This may dampen the potential benefits of trade liberalisation, raising concerns that simply opening up markets to foreign competition is insufficient for improving allocative efficiency without addressing these deeper structural issues.

This thesis comprises three empirical studies examining the impact of trade liberalisation on resource misallocation in the Indian manufacturing sector. The first essay addresses the puzzling observation that despite substantial economic growth in India since the mid-1990s, there has been essentially no improvement in the efficiency of input allocation across plants. It explores whether the pro-competitive effects of trade improve resource allocation in an economy with domestic distortions, through the lens of second-best economic theory. This theory suggests that removing one distortion while others persist may not enhance efficiency. I argue that reducing trade barriers generally improves resource allocation within industries by exposing domestic plants to foreign competition. However, the persistence of domestic distortions, specifically, India's Export-Oriented Unit (EOU) scheme that provided factor input subsidies to select exporters, has dampened some of the gains of liberalisation. These distortions not only persisted throughout the liberalisation process but also counteracted the effect of pre-reform trade protection-induced distortions, thereby undermining the post-reform improvement in allocative efficiency.

Using a standard misallocation framework, I demonstrate in the first essay that trade liberalisation can lead to improved resource allocation by reducing tariff-induced distortions when input markets are distortion-free. However, if input markets are distorted for other reasons, the impact of trade liberalisation on misallocation depends on the correlation between trade protection-induced distortions and input distortions. As observed in India, if trade protection-induced distortions counteract other domestic distortions, then trade liberalisation without accompanying reforms in factor markets can adversely affect resource allocation. This situation arises due to positively correlated distortions in the pre-reform period: plants benefiting from effective input subsidies tend to expand, yet these same plants also benefit from trade protection, which grants them market power and incentivises the reduction in production scale. With trade liberalisation, the removal of tariff-induced distortions that previously offset input distortions can lead to overproduction by subsidised plants, thereby worsening misallocation of resources. Empirical analysis using cross-sectional plant-level data from the Indian Annual Survey of Industries (ASI) from 1989-2016 validates these theoretical predictions. While the decline in output tariffs generally improved resource allocation, this positive impact was less pronounced in industries with significant EOU input distortions.

Consistent with recent economic theory, the first essay posits that the pro-competitive effect of trade should have been the primary channel for improving misallocation. Pre-liberalisation, some plants benefited significantly from protectionist policies like high tariffs, allowing them to maintain high markups, thereby distorting output levels. These plants often operated below optimal scale, leading to inefficient resource allocation. Post-liberalisation, economic theory suggests that tariff reductions should have changed this dynamic. Increased competition from foreign imports puts pressure on domestic plants to lower their markups. This pressure is particularly acute for plants that previously enjoyed high markups under protection. Thus, these plants at the upper end of the trade protection-induced markup distortion should have experienced the steepest markup declines after reforms, prompting substantial production scale expansions. This pro-competitive effect should have led to a compression in markup dispersion, narrowing the efficiency gap between plants. As a result, we expect to see a heterogeneous impact of trade liberalisation on plant-level distortions, with plants initially characterised by high markups experiencing a disproportionate increase in their input utilisation and output compared to others. A plant-level investigation of this varied effect is conducted in the second essay.

While the first essay employs cross-sectional survey data and does not differentiate between continuing and exiting plants, the second essay conducts a longitudinal analysis focusing exclusively on continuing plants to investigate the hypothesis of the pro-competitive effect. Using a balanced panel dataset from 1998 to 2016, I examine pre- and post-reform plant behaviour to assess how liberalisation differentially impacted plant-level distortions and whether this translated into improved input use and output production across plants. The analysis suggests that liberalisation disproportionately reduced distortions for plants with higher pre-reform trade protection-induced distortions, which had previously rendered them undersized. This resulted in increased input utilisation and output production. Therefore, the reduction in misallocation linked to trade liberalisation primarily reflects improvements in plants that were relatively undersized in the pre-reform period due to trade protection-induced markup distortions.

In contrast to the second essay, which assesses plants that are relatively undersized due to trade protection-induced distortions, the third essay shifts focus to plants that tend to be oversized as a result of these distortions. It extends the longitudinal analysis by examining exiting plants from 1999 to 2016. The hypothesis tested is whether trade liberalisation induced the exit of plants that were disproportionately large due to the trade protection-induced markup distortions. Economic theory suggests that as competition increases, some plants may find it difficult to stay profitable and may close down. When trade barriers are high, plants with low markups can still be marginally profitable due to their modest markups. However, as trade protection decreases, these plants must lower their markups even more to stay competitive, gradually eroding their profitability. As a result, the closure of these plants reallocates resources from low-markup to high-markup plants, potentially reducing the variation in plant-level distortions and improving resource allocation. Using a panel dataset, I find that lower trade barriers amplify the role of plant-level distortions in shaping plant selection, with plants that tend to be oversized showing a greater likelihood of exiting. This mechanism of plant selection provides another perspective on how trade liberalisation can alleviate resource misallocation.

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1. Introduction

A widely researched area in economics focuses on understanding why some countries are richer and grow faster than others. A consensus in the development literature has emerged where the large variations in income per capita across countries can be accounted for by differences in total factor productivity (TFP).[1]

A key insight from studies on economic growth is that inefficiencies in resource allocation at the micro level can show up as a reduction in TFP at a more aggregated level (Banerjee and Duflo [2005], Restuccia and Rogerson [2008], and Hsieh and Klenow [2009]). Thus, TFP can be broken down into two main components. The first component focuses on average plant-level productivity, capturing how efficiently output is produced given the inputs. This aspect is crucial for determining the overall productivity of an economy, as it reflects the efficiency with which plants[2] operate. The second component focuses on how efficiently inputs are allocated across plants of different productivities. This involves assessing how well resources such as labour and capital are distributed across plants within the industry. Both components are essential for understanding aggregate productivity differences between countries. For advanced economies, the ability to innovate and improve plant-level productivity is often a key driver of economic performance. In contrast, for developing countries, the focus tends to be on improving the allocation of inputs to enhance productivity. In these contexts, factors such as institutional quality, market efficiency, and policies that facilitate better resource allocation play a significant role in driving economic growth.

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[1] Early works include Klenow and Rodriguez-Clare [1997], Prescott [1998], and Hall and Jones [1999]. For further discussion, see the surveys by Caselli [2005] and Jones [2016].

[2] For the purpose of this study, plants and firms are synonymous.

Addressing policy-induced distortions would help to reduce resource misallocation and improve aggregate productivity (Restuccia and Rogerson [2017]). Cross-plant input misallocation refers to the dispersion in marginal revenue products (MRP) of inputs across plants, indicating potential gains from reallocating inputs from low MRP plants to high MRP plants. A widely used summary measure of misallocation is the dispersion in total factor revenue productivity (TFPR) across plants, typically within an industry. In the context of India, evidence indicates substantial misallocation of inputs, presumably due to distortionary policies and other structural barriers. Hsieh and Klenow [2009] find significant misallocation in China and India relative to the United States, estimating that eliminating misallocation to achieve US efficiency levels could improve manufacturing productivity in India by approximately 40-60 percent.

This thesis aims to understand how the Indian trade reforms have shaped resource misallocation in the manufacturing sector, taking into consideration the presence of other distortions unaffected by trade policy changes. Between 1991 and 2000, India experienced a significant reduction in both tariff and non-tariff trade barriers, with average output tariffs on manufactured goods decreasing from 95% to 35%. Recent research (Edmond et al. [2015]) suggests that a more open economy can mitigate the detrimental effects of domestic market distortions, particularly those driven by excessive markups due to insufficient competition. These markups function as output distortions: plants operating with high markups tend to be undersized relative to those with lower markups, leading to inefficient resource allocation across plants. Opening the economy to foreign competition forces hitherto dominant plants to lower their markups to remain competitive, thus alleviating misallocation induced by markup heterogeneity. Quantitative models, as studied by Edmond et al. [2015], Arkolakis et al. [2018], and others, show that trade liberalisation significantly reduces distortions due to variable markups and improves resource allocation.

Based on this reasoning, one would expect significant gains in India from trade liberalisation. However, evidence suggests that the aggregate effects on misallocation were muted during this period (Bils et al. [2021]). My primary hypothesis is that India's trade reforms were implemented without addressing other pre-existing distortions unrelated to the exercise of domestic market power. Specifically, I identify the Export Oriented Unit (EOU) scheme, which provided (and still continues to provide) subsidies for capital goods and raw materials to exporters in certain industries, as a key underlying distortion that persisted throughout the liberalisation process. Consistent with my main hypothesis, theoretical models, such as those by Bai et al. [2024] also suggest that trade liberalisation amidst persistent market distortions can worsen allocative efficiency by encouraging subsidised plants to expand. This argument implies that if trade liberalisation faces a second-best setting, removing trade barriers may worsen resource misallocation by disproportionately benefiting plants with significant pre-existing market distortions.

The empirical research on the impact of trade reforms on resource misallocation has been limited.[3] Chapter 2 contributes to the literature by empirically examining how persistent distortions, like the EOU scheme, influenced the outcomes of India's trade liberalisation. I argue that trade liberalisation in India occurred within a second-best environment, wherein these reforms produced unintended adverse effects on resource allocation. Using a standard Hsieh and Klenow [2009] misallocation framework, I show that reducing trade barriers, which alleviates trade protection-induced output distortions, leads to better resource allocation when there are no persistent input market distortions. However, in the presence of other underlying distortions, the effect of trade liberalisation depends on how distortions induced by market power relate to the other distortions in the cross-section of plants. If high market power plants also benefit from other distortions before the reform, then trade liberalisation can actually exacerbate misallocation. In this scenario, the output distortions induced by the high markups faced by EOU plants were counteracting the production scale effects of their input subsidies. As trade protection decreases, this counteracting effect diminishes, allowing the effect of input subsidies to dominate, which contribute to overproduction and thereby limit the reduction in misallocation.

To evaluate whether this second-best mechanism resulted in a muted improvement in misallocation, I analyse data from the Indian Annual Survey of Industries (ASI), which covers all formal manufacturing plants over the period 1989-2016. The cross-sectional plant-level data reveals that

[3] The literature has documented improvements in average plant-level productivity following tariff reductions, yet it often overlooks the issue of misallocation. See Holmes and Schmitz [2010] and Melitz and Redding [2014] for a discussion of the literature on trade barriers and productivity gains.

the decline in output tariffs led to an overall improvement in within-industry resource allocation in India. However, in industries characterised by persistent distortions, the presence of EOUs did dampen the positive impact of liberalisation, consistent with my hypothesis. To further substantiate this, I measure plant-level distortions and indeed find a positive correlation between distortions induced by pre-reform trade protection and those induced by EOUs. This indicates that plants with high pre-reform market power also benefited from EOU input subsidies. These findings highlight that removing distortions via trade liberalisation can be detrimental to allocative efficiency without corresponding factor market reforms.

Building on this evidence, Chapter 3 conducts a longitudinal analysis to investigate whether trade liberalisation reduced markup-induced distortions, as predicted by Edmond et al. [2015]. Specifically, I test the pro-competitive hypothesis, which posits that reductions in markups are predominantly observed among ex-ante high-markup plants. These plant-level markups are known to distort output levels, hindering optimal resource allocation across plants. Consequently, the pro-competitive effect triggers substantial expansions in production scales. In the context of India, where other market distortions persist, and assuming that trade protection-induced markup distortions are dominant, high-markup plants exhibit high TFPR, indicating they are undersized, while low-markup plants exhibit low TFPR, indicating they are oversized. To examine the dynamics of plant-level distortions before and after trade liberalisation, I use a balanced panel dataset spanning 1998-2016. This dataset focuses exclusively on continuing plants, unlike the cross-sectional survey in Chapter 2, which does not distinguish between continuing and exiting plants.

Using panel data methods in Chapter 3, I find that trade liberalisation did disproportionately reduce distortions for plants initially characterised by high TFPR. These plants also demonstrated notable increases in input utilisation and output production. For instance, a 10 percentage point decline in tariff rates prompted high-TFPR plants to increase output by 2.5%, wage bill by 1.61%, physical capital by 1.85%, and intermediate inputs by 4.23%, while reducing TFPR by 5.9% relative to low-TFPR plants, which experienced no significant changes. This suggests that trade liberalisation resulted in more significant expansion for high-TFPR plants than for low-TFPR plants. Consistent with theory, these findings highlight that the compression in TFPR dispersion is driven primarily by improvements in plants at the upper end of the TFPR distribution.

Chapter 4 goes beyond the previous chapters by integrating the role of plant selection, specifically examining exiting plants in the longitudinal analysis. I restrict myself to a sub-sample of Census plants that are chosen to be surveyed every year within the panel data, ensuring consistency across years and excluding other plants that maybe dropped due data collection changes year-on-year. Hsieh and Klenow [2009] highlight the role of TFPR in plant profitability and exit, showing that plants with low TFPR are more likely to exit in India. In my study, these low TFPR plants are likely those with low markups and disadvantaged by the EOU scheme and other distortions. This raises the question of whether reduced trade barriers amplify the exit of low TFPR plants, thereby reducing misallocation by reallocating resources from low TFPR to high TFPR plants. Unlike the pro-competitive channel, the selection effect aims to alleviate distortions at the lower end of the TFPR distribution by phasing out low-markup plants following tariff reductions.

The economic rationale behind plant selection posits that as competition intensifies, some plants may struggle to maintain profitability and face closure. Under high trade barriers, plants with low TFPR may sustain marginal profitability due to modest markups despite facing higher effective input costs. However, with reduced trade protection, these plants must further lower markups to compete, eroding their profitability over time. Consequently, the exit of these distorted plants reallocates resources from low to high markup plants, potentially reducing dispersion in plant-level distortions and improving resource allocation within the industry. This exit-induced misallocation effect aligns with the "Darwinian Effect" described by Baqaee et al. [2024], illustrating how reallocating resources from low to high markup plants can mitigate cross-sectional misallocation and improve overall productivity.

It is crucial to distinguish this improvement driven by the exit of low markup plants from that studied in Melitz [2003], whose trade-induced selection mechanism focuses on plant-level productivity rather than distortions. As competition intensifies, low-productivity plants exit the market, reallocating resources to high-productivity plants and thereby improving average plant-level productivity. The Melitz-selection channel enhances the first component of TFP breakdown by focusing on plant-level productivity gains. In contrast, the misallocation-selection channel improves the second component by targeting more efficient resource allocation. This channel also has the potential to enhance the first component if low TFPR plants exhibit low plant-level physical productivity, as indicated by TFPQ. Therefore, the exit of these low TFPR plants would result in a group of surviving plants that are more homogeneous, characterised by higher markups and greater productivity. This uniformity in markups improves resource allocation by reducing markup variability, while the survival of more productive plants enhances average plant-level productivity. Thus, the trade-induced dual effect of improving both components of TFP significantly contributes to an overall increase in aggregate productivity.

In Chapter 4, I examine the data to assess the impact of distortions on plant survival and find that trade liberalisation induces the exit of plants with low TFPR. This suggests that tariff reductions foster market selection by supporting the survival of relatively undersized plants (high TFPR) and the exit of relatively oversized (low TFPR) plants. I argue that the exit of low TFPR plants reduces the dispersion of both trade protection-induced and input distortions, thereby improving overall resource allocation. Revisiting the cross-sectional survey data from Chapter 2, I analyse the distribution of input and output distortions between 1989 (pre-reform) and 1999 (post-reform). I observe a significant compression in the dispersion of these distortions, driven notably by low TFPR plants for input distortions and high TFPR plants for output distortions. The former reflects the selection mechanism, while the latter underscores the predominance of the pro-competitive effect. These findings highlight that the reduction in TFPR dispersion and the subsequent enhancement in resource allocation are influenced by both pro-competitive and selection effects.

In summary, this thesis examines how trade policy changes have affected resource misallocation in the Indian manufacturing sector, focusing on three main questions: Did the pro-competitive effects of trade improve resource allocation despite the persistent market distortions unaffected by trade reforms? Did trade liberalisation disproportionately affect plants that were relatively undersized due to trade protection-induced distortions? Did reduced trade barriers result in the exit of plants that tend to be relatively oversized due to trade protection-induced distortions? These inquiries are crucial for understanding how India's economic landscape has evolved in response to trade liberalisation measures implemented in the 1990s. By examining both the pro-competitive effects of increased trade openness and the selection pressures that lead to the exit of distorted plants, this study aims to provide nuanced insights into the complex interplay between trade policy and allocative efficiency in a developing economy context.

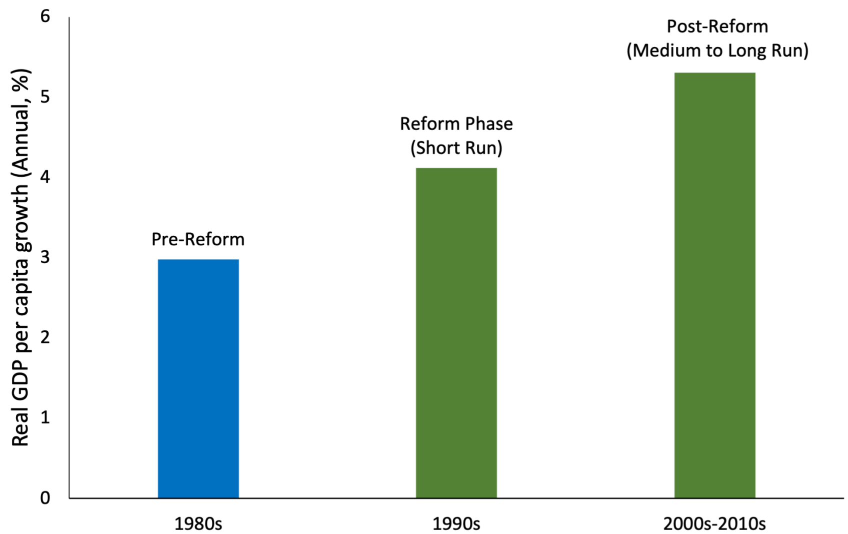
2. Trade Reform and Misallocation in a Second Best Environment

2.1 Introduction

Skeptics of trade liberalisation argue that opening up to trade may not improve resource allocation in developing economies with pervasive underlying distortions like subsidies and market inefficiencies. India's experience in the 1990s illustrates this concern. Despite considerable growth following economic reforms, India saw little to no improvement in input allocation. This paper empirically investigates the impact of trade liberalisation on resource allocation in Indian manufacturing through the lens of second-best economic theory: removing one distortion while the other persists may not be efficiency enhancing. The analysis examines whether the anticipated pro-competitive effects of trade actually improved resource allocation or if the persistent distortions muted these potential gains.

In the 1990s, the Indian government initiated a package of economic reforms that involved abandoning the previously stringent policies of industrial licensing system, foreign direct investment restrictions, and import tariffs and quotas (Joshi and Little [1996] and Ahluwalia [2002]). The reforms were followed by remarkable economic growth achievements in both the short and medium to long run. Figure 2.1 presents the average annual growth rate of real GDP per capita. In the pre-reform period, it maintained an average annual growth of about 3%. This rate surged to over 4% in the reform period and further accelerated to around 5.5% post-implementation.

Figure 2.1: Average Growth in Real GDP per capita in India



Source: Real GDP and population data from PWT 10.01, Feenstra et al. [2015].

Concurrently, there was a surprising lack of improvement in aggregate resource allocation in the Indian manufacturing sector. This paper focuses on cross-plant input misallocation, which translates into cross-plant dispersion in marginal revenue products of inputs. To gauge the extent of misallocation, a summary measure of the dispersion in plant-level revenue productivity, TFPR, is used (Hsieh and Klenow [2009]; HK, hereafter). As depicted in Figure 2.2, the data reveals that allocative efficiency in India remained relatively stagnant over time, with no discernible trend; a finding that is also reported in Bils et al. [2021].

To help understand this fact, I focus on the trade liberalisation component of India's reform package. There was a significant reduction in tariff and non-tariff barriers, with average output tariffs on manufactured goods declining from 95% to 35% between 1991 and 2000. With this dramatic decline in trade restrictions, one would naturally expect to see an improvement in resource allocation. The conventional view posits that a more open economy can mitigate the negative effects of domestic market power distortions in the product markets. High trade barriers allow plants to charge excessive markups domestically due to a lack of competition. High markup plants employ less resources than what would be desirable, while the opposite happens for those with relatively low markups. This variation in plant-level markups generates inefficient allocation of resources. Exposing domestic plants to foreign competition drives down markup-induced misallocation. Edmond et al. [2015] (EMX, hereafter) show in a quantitative model calibrated to Taiwanese firms that the pro-competitive effects of opening up to trade significantly alleviate distortions from high markups and improve resource allocation.[1]

Figure 2.2: Cross-Plant Dispersion in TFPR, 1989-2016

Source: Indian Annual Survey of Industries; missing data in 1995.

However, India's trade liberalisation measures were implemented without addressing domestic distortions in the input markets. This paper identifies India's Export Oriented Unit (EOU) scheme as a key persistent distortion that remained in place during the liberalisation process. The EOU program, initiated prior to the reforms, supports exporters through effective subsidies for capital goods and raw materials. In theory, the effect of trade liberalisation on allocative efficiency is ambiguous. Bai et al. [2024] theorise that with persistent distortions in input and output markets, trade liberalisation can induce welfare losses from increased misallocation due to endogenous

[1] Some other papers that study the effectiveness of international trade in reducing misallocation induced by markup variability are Epifani and Gancia [2011], Holmes et al. [2014], and Arkolakis et al. [2018].

selection of heavily subsidised firms into the export market. Using China as a case in point, the authors estimate a Melitz model with distortionary taxes and find trade exacerbated distortions, offsetting the conventional gains from trade. The argument posited is that, in a second-best setting, the removal of trade barriers may worsen resource misallocation by disproportionately favouring firms with higher pre-existing distortions.

Despite considerable interest in the effects of trade policy, there has been limited empirical research into its impact on resource misallocation. This paper is among the first attempts to shed light on the role of trade reforms in shaping misallocation with a focus on India. Building on the theoretical groundwork of Bai et al. [2024], I contribute to the ongoing discourse by providing a nuanced understanding of how the presence of a specific distortionary policy, like the EOU scheme, can influence the outcomes of trade liberalisation efforts in developing economies. I argue that India's trade reforms faced a second-best environment and produced unintended consequences that reduced the effect of a successful liberalisation.

Using a standard HK misallocation framework, I illustrate that reducing trade barriers, which alleviate output distortions induced by protectionist policies, leads to a better allocation of resources when input markets are distortion-free. However, when input markets are distorted, the impact of trade liberalisation depends on the correlation between the prevailing domestic distortions. Trade liberalisation can exacerbate misallocation if output and input distortions are positively correlated before reform. In this case, trade protection-induced output distortions faced by the EOU plants counteract the distortions of their input subsidies, creating a second-best environment. This counteracting effect diminishes as trade protection declines. Now the EOU input subsidies dominate and induce overproduction, thereby dampening the improvement in misallocation.

I empirically test and confirm the qualitative predictions of the model with data from Indian manufacturing plants. Using cross-sectional plant-level data from 1989 to 2016, I find that the decline in output tariffs led to an overall improvement in within-industry resource allocation in India. However, in the most distorted industries, the mere presence of EOUs dampened the positive impact of liberalisation. This adverse outcome is consistent with a second-best environment. To confirm this hypothesis, I measure distortions at the plant-level and find that the trade protection-induced distortions indeed compensated for the EOU-induced distortions in the pre-reform period. The findings highlight how interactions between targeted interventions and economy-wide reforms can modulate the impact of trade liberalisation in developing countries.

This paper complements the recent work analysing the impact of other Indian economic reforms on resource misallocation. Treating the policy changes as natural experiments, other studies have looked at episodes of reforms in areas like industrial licensing (Chari [2011]); reservation laws (Garcia-Santana and Pijoan-Mas [2014]), deregulation (Alfaro and Chari [2014]); FDI liberalisation (Bau and Matray [2023]). The findings from their micro-level empirical research suggest that the specific reform initiatives in India have improved allocative efficiency by reducing misallocation of resources across plants.

The chapter is structured as follows: Section 2.2 outlines India's trade policy. Section 2.3 presents the HK model to illustrate a second-best setting, where trade is liberalised in the presence of other market distortions. Section 2.4 sketches the theoretical framework of EMX, to help understand how trade liberalisation disproportionately exposes previously dominant plants to increased competitive pressure, resulting in heterogeneous changes in their markups and output distortions. Section 2.5 details the empirical methodology, data, and discusses the results. Section 2.6 analyses plant-level distortions in line with the theoretical predictions of the HK model. Section 2.7 concludes.

2.2 Indian Trade Policy

In the 1990s, India reformed trade policies to reduce trade barriers and minimise distortions. However, the government continued its pre-existing distortionary support to exporters during this period.

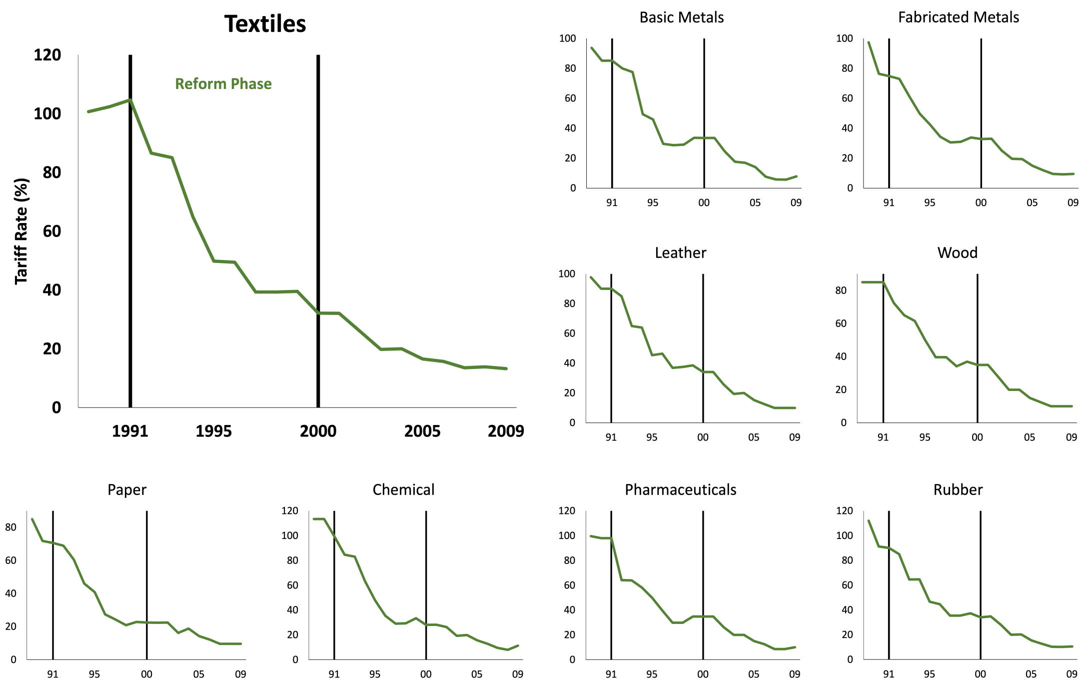
2.2.1 Trade Liberalisation (1990s -)

Prior to 1991, India's approach to development emphasised self-sufficiency and import substitution, with a significant amount of government intervention in the economy. Compared to other Asian countries, India had one of the most prohibitive trade policies, with nominal tariffs over 100% in the manufacturing sector. In addition to high tariffs, there was a range of restrictive non-tariff barriers, including quantitative restrictions on imports, a complex licensing system, and a complete ban on import of certain goods.

In August 1991, due to various economic challenges, including a severe balance of payments crisis, India introduced a set of trade policy changes as part of the IMF adjustment program. A key objective of the new trade policy was to reduce government regulations on domestic industries and increase external trade. To achieve this, the import licensing system on nearly all intermediate inputs and capital goods was abolished. The number of products requiring import licenses decreased from 87% in 1990 to 15% by 1997; only 31 items remained under full import licensing by 2000. The percentage of imports under canalisation also decreased from 87% in 1990 to less than 10% by 2000. Furthermore, the number of products subject to quantitative restrictions on imports decreased from over 2,700 items in 1990 to 600 items in 2000. By March 1996, more than 6,000 tariff lines had been made free; this number had risen to over 8,000 by March 2000.

This period of pro-market policy is associated with a more open trade policy that focused on a substantial reduction in output tariffs. Tariffs differed greatly across industries in 1989, but were lowered and standardised during the 1990s. The average output tariff rate for manufactured goods decreased from 95% to 35% between 1991 and 2000. Figure 2.3 presents the evolution of tariffs in select manufacturing industries, which is representative of the overall trend of a sharp decline in output tariffs over the 1990s; the two vertical bars indicate the period where majority of the reduction took place. The liberalisation process was consolidated but was executed cautiously and slowly. India demonstrated a continued commitment to liberalise trade post the Eighth Five Year Plan (1992-1997) by further reducing barriers and trade restrictions. Although the pace slowed, the decline in output tariffs continued until 2009, after which it became relatively stable. For more information on India's trade liberalisation period, see Panagariya [2005] and Das [2016].

Figure 2.3: Average Tariff Rates in the Indian Manufacturing Sector, NIC-08 2-Digit



Source: World Integrated Trade Solutions and Ahsan and Mitra (2014)

The nature of India's trade liberalisation effectively addresses concerns regarding internal factors influencing the trade policy. To begin with, the timing of the trade reform was unexpected and externally imposed by the IMF. This swift and unanticipated implementation prevented the reforms from attracting attention on the political front (Varshney [1999]). Furthermore, Topalova [2007] finds no evidence to support the notion that tariff changes were correlated with pre-reform industry characteristics such as wages, the number of employees, or industrial concentration. These findings indicate that the trade reforms were not influenced in favour of specific industries.

2.2.2 Export Oriented Units (1980s -)

In the 1980s, the focus of India's economic policy gradually moved towards export-led growth and the maintenance of foreign exchange reserves. The government established export promotional institutes and implemented various export promotion measures to encourage exports. One of the notable export promotion schemes was the creation of Export Oriented Units (EOUs) in 1981. This scheme continued to operate, with minor amendments, throughout and after the liberalisation process.

The EOUs are industrial units that export more than 50% of their production.[2] The EOU Scheme was launched to enhance the competitiveness of Indian exports in terms of both quality and cost. To achieve this goal, the scheme offered several fiscal and non-fiscal incentives and benefits to EOUs. The units were exempt from customs and excise duties on capital goods and raw materials that were imported. Additionally, EOUs were reimbursed for Central Sales Tax (CST) paid on domestically procured items and the duty paid on fuel obtained from domestic oil companies. The units did not require import licenses and industrial licenses for items reserved for Small Scale Industries (SSI). Even the goods appearing in the restricted list of the Export-Import (EXIM) Policy were permitted to be imported by EOUs.

For eligibility under this scheme, a minimum investment of Rs. 10 million in plant and machinery (P&M) was mandatory. Upon initial approval and registration, EOUs were granted a period of 5 years to avail the benefits. However, to maintain registration and continuity of the benefits, these units were required to maintain positive net foreign exchange earnings and meet the minimum export performance criteria outlined in the EXIM policy. These units are authorised and overseen by the Development Commissioners of Seven Central Government Special Economic Zones (SEZs). The EOU scheme is governed by the provisions of Chapter VI in the Foreign Trade Policy (FTP) and the relevant Handbook of Procedures (HBP) that are regularly issued by the government.

The significance of the EOU scheme is underscored by the substantial growth in the share of EOU exports in the country's total exports, rising from 1.4% in 1984-85 to 5.3% by 1990-91. During the late 1980s, EOUs exhibited remarkable export growth rates, ranging from 40-50% year-on-year,

[2] Although EOUs are generally obliged to export their entire production, the supervising authority may allow these units to sell a part of the production (not exceeding 50% of the free-on-board value of their exports) on the domestic market. This permission is granted to units with a positive net foreign exchange standing.

much higher than overall export growth. This rapid expansion of EOUs and exports during the 1980s highlights the EOU scheme's pivotal role as a strategic policy initiative.

2.3 Plant-Level Distortions and Misallocation

The pro-competitive theory suggests that trade liberalisation can improve resource allocation. Now, I discuss how the presence of other market distortions can mitigate these positive effects.

2.3.1 Economic Environment

To illustrate how a second-best environment can arise and the consequent effect of trade liberalisation on resource misallocation, I use the theoretical framework proposed by HK to model and measure misallocation. I consider an economy with S manufacturing industries. In industry-s, there are M_s plants that produce differentiated intermediate goods in a monopolistically competitive market. In addition to differing in their productivity, I assume that plants potentially face different output, capital, and raw material distortion. The output distortion captures the EMX markup distortion, and the input distortions capture the other market distortions (namely, the EOU scheme).

Industry output, Y_s, is a CES aggregate of M_s differentiated products in industry-s:

$$Y_s = \left(\sum_{i=1}^{M_s} Y_{si}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} \tag{2.1}$$

The production function for each differentiated product, Y_{si}, is given by a Cobb-Douglas function of plant TFP, capital, labour, and raw materials.

$$Y_{si} = A_{si} K_{si}^{\alpha_{k_s}} L_{si}^{\alpha_{l_s}} M_{si}^{\alpha_{m_s}} \tag{2.2}$$

The production function exhibits constant returns to scale, where $\alpha_{m_s} = 1 - \alpha_{k_s} - \alpha_{l_s}$. The output elasticities, α, are industry-specific, but common across plants within an industry.

Given the inverse demand function from the industry level, $P_{si} = P_s Y_s^{\frac{1}{\sigma}} Y_{si}^{-\frac{1}{\sigma}}$, each plant-$i$ in industry-s maximises current profits, where $P_{si}Y_{si}$ is the revenue, and w, r, and p_m are the per unit cost of factor input which are assumed to be the same across all plants:

$$\pi_{si} = (1 - \tau_{y_{si}})P_{si}Y_{si} - wL_{si} - (1 - \tau_{k_{si}})rK_{si} - (1 - \tau_{m_{si}})p_m M_{si} \tag{2.3}$$

Trade protection-induced distortion: The term $\tau_{y_{si}}$ is a plant-specific implicit output tax that reduces the plant's revenue. A high output tax drives the plants to operate below the optimal scale. This output tax reflects plant-specific markups induced by market power in the product market, which are higher in plants having greater market share and lower demand elasticity (EMX). As a result, high markup plants produce too little compared to the optimal level. This markup-induced production scale effect is captured by the plant's response to a higher output tax, aligning with the description in Edmond et al. [2023]. Therefore, plants benefiting more from foreign competition and able to charge higher markups will show a higher value for $\tau_{y_{si}}$. Hence, the "output tax" here is directly linked to import tariffs (indicative of trade protection) and plant-level markups.

For the purpose of this section, $\tau_{y_{si}}$ is treated as exogenous and will be directly measured in the data. I assume that all plants face a uniform baseline demand elasticity (σ), setting a common theoretical markup. This reflects market power from market differentiation within the manufacturing sector. The plant-specific component of trade protection-induced markups is captured in $\tau_{y_{si}}$. To provide a better understanding, Section 2.4 sketches the EMX framework of trade protection-induced markup heterogeneity that is captured by this plant specific distortion.

EOU-induced distortion: Establishments face plant-specific implicit input subsidies, $\tau_{k_{si}}$ and $\tau_{m_{si}}$. These input distortions capture the government support provided to EOU plants for capital goods and raw materials, respectively. By the design of the EOU scheme, plants which receive capital subsidies also receive raw material subsidies. Subsidised, and thus lower, input costs imply that these plants face high values of $\tau_{k_{si}}$ and $\tau_{m_{si}}$. As they benefit from cheaper inputs, the EOU distortion drives the plants to exceed their optimal scale of production.

The plant-specific distortions drive wedges between the marginal revenue product of inputs (MRP) across plants. The MRP of capital is proportional to the revenue-capital ratio:

$$MRPK_{si} \triangleq \alpha_{k_s} \frac{\sigma - 1}{\sigma} \frac{P_{si} Y_{si}}{K_{si}} = r \frac{1 - \tau_{k_{si}}}{1 - \tau_{y_{si}}} \tag{2.4}$$

The MRP of labour is proportional to the revenue per worker:

$$MRPL_{si} \triangleq \alpha_{l_s} \frac{\sigma - 1}{\sigma} \frac{P_{si} Y_{si}}{L_{si}} = w \frac{1}{1 - \tau_{y_{si}}} \tag{2.5}$$

The MRP of raw materials is proportional to the revenue-material ratio:

$$MRPM_{si} \triangleq \alpha_{m_s} \frac{\sigma - 1}{\sigma} \frac{P_{si} Y_{si}}{M_{si}} = p_m \frac{1 - \tau_{m_{si}}}{1 - \tau_{y_{si}}} \tag{2.6}$$

2.3.2 Resource Misallocation

The plant's revenue productivity, $TFPR_{si}$, can be written as follows:

$$TFPR_{si} \triangleq P_{si} A_{si} = \frac{P_{si} Y_{si}}{K_{si}^{\alpha_{k_s}} L_{si}^{\alpha_{l_s}} M_{si}^{\alpha_{m_s}}} \tag{2.7}$$

From the first-order conditions, it can be shown that plant TFPR is proportional to a geometric average of the plant's MRPs, and is thus indicative of distortions:

$$TFPR_{si} \propto (MRPK_{si})^{\alpha_{k_s}} (MRPL_{si})^{\alpha_{l_s}} (MRPM_{si})^{\alpha_{m_s}} \propto \frac{(1 - \tau_{k_{si}})^{\alpha_{k_s}} (1 - \tau_{m_{si}})^{\alpha_{m_s}}}{1 - \tau_{y_{si}}} \tag{2.8}$$

A high plant TFPR is a sign that the plant faces taxes that raise its marginal revenue products, rendering the plant smaller than optimal. Conversely, plants receiving subsidies exhibit a low TFPR, indicating that they tend to be oversized. Notice that what matters is the net distortion, which could be low even if there are high gross distortions. For instance, if a plant faces both an input subsidy and an output tax, the distortions may offset each other and the plant may not be inefficiently sized.

When $\tau_{y_{si}}$, $\tau_{k_{si}}$, and $\tau_{m_{si}}$ are all zero, TFPR must be the same for all plants, despite differences in physical productivity, A_{si}. In the absence of distortions, more inputs would be allocated to plants with higher A_{si} until their higher output results in a lower price and the exact same TFPR as the other plants. The more productive plant faces a lower price exactly in proportion to its higher productivity.

The extent of misallocation can be summarised by the standard measure, variance of log TFPR, expressed as:

$$\mathbf{V} \equiv Var(lnTFPR_{si}) = Var[\alpha_{k_s} ln(1-\tau_{k_{si}}) + \alpha_{m_s} ln(1-\tau_{m_{si}}) - ln(1-\tau_{y_{si}})] \tag{2.9}$$

Intuitively, resource misallocation is worse when there is greater dispersion in marginal revenue products. The first two terms on the right-hand side of Equation 2.9 give the capital and raw material distortion, while the third term gives the influence of output distortion on misallocation. Let the variance of $ln(1-\tau_{k_{si}})$, $ln(1-\tau_{m_{si}})$, and $ln(1-\tau_{y_{si}})$ be denoted by σ_k^2, σ_m^2, and σ_y^2, respectively, and their correlation[3] by ρ_{ky}, ρ_{my}, and ρ_{km}. Then,

$$\mathbf{V} = \alpha_{k_s}^2 \sigma_k^2 + \alpha_{m_s}^2 \sigma_m^2 + \sigma_y^2 + 2\left(\alpha_{k_s}\alpha_{m_s}\rho_{km}\sigma_k\sigma_m - \alpha_{k_s}\rho_{ky}\sigma_k\sigma_y - \alpha_{m_s}\rho_{my}\sigma_m\sigma_y\right) \tag{2.10}$$

Equation 2.10 highlights that the indicator of resource misallocation is a function of moments of the distribution of distortions. It is influenced by how dispersed the distortions are, as well as how they correlate with one another.

2.3.3 Trade Liberalisation

The policy experiment in India involves lowering trade barriers while keeping the support of input subsidies unaltered. EMX argue that trade liberalisation would lead to a compression in markup dispersion across plants. This is because the hitherto dominant plants, who charged relatively high markups, are forced to dramatically reduce their markups to remain competitive. This narrowing of markup differences among domestic plants reduces the overall dispersion in markups. Consequently, trade liberalisation results in a decrease in the dispersion of output distortion, σ_y, without affecting σ_k and σ_m.

[3] The variance of TFPR depends on the variances of the distortions and their covariance. The covariance, in turn, depends on the standard deviation of the distortions and the correlation between them. The expansion of the covariance component is depicted in the last three terms on the right-hand side of Equation 2.10.

Case I: Without EOU scheme. In industries that do not have plants registered under the EOU scheme, the model follows the assumption of $\sigma_k = 0$ and $\sigma_m = 0$. Although this assumption may not completely reflect real-world conditions where input distortions can arise from other factors as well, I make this simplification to argue the role of the EOU policy. Thus, the plants in this industry only face the output distortion. Then, from Equation 2.10:

$$\mathbf{V} \;=\; \sigma_y^2 \tag{2.11}$$

Trade liberalisation leads to an unambiguous reduction in resource misallocation in industries without EOU plants. This suggests that opening up to trade in the absence of input market distortions will lead to an improvement in the allocation of resources.

Case II: With EOU scheme. Industries wherein some plants are registered under the EOU scheme, the industry faces both input and output distortion. As the EOU scheme remained unchanged during the reform phase, I assume that $\sigma_k = \overline{\sigma}_k$ and $\sigma_m = \overline{\sigma}_m$. In the presence of input distortions, the extent of resource misallocation is influenced not only by the dispersion of distortions but also by the correlation between the distortions. Equation 2.10 can be written as:

$$\mathbf{V} \;=\; \kappa + \; \sigma_y^2 \; - 2\,\sigma_y\left(\rho_{ky}\alpha_{k_s}\overline{\sigma}_k \;+\; \rho_{my}\alpha_{m_s}\overline{\sigma}_m\right) \tag{2.12}$$

where $\kappa = \alpha_{k_s}^2\overline{\sigma}_k^2 + \alpha_{m_s}^2\overline{\sigma}_m^2 + 2\alpha_{k_s}\alpha_{m_s}(\rho_{km}\overline{\sigma}_k\overline{\sigma}_m)$, the component that is invariant to trade liberalisation. To assess the misallocation effects of reducing trade protection-induced output distortions in the presence of pre-existing input market distortions, it is crucial to consider the relationship between the distortions before liberalisation. The design of the EOU scheme indicates that there exists a positive correlation between distortions affecting capital and those affecting raw materials, denoted as $\rho_{km} > 0$. However, the correlation between the input and output distortion, i.e., ρ_{ky} and ρ_{my}, is unknown and could have varying implications. If trade channels resources towards lesser distorted firms, it can improve allocative efficiency. Conversely, if trade disproportionately favours plants with higher gross distortions, it can exacerbate misallocation.

Scenario 1: Amplifying Scale Distortions. If the EOU input distortion is negatively correlated with the trade protection distortion, we have ρ_{ky}, $\rho_{my} < 0$ in Equation 2.12. A negative correlation between the distortions suggests that plants experiencing a higher output tax distortion in the pre-reform period faced a lower input subsidy distortion. The relatively high output tax leads plants to operate below the optimal production level, similar to the production scale induced by higher input prices from a lack of subsidies. The piling up of these production scale effects make the plants severely undersized. Post-liberalisation, while the input distortions persist, the reduced trade protection-induced output distortion allowed these plants to expand and produce closer to their optimal scale. This post-reform effect reduces the severity of the pre-existing higher effective input prices, and leads to an unambiguous improvement in resource allocation.

Scenario 2: Counteracting Scale Distortions. If the EOU input distortion is positively correlated with the output distortion, we have ρ_{ky}, $\rho_{my} > 0$ in Equation 2.12. This indicates that, before liberalisation, EOU plants that received input subsidies also enjoyed greater market power and faced higher output taxes. While the input subsidies enabled the plants to expand beyond the optimal scale, the trade protection-induced output distortion counteracted this by shrinking production. This created a second-best environment in the pre-reform period, where the production scale effect from the output and input distortions partially offset each other.

However, this counteracting effect from output tax diminishes in the post-reform period. The increase in foreign competition reduces the trade protection-induced output distortions, alleviating the problem of underproduction. Continuing to provide input subsidies to these plants now leads them to be severely oversized. As a result, the distortions in input allocation become dominant in the post-reform period, leading to either the dampening of the improvement in resource allocation or a potential exacerbation of misallocation.

Given the theoretical ambiguity, I use data from the Indian manufacturing plants to empirically investigate the effect of trade reforms in the presence of pre-existing input market distortions. The analysis proceeds in two steps to validate the predictions of the HK framework: First, I find evidence consistent with a second-best environment, wherein the presence of EOUs adversely affect misallocation; Second, I confirm this hypothesis by measuring plant-level distortions and examining their correlation. The key variable of interest in this analysis is the interaction of the trade protection policy and the EOU scheme. The existence and magnitude of this correlation would lead to different outcomes for the policy's effectiveness.

2.4 Understanding the Heterogeneity in Output Distortion

This section sketches the framework of trade protection-induced markup heterogeneity that is captured in the plant-specific output distortion, $\tau_{y_{si}}$, in the HK model. The goal is to understand the variability in these distortions. I discuss the theoretical underpinnings of the trade protection-induced misallocation channel, summarising key aspects from EMX's fully specified model, which features variable markups that respond differently to changes in trade protection policies. The EMX framework describes how trade liberalisation improves resource allocation by reducing markup heterogeneity.

Setup: Consider a static world economy comprising two identical countries, Home (H) and Foreign (F). There is a single factor of production, labour, that is inelastic in supply and immobile between countries. Each industry within these countries has N_s plants, where plant-i in industry-s produces output using labour, denoted as $Y_{si} = A_{si}L_{si}$, where A_{si} is the productivity. The countries engage in trade, where there are costs associated with shipping goods between countries, represented by an iceberg trade cost $\tau \geq 1$. This cost implies τY_{si}^F of the output must be shipped by foreign plants to receive Y_{si}^F in Home markets.

In terms of market structure, plants within each industry compete in a Cournot framework, where each firm decides its output in response to competitors' outputs in the same industry. In the domestic market, plants maximise profits given the wage rate, w, and demand conditions, characterised by a demand system that reflects consumer preferences across industries and goods. The model incorporates elasticities of substitution (γ across plants within industries and θ across industries, where $\gamma > \theta$) to capture how consumers' preferences and production decisions respond to changes in prices and costs.

EMX show that the solution to the plant's problem is characterised by a price that is a markup over marginal cost:

$$P_{si}^{H} = \frac{\epsilon_{si}^{H}}{\epsilon_{si}^{H} - 1} \frac{w}{A_{si}} \tag{2.13}$$

where $\epsilon_{si}^{H} > 1$ is the demand elasticity faced by the plant in its domestic market. With the nested-CES demand system and Cournot competition, this demand elasticity is a weighted harmonic average of the underlying elasticities of substitution, γ and θ. Specifically:

$$\epsilon_{si}^{H} = \left(\omega_{si}^{H} \frac{1}{\theta} + (1 - \omega_{si}^{H}) \frac{1}{\gamma} \right)^{-1} \tag{2.14}$$

where $\omega_{si}^{H} \in [0, 1]$ is the plant's share of sectoral revenue in its domestic market. The Home plant's domestic market share is given by:

$$\omega_{si}^{H} = \frac{P_{si}^{H} Y_{si}^{H}}{\sum_{i=1}^{N_s} P_{si}^{H} Y_{si}^{H} + \tau \sum_{i=1}^{N_s} P_{si}^{F} Y_{si}^{F}} \tag{2.15}$$

These domestic market shares are affected by the iceberg trade cost (τ), thereby influencing a plant's markup. Equation 2.14 indicates a linear relationship between a plant's inverse markup and its market share, expressed as:

$$\frac{1}{\mu_{si}^{H}} = 1 - \frac{1}{\gamma} - \left(\frac{1}{\theta} - \frac{1}{\gamma} \right) \omega_{si}^{H} \tag{2.16}$$

where $\mu_{si}^{H} = \frac{\epsilon_{si}^{H}}{\epsilon_{si}^{H} - 1}$ denotes the plant's gross markup from Equation 2.13. Since $\gamma > \theta$, the coefficient on the market share ω_{si}^{H} is negative. This implies that plants with relatively high market shares (higher A_{si}) have low demand elasticity and charge higher markups.[4] The variation in markup among plants depends on both the gap between θ and γ and the dispersion of market shares.

Markup-induced Misallocation: In this model, variable markups are a source of misallocation. Revenue productivity can be written as:

[4] The first-order condition of EMX yields: $MRPL_{si} = \mu_{si} w$. Combining this with the first-order condition of the HK model, as in Equation 2.6, we obtain $\tau_{y_{si}} = 1 - \frac{\overline{\mu}}{\mu_{si}}$, where $\overline{\mu}$ can be thought of as the baseline theoretical markup σ in HK model. According to EMX, plants with a larger market share have markups μ_{si} greater than the baseline markup $\overline{\mu}$, resulting in a higher output tax, $\tau_{y_{si}}$.

$$TFPR_{si}^{H} = P_{si}^{H} A_{si} = \mu_{si}^{H} w \tag{2.17}$$

Plants with higher market share charge higher markups, resulting in higher TFPR, which signals that they are operating below their efficient size. This effect mirrors what a high $\tau_{y_{si}}$ would do to a plant's TFPR. Conversely, plants with a smaller market share will charge lower markups and exhibit lower TFPR, suggesting they are oversized, similar to a plant facing a low $\tau_{y_{si}}$.

Trade Liberalisation, Markups, and Misallocation: Equation 2.15 illustrates that reducing τ (trade liberalisation) disproportionately affects previously dominant plants in the EMX model. This direct effect is predominant: the heightened "neck-to-neck" competition from foreign plants that comes with liberalisation causes dominant firms to lose a larger share of the market compared to others. Consequently, their domestic market share ω_{si}^{H} diminishes significantly, resulting in a notable decline in markups for these dominant players.

Furthermore, the trade-induced heterogeneous reduction in markups results in varying effects on TFPR, with the most significant decline observed in ex-ante high TFPR (markup) plants. This highlights the nuanced and differential impact of trade liberalisation on plants based on their pre-liberalisation market shares and markups. The non-proportional change in markups following trade reform is what drives the reduction in markup dispersion, which translates into a compression in TFPR dispersion. This implies improved efficiencies in resource allocation in the post-reform period, as resources are reallocated towards more productive uses, enhancing overall economic performance and competitiveness.

The conceptual framework outlined in this section provides the theoretical foundation to understand the dynamics of trade protection-induced misallocation, highlighting the role of variable markups, market structure, and distortions in resource allocation. This theoretical basis is captured in the plant-specific output distortions in the HK model (Section 2.3), which consequently change with trade policy adjustments. I have applied the EMX concepts to a specific economic environment in HK to illustrate how trade liberalisation interacts with pre-existing distortions to influence resource misallocation. This paper utilises the HK model for empirical investigations in the subsequent sections to understand the complex relationship between trade policy, underlying market distortions, and economic efficiency.

2.5 Trade Policy and Misallocation: Cross-Sector Evidence

I now empirically investigate the effect of trade liberalisation on resource misallocation, particularly considering the role of pre-existing input market distortions that remain unchanged by trade policy changes. The focal point of this analysis is the interaction between the trade reform and the EOU input subsidy scheme.

2.5.1 Empirical Framework

The empirical strategy exploits India's externally-imposed trade reforms to study the impact of tariff reductions on misallocation. The econometric specification pools plants within an industry and year. The baseline regression takes the following form:

$$sd[ln(TFPR_i)]_{st} = \gamma_t + \eta_s + \beta_1 TR_{st-1} + \beta_2' \mathbf{X}_{st} + \epsilon_{st} \tag{2.18}$$

where $sd[ln(TFPR_i)]_{st}$ is the dispersion of $ln(TFPR_i)$[5] in industry-s in year-t; TR_{st-1} is a measure of lagged tariff rate at the 3–digit National Industrial Classification (NIC) level; and $\mathbf{X}_{st}$ is a set of industry characteristics, including the industry size (denoted by average employment) and the share of state-owned enterprises (SOEs). γ_t is a set of year dummies and η_s are the industry fixed effects. I use nominal output tariffs as my measure of trade protection to reflect the level of import penetration and the subsequent competitive pressure. The estimation employs lagged, instead of current, tariffs to address the possibility of a potential delay in plants' response to the trade reform. The inclusion of industry fixed effects accounts for unobserved industry-specific

[5] $TFPR_{si}$ is calculated as outlined in Equation 2.7. In the absence of distortions, revenue factor shares of output would be proportional to the parameters $\alpha_{k_s}, \alpha_{l_s}, \alpha_{m_s}$ in a market characterised by monopolistic competition. However, due to distortions in Indian factor markets, the revenue shares may not provide an unbiased estimation of these parameters. Consequently, distinguishing between resource misallocation and parameter bias becomes challenging in the presence of distortions. Following the approach of HK, I incorporate US factor shares into my analysis under the assumption that factor markets in the US experience fewer distortions compared to those in India, and the technology used in both countries' industries remains consistent.

heterogeneity in the determinants of misallocation, including the influence of political economy factors, provided these factors remain relatively stable over time. Year dummies are included to control for macroeconomic shocks that affect all plants uniformly. The magnitude and sign of the coefficient on lagged tariff rate is of particular interest. With the decline in trade protection expected to reduce the market power of plants and improve resource allocation, the hypothesis is that a reduction in output tariffs will decrease misallocation, implying $\beta_1 > 0$.

Regression specification in Equation (2.18) describes the overall effect of the decline in output tariffs on within-industry misallocation. To understand how this effect is shaped by the presence of pre-existing distortions in the input markets (EOUs), I estimate the following equation:

$$sd[ln(TFPR_i)]_{st} = \gamma_t + \eta_s + \beta_1 TR_{st-1} + \beta_2 EOU_{st} + \beta_3 TR_{st-1} \times \ EOU_{st} + \beta_4' \mathbf{X}_{st} + \epsilon_{st} \quad (2.19)$$

where EOU_{st} is a dummy that takes the value of 1 if the industry has an EOU plant. The coefficient β_2 tells us the marginal effect of EOUs on misallocation, whereas the coefficient β_3 reveals how the reduction in tariff rates affects misallocation in industries with EOUs. A negative and significant coefficient on the interaction term, β_3, would suggest that misallocation is adversely impacted following the reduction in output tariffs in EOU industries. β_1 indicates the impact of liberalisation on industries without EOU plants, while $\beta_1 + \beta_3$ represents the average overall effect of liberalisation on within-industry misallocation.

2.5.2 Plant-Level Data

I employ data on Indian manufacturing plants from the Indian Annual Survey of Industries (ASI). The period covered is from 1989-90 to 2016-17, with the exception of fiscal year 1995–1996 where no survey was conducted. This data set of repeated cross-sectional surveys is collected by the Indian government's Central Statistical Office (CSO) and has been extensively used in the macro-development literature (HK, Jagadeesh [2009], Chari [2011], and others). In all cases, the survey is undertaken from April of a given year through March of the following year; I reference the surveys by the earlier of the two years covered. Industries are grouped using India's NIC code, which is closely related to the International Standard of Industrial Classification (ISIC) codes.

The ASI is a nationally representative survey of formal manufacturing plants in India. The coverage includes plants with at least 10 workers using power, and plants with at least 20 workers not using power. Plants fall into two categories: Census and Sample. Census plants are surveyed every year, while Sample plants are surveyed randomly every year and include plants that are not a part of the census component. Manufacturing activity undertaken in the informal sector is not covered by the ASI. The variables of interest are the plant's industry code, gross output, labour compensation, employees, capital, and intermediate inputs.

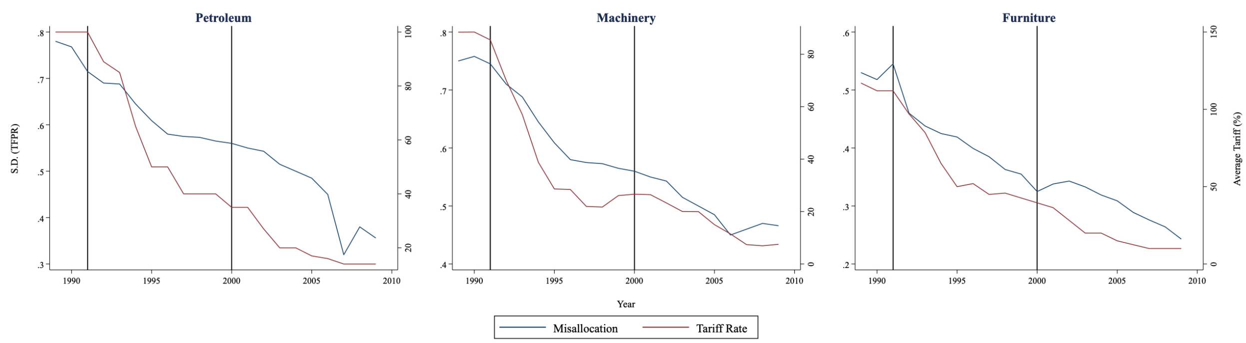
I construct gross output as the sum of shipments, changes in finished and semi-finished good inventories, and other revenues. I construct labour costs as the sum of wages, salaries, bonuses, and supplemental labour costs. The measure of labour is computed as the average number of personnel in the plant over the year. Capital is constructed as the average of the opening and closing book value of fixed assets (net of depreciation). Intermediate inputs are the sum of materials, fuels, and other expenditures. I restrict the sample to plants that have non-missing and positive values for quantitative variables. Official sampling weights are used in all calculations. Appendix Section 2.8.1 provides more details about the data and variable construction.

Plant-level data is supplemented with yearly output tariff data at the six-digit level of the Indian Trade Classification Harmonized System (HS) code. Tariff data for 1989-1995 is from Ahsan and Mitra [2014], while data for the period of 1996-2016 is obtained from World Integrated Trade Solutions (WITS). Plants in the ASI database are classified based on 3-digit NIC codes, whereas the tariff data is available in HS code. To enable matching trade data with plant-level data, Debroy and Santhanam [1993] have provided a document that links the HS code items with the 3-digit NIC code. The matching has been carried out for over 5,000 product lines to calculate the average industry-level output tariffs.

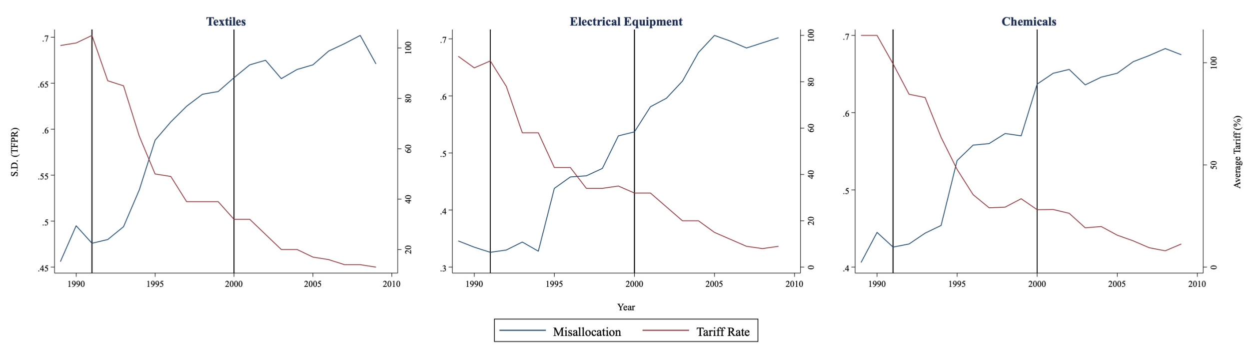
Information about the EOUs is gathered from secondary data sources. I rely on various ministry notifications and records from both central and state governments. Additionally, relevant information is sourced from the official websites of Special Economic Zones (SEZs) and annual reports of the Ministry of Commerce and Industry and Reserve Bank of India (RBI). However, due to data limitations, the specific identification of EOU plants is not possible. Therefore, the focus is on collecting textual data that indicates whether an industry has an EOU plant.

With the compiled dataset, I now investigate the impact of India's trade liberalisation on within-industry resource misallocation. Figure 2.4 provides a useful visualisation by plotting the declining tariff rates against the dispersion of plant revenue productivity (TFPR) over time in the two types of industries. Panel (A) depicts the industries without EOU plants. In the early 1990s, tariffs were substantially high at around 100%, coinciding with higher misallocation as indicated by greater dispersion in plant revenue productivity. As tariff rates declined steadily, misallocation also fell as seen by the convergence in TFPR across plants. Thus, in industries without EOU input distortions, lowering trade barriers improved allocative efficiency.

Figure 2.4: Tariff Rates and Misallocation



(A) Sample industries without EOUs



(B) Sample industries with EOUs

In contrast, Panel (B) illustrates the trends for industries with EOU presence. While tariffs followed a similar downward trajectory as in Panel (A), misallocation persisted and TFPR dispersion increased. This unintended outcome highlights a potential dampening of the trade liberalisation effects in the presence of input market distortions, where reducing tariffs and associated output distortions did not alleviate misallocation. With this motivating visualisation, I conduct the regression analysis to systematically estimate the overall and heterogeneous effects of tariff reduction on within-industry misallocation.

2.5.3 Main Results

I now examine the link between tariff reduction and misallocation. If trade liberalisation is associated with an improvement in resource allocation, then the dispersion in TFPR will decline with the reduction in tariff rates. Results of the regression analysis are reported in Table 2.1.

Column (1) presents the overall effect of trade liberalisation from the baseline regression (equation 2.18). Tariffs are measured in fractional terms; therefore, the positive and statistically significant coefficient on the tariff rate indicates that a 10 percentage point decline in output tariffs leads to about 0.55% reduction in misallocation. This suggests that trade liberalisation had an overall favourable impact on within-industry resource misallocation. When we consider this improvement resulting from trade liberalisation alongside the lack of trend in the aggregate measure of resource misallocation (HK and Bils et al. [2021]), my findings suggest the presence of additional factors that potentially influenced and dampened the improvement in aggregate resource allocation. These factors may have acted as a counterforce on allocative efficiency, with trade liberalisation helping to alleviate their negative effects.

Column (2) reports the heterogeneous effects of trade liberalisation in the presence of the EOU scheme. When focusing exclusively on the liberalisation effect in industries without EOU plants, the coefficient on tariff rates remains positive and statistically significant. This aligns with the expectation that trade liberalisation would decrease the variation in markups by subjecting Indian plants to increased competition from foreign counterparts. Consequently, in an environment without input market distortions, the compression in markup dispersion would reduce misallocation caused by inefficiently high markups in the pre-reform period.

Table 2.1: Trade Liberalisation and Misallocation: Overall and Partial Effects

Std. Dev. of TFPR	(1)	(2)
TR_{st-1}	0.071***	0.083***
	(0.018)	(0.013)
EOU_{st}		0.089***
		(0.016)
$TR_{st-1} \times \ EOU_{st}$		-0.050***
		(0.015)
Share of SOEs	0.062***	0.069***
	(0.011)	(0.027)
Employment	-0.041**	-0.048**
	(0.015)	(0.021)
N	1,485	1,485
R-squared	0.098	0.116
Industry FEs	Yes	Yes
Year FEs	Yes	Yes

Note: The dependent variable is the standard deviation of $log(TFPR)$. TR_{st-1} is the lagged output tariff. EOU$_{st}$ equals 1 if the industry has an EOU plant. Standard errors are in parentheses. ***, **, and * are statistically significant at 1%, 5%, and 10% levels, respectively. All regressions include industry and year fixed effects.

Conversely, I find the coefficient on the interaction term of tariff rate to be negative and statistically significant. This implies that in industries with EOU plants, the targeted input subsidies distort the allocation of resources when the economy opens to trade. This outcome lends support to the second-best theory studied in Bai et al. [2024]. The government support scheme may have exacerbated resource misallocation by providing an additional incentive to subsidised plants to expand. Thus, the impact of trade liberalisation on misallocation differs across industries, depending on whether they face domestic distortions in the input markets. Although the overall average effect of these diverse impacts is positive, it is evident that the EOU scheme dampens the improvement in resource allocation. Furthermore, the findings indicate that industries with EOUs encounter higher level of misallocation compared to those without EOUs. This result can be attributed to other discriminatory government support available for industries catering to the export market.

In both specifications, I find that resource allocation improves with the diminishing proportion of state-owned plants. This is in line with the literature, which highlights how publicly owned plants tend to be significantly less efficient compared to the private sector (Majumdar [1998] and Shirley and Walsh [2000]). State-owned plants in India often benefit from political connections and favourable policies. Consequently, the argument arises that state ownership of plants distorts the allocation of resources in the economy. HK estimate that marginal factor productivity of SOEs in India is at least 30% lower than that of private enterprises. Additionally, the results indicate that misallocation worsens as the average plant size reduces. A potential explanation could be the lack of access to credit amongst small plants and the consequent financial constraints they face. The literature, including Buera et al. [2011] and Cao et al. [2023], has examined how a firm's ability (or inability) to access credit can result in resource misallocation.

2.5.4 Robustness Checks

In this subsection, I discuss a variety of robustness checks that are performed to validate the heterogeneous effect of trade reforms on misallocation, as found above.

2.5.4.1 Average Impact of Trade Policy and State Characteristics

A concern arises that the heterogeneity in regression coefficients presented in Table 2.1 might be influenced by the specific conditions under which the plants operate. Factors such as geographical location, level of financial development, and institutional factors within the state where plants are situated could potentially impact resource allocation. To investigate this, I initially categorise plants based on the state classifications outlined in Table 2.2 and compute the misallocation measure for each subgroup. I then estimate regression Equation 2.19 separately for each subgroup.

Table 2.2: State Classification by Characteristics

Geography		Credit per Capita, 1991		Labour Laws	
Coastal	Land-Locked	Above Median	Below Median	Pro-Employer	Neutral/Pro-Worker
Andhra Pradesh	Assam	Andhra Pradesh	Assam	Andhra Pradesh	Assam
Daman & Diu	Bihar	Chandigarh	Bihar	Karnataka	Bihar
Dadra & Nagar Haveli	Chandigarh	Daman & Diu	Dadra & Nagar Haveli	Kerala	Gujarat
Goa	Chattisgarh	Goa	Madhya Pradesh	Madhya Pradesh	Assam
Gujarat	Delhi	Gujarat	Nagaland	Rajasthan	Jammu & Kashmir
Karnataka	Haryana	Haryana	Odisha	Tamil Nadu	Maharashtra
Kerala	Himachal Pradesh	Himachal Pradesh	Rajasthan		Odisha
Maharashtra	Jammu & Kashmir	Jammu & Kashmir	Uttar Pradesh		Punjab
Odisha	Jharkhand	Karnataka			Uttar Pradesh
Puducherry	Madhya Pradesh	Kerala			West Bengal
Tamil Nadu	Nagaland	Maharashtra			
West Bengal	Punjab	Puducherry			
	Rajasthan	Punjab			
	Uttar Pradesh	Tamil Nadu			
	Uttrakhand	West Bengal			

Source: Financial status is compiled from RBI reports; Labour Laws classified by Besley and Burgess [2004].

First, I investigate whether the geographical location of the industry could account for the differential impact of the trade reform. Trade liberalisation might not result in a substantial increase in competition in land-locked regions compared to coastal regions. This difference could be attributed to variations in market integration and access to internationally traded goods between coastal and inland regions. Despite the geographical differences, as seen in columns (1) - (2) of Table 2.3, the point estimates remain relatively consistent, affirming that the distinct effects of the trade reform are attributable to the EOU scheme.

Next, I examine the level of financial development in each state, measured by credit per capita in 1991. States with credit levels above the median are considered to have a high level of financial development. Financial development is expected to play a role in mitigating misallocation, as better access to sufficient credit would mean investment in more efficient technologies and survival in the face of foreign competition. Plants in regions with less developed financial markets before the reform may struggle to respond effectively to competitive pressure, leading to a deterioration in allocative efficiency. As reported in columns (3) - (4) of Table 2.3, I find no discernible impact of financial development on the plant's response to trade liberalisation.

Finally, I explore the influence of institutions, specifically indicated by the labour laws governing each state. Diverse regulations and restrictions are likely to result in varying responses of plants to the trade reforms. The categorisation by Besley and Burgess [2004] divides Indian states into those with pro-worker, neutral, or pro-employer labour laws. Interestingly, the heterogeneous effect of trade liberalisation on misallocation remains virtually unchanged. These results, presented in columns (5) - (6) of Table 2.3, align with HK's findings that there is no significant correlation between TFPR dispersion and labor market regulations in India.

Table 2.3: Trade Liberalisation and Misallocation: Average Impact

	(1)	(2)	(3)	(4)	(5)	(6)
Std. Dev. of TFPR	Coastal	Land-Locked	High Financial Dev.	Low Financial Dev.	Pro-Employer	Neutral/Pro-Worker
TR_{st-1}	0.081***	0.069***	0.048***	0.076***	0.071***	0.082***
	(0.004)	(0.005)	(0.002)	(0.014)	(0.012)	(0.016)
EOU_{st}	0.077**	0.155**	0.095***	0.082***	0.069***	0.093***
	(0.012)	(0.014)	(0.006)	(0.009)	(0.010)	(0.021)
$TR_{st-1} \times EOU_{st}$	-0.032**	-0.049**	-0.051***	-0.038***	-0.036**	-0.057**
	(0.011)	(0.007)	(0.003)	(0.010)	(0.008)	(0.005)
N	1,231	1,370	943	1,370	1,310	1,370
R-squared	0.083	0.081	0.154	0.097	0.104	0.078
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry FEs	Yes	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes

Note: The dependent variable is the standard deviation of $log(TFPR)$. TR_{st-1} is the lagged output tariff. EOU$_{st}$ equals 1 if the industry has an EOU plant. Each column reports results from the sub-sample of the state characteristic. Standard errors are in parentheses. ***, **, and * are statistically significant at 1%, 5%, and 10% levels, respectively. All regressions include size, share of state-owned enterprises, and industry and year fixed effects.

2.5.4.2 Parameter Values

In the presence of input market distortions, distinguishing between resource misallocation and parameter bias becomes challenging. To mitigate this issue, I applied the approach proposed by

HK, which incorporates U.S. input shares in the baseline results. However, the assumption that both India and the U.S. use the same technology may be questionable. Given this, I proceed cautiously and check the results using Indian values. The findings reported in columns (1) - (2) of Table 2.11 in Appendix Section 2.8.2 are qualitatively similar.

2.5.4.3 Winsorising Outliers

While it is not possible to completely eliminate arbitrary measurement errors that may arise from inaccuracies in reporting, I address the potential influence of outliers on the results. To do this, I winsorise 5% of the extreme observations, as opposed to 1% in the baseline analysis. I then evaluate the effect of this adjustment on the outcomes. The results, presented in columns (3) - (4) of Table 2.11 in Appendix Section 2.8.2, demonstrate that the estimates remain consistent with those obtained in the original analysis.

2.5.4.4 Increase in Functional EOUs

After 1999, there was a notable growth in the number of operational EOUs in the Indian manufacturing sector. However, due to insufficient information in the available data, it's not feasible to identify specific plants registered as EOUs within each industry. In order to explore how the results are influenced by the number of EOUs within an industry, I conduct the analysis focusing on the sub-period 2000 to 2016. The findings, presented in columns (5) - (6) of Table 2.11 in Appendix Section 2.8.2, reveal that the effect of trade liberalisation remained qualitatively similar; though the estimated interaction coefficient on tariff rates in industries with EOUs is slightly higher during this sub-period. This suggests that EOUs may have dampened the improvement to a slightly greater extent in these particular industries.

2.5.4.5 Alternative Measure of Trade Protection

Import volume serves as a consistent measure for indicating the relative openness of industries and the evolution of trade protection over time. By directly reflecting the actual quantity of goods entering a country, it can also capture the effect of lower non-tariff barriers. Examining the trade flow data, this measure provides valuable insights into the magnitude of import competition in domestic industries. I employ this alternative trade protection measure in the regression analysis and find qualitatively similar results, as shown in Table 2.12 in Appendix Section 2.8.2.

2.5.5 Trade Liberalisation and Concurrent Reforms

The 1991 trade liberalisation policy was initiated as part of a package of economic reforms, including foreign direct investment (FDI) liberalisation, de-reservation of small-scale industry (SSI), and de-licensing. These reforms were designed to enhance efficiency and domestic competition within the manufacturing industry, with the potential to alleviate resource misallocation. If the decline in output tariffs over time and across industries is linked with the implementation of these other reforms, the empirical approach employed might incorrectly attribute the effect of these concurrent reforms to the trade liberalisation policy. I create a dataset to control for the simultaneous pro-competitive reforms at the industry level, consisting of industry-specific measures as follows:

FDI Liberalisation. The 1991 foreign investment policy lifted the 40% foreign equity cap, allowing automatic clearance for up to 51% foreign equity in industries previously reserved for domestic players. To represent FDI openness, I define a variable "FDI" that takes a value of 1 where FDI was permitted up to 51%, and a value of 0 otherwise. The measure is based on publications of the Government of India's Handbook of Industrial Statistics.

De-reservation of SSI. In 1997, the de-reservation policy removed the exclusivity of SSI production in certain product categories, thereby allowing larger companies and foreign investors to enter. Using de-reservation data from Ministry of Micro, Small & Medium Enterprises, I construct "SSI" that is equal to 1 if a product in the industry has been de-reserved, and 0 if not.

De-licensing. Before 1991, a complex industrial licensing system required government permits for establishing or expanding businesses, effectively constraining entry of new plants and limiting competition. The delicensing of industries facilitated market entry and business operations by reducing government interference. The variable "LIC" is defined as in Aghion et al. [2008], and takes the value of 1 if the licensing requirement was removed for any product in the industry, and a value of 0 otherwise.

Table 2.4: Trade Liberalisation and Misallocation: Simultaneous Industrial Policies

Std. Dev. of TFPR	(1)	(2)	(3)	(4)
TR_{st-1}	0.051***	0.060***	0.058***	0.063***
	(0.013)	(0.017)	(0.016)	(0.012)
FDI_{st-1}	-0.048***			-0.058***
	(0.010)			(0.014)
SSI_{st-1}		-0.061***		-0.069***
		(0.012)		(0.011)
LIC_{st-1}			-0.037***	-0.029**
			(0.008)	(0.008)
$TR_{st-1} \times FDI_{st-1}$				0.043***
				(0.016)
$TR_{st-1} \times SSI_{st-1}$				0.035**
				(0.014)
$TR_{st-1} \times LIC_{st-1}$				0.028**
				(0.013)
N	1,485	1,485	1,485	1,485
R-squared	0.102	0.111	0.125	0.116
Controls	Yes	Yes	Yes	Yes
Industry FEs	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes

Note: The dependent variable is the standard deviation of $log(TFPR)$. TR_{st-1} is the lagged output tariff. FDI$_{st-1}$ equals 1 if foreign direct investment up to 51% was allowed in the industry. SSI_{st-1} equals 1 if product de-reservation occurred within the industry. LIC_{st-1} equals 1 if licensing requirements were abolished in the industry. Standard errors are in parentheses. ***, **, and * are statistically significant at 1%, 5%, and 10% levels, respectively. All regressions include size, share of state-owned enterprises, and industry and year fixed effects.

The results presented in column (1) - (3) of Table 2.4 demonstrate the overall impact of trade liberalisation on within-industry resource misallocation, with controls for the concurrent reforms.

While the introduction of domestic competition through other reforms understandably reduced misallocation, my findings suggest that trade liberalisation independently contributed to alleviating resource misallocation in the manufacturing sector. In column (4), I explore the interaction between the trade reform and other reforms to examine if these policies worked in tandem. The data indicates that there may be significant complementarity between different industrial policies. The effect of trade reforms appears to be strengthened when foreign direct investment was permitted, and restrictive licensing and reservation requirements were eliminated.

2.5.6 Trade Liberalisation and Domestic Competition

To examine the effects of trade protection and competition, I investigate whether the impact of liberalisation is more pronounced on resource misallocation in industries with lower degrees of pre-reform competition. Because of the potential influence of liberalisation on competitiveness, I assess the level of competition in the initial year of study, 1989. To measure competition, I use the pre-reform Herfindahl-Hirschman Index (HHI), defined as the sum of squared market shares of plants. The variable "HHI" is assigned a value of 1 if the index is above the cross-industry average in 1989. I regress my measure of misallocation on tariffs, the competition metric, and the interaction between tariffs and this metric.

A higher HHI implies a lower degree of competition and increased market control, potentially leading to higher markups at the plant-level. Therefore, the underlying hypothesis is that industries with a higher pre-reform HHI value face greater misallocation resulting from increased market power. The results presented in Table 2.5 indicate that the influence of liberalisation on resource misallocation is more pronounced in industries with weaker competitive conditions in the pre-reform period. This is because the increase in foreign competition resulting from lower trade barriers has a greater potential to diminish the market power of previously dominant plants in these industries. Consequently, this leads to a significant improvement in allocative efficiency, particularly within industries with higher levels of market concentration.

Table 2.5: Trade Liberalisation and Misallocation: Domestic Competition

Std. Dev. of TFPR	(1)
$TR_{st-1} \times \ HHI_{s,89}$	0.064***
	(0.013)
TR_{st-1}	0.042***
	(0.011)
N	1,485
R-squared	0.178
Controls	Yes
Industry FEs	Yes
Year FEs	Yes

Note: The dependent variable is the standard deviation of $log(TFPR)$. TR_{st-1} is the lagged output tariff. $HHI_{s,98}$ takes the values of 1 if Herfindahl-Hirschman Index in 1989 is above the average across industries. Standard errors are in parentheses. ***, **, and * are statistically significant at 1%, 5%, and 10% levels, respectively. All regressions include size, share of state-owned enterprises, and industry and year fixed effects.

2.5.7 Trade Liberalisation and Long Run Effect

Overall, the results strongly corroborate the notion that trade liberalisation is associated with increased allocative efficiency within-industry. To assess the long-term impact of this policy, I run baseline regression specification (Equation 2.18), by replacing TR_{st-1} with TR_{st-j} where $j \in (1, 4)$. I isolate the effect of each specific lag to determine how tariffs from different years (one year ago, two years ago, etc.) individually impact misallocation. The results reported in Table 2.6 show a sustained, long-term reduction in misallocation within the industry in response to declining tariffs over the preceding years. The gradual decrease in the coefficient values from TR_{st-1} to TR_{st-4} (column (1) to column (4)) indicates that while the most substantial effects of trade liberalisation on reducing misallocation occur in the short term, the benefits persist over time, albeit at a diminishing rate.

Table 2.6: Trade Liberalisation and Misallocation: Lagged Effects

Std. Dev. of TFPR	(1)	(2)	(3)	(4)	(5)
TR_{st-1}	0.055***				0.068***
	(0.021)				(0.019)
TR_{st-2}		0.064***			0.071***
		(0.018)			(0.021)
TR_{st-3}			0.049***		0.043***
			(0.013)		(0.017)
TR_{st-4}				0.022**	0.019**
				(0.010)	(0.009)
N	1,485	1,430	1,375	1,320	1,320
R-squared	0.122	0.131	0.096	0.083	0.081
Controls	Yes	Yes	Yes	Yes	Yes
Industry FEs	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes

Note: The dependent variable is the standard deviation of $log(TFPR)$. The independent variable is lagged output tariff, TR_{st-j}, where $j \in (1, 4)$. Standard errors are in parentheses. ***, **, and * are statistically significant at 1%, 5%, and 10% levels, respectively. All regressions include size, share of state-owned enterprises, and industry and year fixed effects.

Furthermore, column (5) presents the regression results when all four lags of the tariff variable are included in a single regression. This approach captures the cumulative and potentially interrelated effects of tariffs over multiple years, providing a more comprehensive view of how past trade policy changes influence current misallocation. The results suggest that when considering all four lags together, the cumulative impact of tariff reductions over the previous four years is robust and significant, reinforcing the long-term benefits of trade liberalisation on allocative efficiency.

2.6 Plant-Level Distortions

In this section, I empirically examine distortions at the plant-level to test key predictions of the theoretical model regarding the second-best environment and the inferred distortions. To do this, the distortions are computed following the approach in HK based on plant input and output data.

Specifically, in subsection 2.6.1, I examine the correlation between input and output distortions in 1989 for industries with EOU presence. The goal is to assess whether the output distortion indeed compensated for input distortions, creating a counteracting effect as predicted. In subsection 2.6.2, I analyse the relationship between changing tariff rates and the dispersion in output distortion over time. This investigation serves to substantiate the proposed link between trade protection and output distortions at the plant level, as hypothesised in the HK theoretical framework. Additionally, I corroborate that EOUs indeed encounter lower effective input costs, thereby providing empirical support for the association between EOUs and input distortions. Lastly, subsection 2.6.3 examines plants within an EOU industry to validate the reliability of the industry-level EOU indicator created using secondary data sources. This comprehensive examination contributes to the overall robustness of my findings and enhances the understanding of the dynamics within EOU industries.

The plant-level distortions are computed as follows:

Capital Distortion:

$$1 - \tau_{k_{si}} = \frac{\alpha_{k_s}}{\alpha_{l_s}} \frac{wL_{si}}{rK_{si}} \tag{2.20}$$

Raw Material Distortion:

$$1 - \tau_{m_{si}} = \frac{\alpha_{m_s}}{\alpha_{l_s}} \frac{wL_{si}}{p_m M_{si}} \tag{2.21}$$

Output Distortion:

$$1 - \tau_{y_{si}} = \frac{\sigma}{\sigma - 1} \frac{wL_{si}}{\alpha_{l_s} P_{si} Y_{si}} \tag{2.22}$$

Following HK, the rental price of capital is set at $r = 10\%$, which equals the sum of a 5% real interest rate and a 5% depreciation rate. The effective cost of capital for plant-i in industry-s is represented as $(1 - \tau_{k_{si}})r$, indicating that it deviates from 10% when $\tau_k \neq 0$. Additionally, I set the baseline elasticity of substitution between the plant gross output to σ = 3. I identify a capital distortion when the ratio of labour compensation to the capital stock is lower than expected based on the output elasticities with respect to capital and labour. Similarly, I identify an output distortion when the labour share is low compared to what one would think from the industry elasticity of output with respect to labour (adjusted for rents). It is important to note that higher values of $1 - \tau_{k_{si}}$ and $1 - \tau_{m_{si}}$ indicate increased effective input costs, implying low levels of input subsidies. Additionally, a higher $1 - \tau_{y_{si}}$ suggests a low level of markups.

2.6.1 Correlated Pre-Reform Distortions

The data suggests that trade liberalisation does not fully address resource misallocation in industries already impacted by input market distortions from the EOU scheme. This adverse outcome is consistent with the characteristics of a second-best setting.

From the HK model, the hypothesis is that when input market distortions exist, trade liberalisation can only enhance the efficiency of resource allocation if the distortion resulting from trade protection amplifies the production scale effect of the pre-reform EOU distortion. Conversely, if the distortion from trade protection counteracts the impact of the EOU distortion before liberalisation, then the reduction of trade barriers will dampen or even worsen misallocation. To verify whether the distortions resulting from trade protection indeed offset the distortions in the input market, I measure plant-level distortions in the manufacturing sector and examine their correlation in the pre-reform period. Specifically, the goal is to determine the sign of ρ_{ky} and ρ_{my} in Equation 2.12 for industry with EOUs.

The industry-level EOU indicator compiled from secondary sources is limited to informing whether an industry has at least one plant registered under the EOU scheme. To understand the relationship between the distortions before trade liberalisation, I focus on industries active in 1989 and compute the correlation between effective input and output distortion for industries identified as having EOU plants. Furthermore, I contrast these correlation measures with those observed in industries without EOUs. The results of this analysis are presented in Table 2.7, providing a numerical summary for all industries within each group.

Table 2.7: Correlation between Input and Output Distortion

Industry Type	ρ_{ky}	ρ_{my}
With EOUs	0.326	0.482
Without EOUs	0.110	0.098

The data shows a moderately positive correlation between input and output distortions in industries with EOUs, as indicated by ρ_{ky} and ρ_{my} in columns (1) and (2), respectively. This finding of positively correlated distortions aligns with the results of Kabiraj [2020], who examined misallocation in India during the 2005-06 period. This implies that, in the pre-reform period, the trade protection-induced output distortion compensated for the EOU-induced input distortions. Essentially, this created a second-best environment wherein plants facing higher trade protection-induced output distortions benefited from effective input subsidies under the EOU scheme. This positive correlation explains the negative coefficient on the interaction term reported earlier in Table 2.1, where reducing tariff rates in EOU industries had less of a positive effect on misallocation. Moreover, when examining the correlation between the input and output distortion in industries without EOU plants, I find that although the correlation is non-zero, it is very weak. This, however, suggests the potential presence of factor input distortions within non-EOU industries, contrary to the model's strong assumption of no input distortions.

The results demonstrated in Table 2.7 support the hypothesis of counteracting production scale distortions, which illustrates how pre-existing plant-level input distortions can alter the benefits of trade liberalisation. The direction and magnitude of this effect are critically dependent on the correlation between the varying distortions faced by the plants. This indicates that policies aimed at mitigating input market distortions may complement trade liberalisation efforts.

2.6.2 Examining Policy-Induced Distortions

To validate that the correlation measures are indeed capturing policy-induced distortions, I evaluate plant-level distortions alongside trade policy changes. The aim is to bridge the theoretical propositions of the HK model with empirical findings, thereby providing a comprehensive assessment of the model's predictive power in understanding the dynamics of policy-induced distortions.

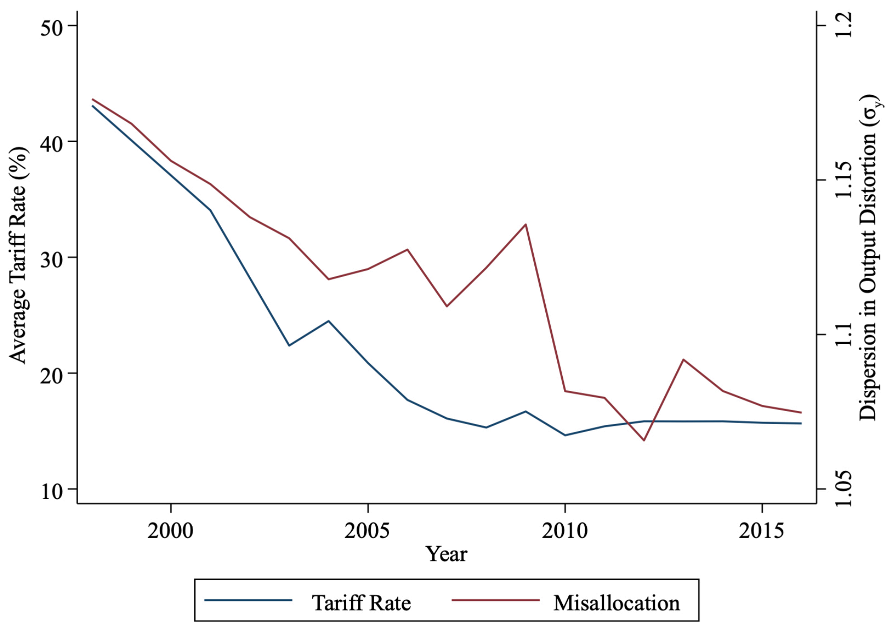
2.6.2.1 Trade Protection-Induced Distortion

I examine in the data whether trade protection is linked to output distortions at the plant level, as theorised in the model. Leveraging the panel structure of the ASI data, I analyse the relationship between the time-series variation in output tariffs and the dispersion in plant-level output distortion. Since official panel identifiers are available from 1998, I concentrate on the sub-period spanning 1998-2016. As visualised previously in Figure 3, tariffs steadily declined during this period. This focused investigation into output distortions complements the regression analysis, which assesses the overall dispersion of distortions and comprehensively covers the liberalisation period through cross-sectional survey data.

I argue that in the presence of high trade protection, plants can charge excessive markups due to limited foreign competition. This leads to a greater output distortion, particularly for plants that disproportionately benefit more from the protective trade barriers. The relationship between trade protection and output distortion is theorised to be positive, implying that higher trade barriers are associated with more significant variations in output distortion among plants within an industry. To investigate this, I calculate the average standard deviation of plant-level output distortion and examine how this measure of dispersion evolves with the average output tariff rates over the sub-period.

As illustrated in Figure 2.5, there is a clear compression in output distortion dispersion over the years. The left vertical axis depicts the average tariff rate in the manufacturing sector. The right vertical axis represents the average within-industry standard deviation in output distortion. Each data point on the graph represents a year. When tariffs were at their peak from 1998-2000, dispersion in output distortion was also at its highest. As tariffs declined over time, the variation in output distortion also followed a downward trajectory, remaining mostly at lower levels. While the dispersion does not decline as smoothly as the tariff rate, there does appear to be a directional correlation: higher tariffs align with greater variability in output distortions. While correlation does not imply causation, the argument posits that the reduction in tariffs led to increased foreign competition, thereby narrowing markup differences and the induced output distortions across plants within the industry.

Figure 2.5: Tariff Rates and Dispersion in Output Distortion



This empirical evidence is consistent with the theoretically modeled mechanism wherein trade reform reduces distortions induced by trade protection and lowers σ_y. It aligns with economic theories advocating for trade liberalisation as a strategy to improve allocative efficiency by promoting competition and diminishing market distortions.

2.6.2.2 EOU-Induced Distortions

To ascertain the role of the EOU scheme in generating input distortions, I now examine whether EOUs are associated with receiving effective input subsidies. I compute the average effective input cost for industries with and without EOU plants in 1989 and find that the differences in means are highly statistically significant. Table 2.8 illustrates that industries with EOU plants exhibit substantially lower average effective input costs compared to those without EOUs. Specifically, the average $1-\tau_k$ is 0.359 for industries with EOUs, contrasting with 0.564 for non-EOU industries. Similarly, industries with EOU presence have an average $1-\tau_m$ of 0.858, while industries without EOUs have an average of 0.967.

Table 2.8: Average Effective Input Cost

Industry Type	$Avg.(1-\tau_{k_s})$	$Avg.(1-\tau_{m_s})$
With EOUs	0.359	0.858
Without EOUs	0.564	0.967

This outcome aligns with expectations given the benefits and subsidies provided to EOUs. The significantly lower input costs reflect the extent of distortions and effective subsidies in enabling EOUs to access cheaper capital and intermediate inputs. Within the industry, this likely creates an uneven playing field, disadvantaging non-EOU plants competing in the same product markets. The wider the gap in input costs between EOUs and non-EOUs, the greater the potential for misallocation inefficiencies, as resources may flow more towards protected and subsidised EOUs rather than the most productive plants.

2.6.3 Validating Industry-Level EOU Indicator

As I lack specific information about which plants are categorised as an EOU, a concern may arise about the reliability of the industry-level EOU indicator. To evaluate the validity of using this textual indicator of EOU status as a stand-in for plant-level input distortions, I construct a plant-level indicator of likely EOU status based on observable plant characteristics. My plant-level measure is then compared to the industry-level EOU assignment to assess the latter's reliability. The analysis is focused on industries operational in 1989, a deliberate choice to facilitate more granular examination of pre-reform characteristics and the availability of data pertaining to plant observable during that period.

First, I identify plants that potentially have EOU status based on their fulfilling the EOU registration criteria. While specific data concerning the export status of the plant is unavailable, the ASI cross-sectional survey data does contain information about the plant's initial investment in P&M. Although this method may not yield the precise EOU plants, I aim to identify the plant category within which a potential EOU might exist. Even capturing only a subset of true EOUs could be useful, as these candidates can reveal insights into key qualities of EOU plants when analysed more closely.

I find these likely EOU plants are concentrated in industries classified as having EOU presence based on the textual evidence, providing some validation for using the industry-level indicator. On average, these industries have 7-12% of plants meeting the P&M investment criteria I set forth, compared to only 1-3% of plants in industries lacking textual evidence of EOU presence. A potential reason for this discrepancy could be that industries primarily engaging in import competition may lack the necessary incentives or financing options to invest substantially in P&M. This reluctance could stem from the absence of government programs akin to EOU schemes that specifically incentivise capacity expansion. In contrast, export-oriented plants, that aim to qualify for and derive benefits from such schemes, likely find it imperative to attain the requisite scale and investment in P&M. This insight suggests a nuanced relationship between plant characteristics, government support mechanisms, and investment behaviors, emphasising the role of government policies in driving plant-level investment decisions.

To examine EOU-induced differences in effective input prices, I now zoom in on a large and important EOU industry, specifically Textiles (4-Digit NIC), to conduct a comparative analysis between likely-EOU plants and other plants within the same industry. The numerical summary of this analysis is presented in Table 2.9. The top row reports the overall measure for the entire industry, while the bottom two rows elucidate the source of this finding. The estimates in columns (1) and (2) report the average effective input costs. The differences in means between the plant groups are highly statistically significant. The results indicate that likely-EOU plants face substantially lower effective input costs, consistent with them receiving input subsidies. This supports the view that the industry-level EOU indicator accurately reflects the presence of EOUs and serves as a reliable proxy for plant-level input distortions.

Table 2.9: Distortions in Textiles EOU Industry

	$Avg.(1-\tau_{k_{si}})$	$Avg.(1-\tau_{m_{si}})$	ρ_{ky}	ρ_{my}
Overall	0.282	0.798	0.383	0.538
EOU Plants	0.177	0.383	0.507	0.546
Non-EOU Plants	0.322	0.996	0.274	0.271

In column (3) - (4), I report the correlation between the distortions within these likely-EOU plants and make a comparison with the remaining plants. I depict the correlation between the effective output and input distortion in Figure 2.6 and Figure 2.7. In both figures, the horizontal axis represents the per unit effective output distortion, while the vertical axis represents the per unit effective capital and raw material distortion, respectively. The visual representation plots the correlation measure for the whole of Textiles industry with EOUs, along with a closer examination of the underlying source of this correlation as detailed in Table 2.9. The EOU scheme plays a pivotal role: the positive relationship becomes more pronounced when incorporating the likely-EOU plants in the analysis, as depicted by the steeper fitted line in the plots.

It is noteworthy that the non-EOU plants also experience a marked positive correlation between the distortions, suggesting the presence of additional distortions. This offers a potential explanation for the regression outcome indicating that EOU industries exhibit a higher degree of resource misallocation than non-EOU industries. This may be attributed to other discriminatory governmental measures active within the industries participating in the export market. An instance of such a measure can be found in the policies introduced by the Small Industries Development Organisation (SIDO). Those registered with SIDO benefit from subsidised loans and favourable credit terms. Additionally, the opportunity to engage in bulk purchasing allows them to secure reduced prices of raw materials and essential resources. The differential access to inputs resulting from policies unrelated to the EOU scheme may also mute the gains from improved resource allocation.

Figure 2.6: Correlation between Effective Output and Capital Distortion

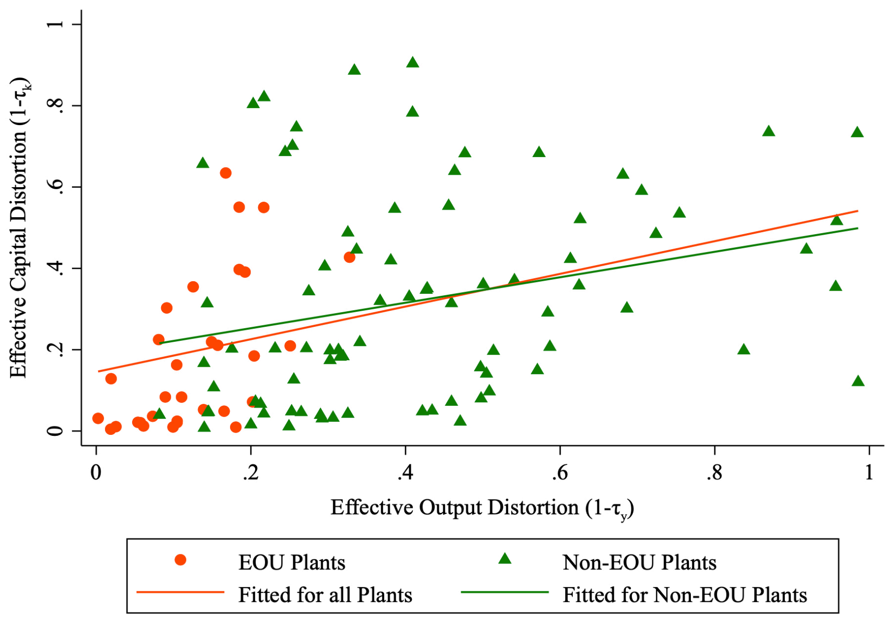
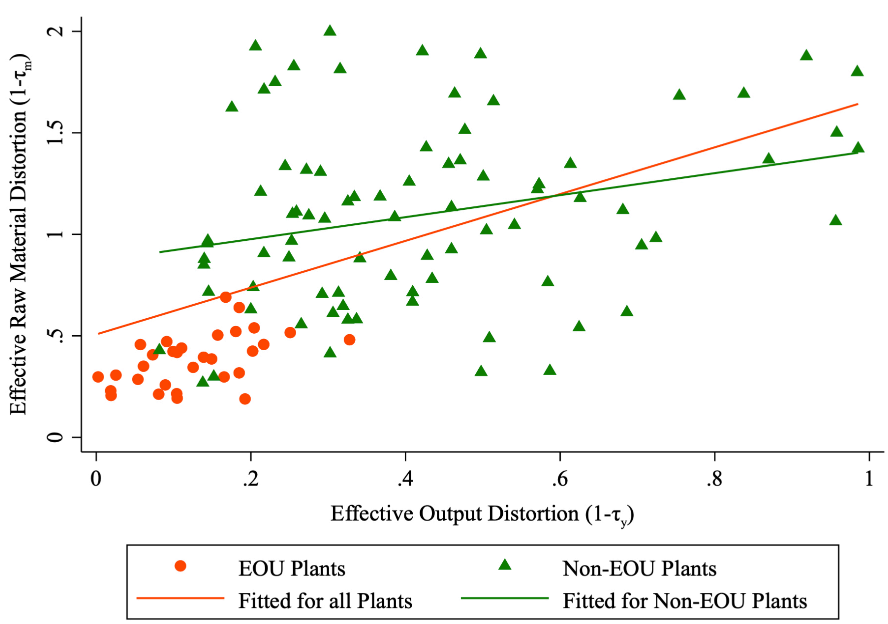


Figure 2.7: Correlation between Effective Output and Raw Material Distortion



2.7 Conclusion

This paper presents novel empirical evidence on the relationship between trade liberalisation and within-industry misallocation in Indian manufacturing. It sheds light on how the presence of persistent domestic distortions can adversely influence the impact of a successful trade liberalisation. While India had substantially lowered trade barriers in the 1990s, significant input market distortions persisted in the form of effective input subsidies to exporters under the Export Oriented Unit (EOU) scheme. Using plant-level data, I find that the decline in output tariffs is associated with an overall improvement in within-industry resource allocation in India. However, in the most distorted industries, the pre-existing distortions reduced the positive effect of trade liberalisation on resource misallocation.

I interpret these adverse effects through the lens of a standard Hsieh and Klenow [2009] misallocation framework. I find a positive correlation between the trade protection-induced output distortion and EOU-induced input distortions in the pre-reform period. This indicates that trade barriers mitigated the effects of underlying input market distortions, creating a second-best environment. The mechanism relies on the distortions having counteracting production scale effects. While the subsidised factor inputs incentivise EOU plants to acquire more inputs than necessary, the trade protection-induced output distortion shrinks production. Post-liberalisation, this counteracting effect diminishes due to reduced output distortions. Now, input subsidies dominate and lead to severe oversizing of EOU plants and worsening of misallocation. Therefore, removing such output distortions via trade liberalisation can be detrimental to allocative efficiency without commensurate factor market reforms.

The empirical analysis further notes that differences in geographical and institutional factors did not drive the heterogeneous plant responses. Additionally, when accounting for simultaneous reforms, I find that trade liberalisation independently played a role in alleviating resource misallocation in the manufacturing sector. The data indicates the potential for a significant synergy between pro-competitive industrial policies. Notably, the reduction in resource misallocation is more pronounced in industries that were less competitive before liberalisation. Therefore, policies fostering domestic competition not only diminished market power distortions but also facilitated greater improvements in allocative efficiency.

Overall, this paper demonstrates that lowering trade barriers has had a positive and lasting effect of reducing inefficiencies and improving resource allocation in the Indian manufacturing sector. However, the effectiveness of trade liberalisation can be significantly enhanced when coupled with measures to address input market distortions and policies to enhance domestic competition. From a policy perspective, this paper emphasises the need for comprehensive and coordinated reforms to achieve efficient resource allocation. A strategic sequencing of reforms can enable complementary policies to support trade opening through a smooth policy transition. This may involve first addressing the domestic distortions, then steadily opening up to trade while monitoring for unintended consequences.

A bridge to the next chapter. In this chapter, I have documented the nuanced impact of trade liberalisation on within-industry resource misallocation in India. While there was an overall improvement in resource allocation, persistent distortions like those caused by EOUs weakened these gains. The key factor argued to drive the improvement, as discussed extensively in the literature, is the pro-competitive effect of trade. This effect entails a disproportionate reduction of trade protection-induced markup distortions in dominant plants, which lose a larger market share, leading to a more uniform distribution of distortions and improved resource allocation efficiency.

While the empirical analysis in this chapter highlights the association between declining tariff rates and reduced distortion dispersion at the industry level, it does not pinpoint the specific plants driving this reduction. To explore the role of plants with initially high trade protection-induced distortions in reducing distortion dispersion, a panel dataset focusing exclusively on continuing plants is essential. This approach contrasts with the cross-sectional survey data used in this chapter, which does not distinguish between continuing and exiting plants, thereby limiting its ability to attribute changes in distortion dispersion to specific plant dynamics.

In the next chapter, I conduct a longitudinal analysis to explore how trade liberalisation affects trade protection-induced distortions over time. Specifically, I will test the pro-competitive hypothesis across two key dimensions: First, whether tariff reductions primarily affected the distortions in plants that faced high trade protection-induced distortions in the pre-reform period; Second, whether these plants experienced disproportionate changes in their input utilisation and output production, as predicted by theory. By examining a balanced panel dataset, this analysis will allow me to identify the sources of improvement in allocative efficiency, providing a deeper understanding of the plant-level dynamics involved.

2.8 Appendix

2.8.1 Data Description

The Indian plant-level dataset used is the Indian Annual Survey of Industries (ASI), spanning the years 1989-90 to 2016-17. The reference period of the survey is the accounting year, which begins on the 1st of April and ends on the 31st of March the following year. I reference the surveys by the earlier of the two years covered. The datasets used for the years 1989-1994 are summary datasets rather than the detailed ones that are available for the later years. These summary datasets contain only a subset of the variables available in the full survey schedule, albeit including all the variables needed for the analysis in this paper.

The ASI is published by the Ministry of Statistics and Programme Implementation (MOSPI), and is a representative sample of formal manufacturing plants registered under the Factories Act, 1948. A factory (plant) is one, which is registered under Sections 2m(i) and 2m(ii) of this Act. The Sections 2m(i) and 2m(ii) refer to any premises:

- wherein ten or more workers are working, or were working on any day of the preceding twelve months, and in any part of which a manufacturing process is being carried on with the aid of power, or
- wherein twenty or more workers are working, or were working on any day of the preceding twelve months, and in any part of which a manufacturing process is being carried on without the aid of power.

Plants fall into two categories: Census and Sample. Census plants typically consist of plants over a 100 workers as well as all plants in industrially-backward states. Census plants are surveyed every year, while sample plants are sampled at random every year. Please see Bils et al. [2021] for a detailed overview of ASI sampling methodology.

2.8.1.1 Deflators and Industry Classification

I use 2-digit NIC deflators from the Reserve Bank of India (RBI) Handbook of Statistics on the Indian Economy to deflate financial variables like gross output. Additionally, I create an annual capital deflator by referring to the table of gross capital formation provided by RBI. To create a harmonised industry classification, I use official NIC concordances from MOSPI that are consistent between 1989 and 2016. I first match the 3-digit NIC-1987 codes with the 3-digit NIC-1998 codes, which represents the next revision of the industrial group classification; subsequently, I match the 3-digit NIC-1998 codes with the 3-digit NIC-2008 classification. The NIC-2008 2-digit industries included in the analysis are listed in Table 2.10. I exclude services and mining industries.

Table 2.10: Manufacturing Industry Classification

NIC 2 Digit-Code	Industry	NIC 2 Digit-Code	Industry
10	Food Products	22	Rubber and Plastics
11	Beverages	23	Nonmetallic Minerals
12	Tobacco	24	Basic Metals
13	Textiles	25	Fabricated Metals
14	Wearing Apparel	26	Computer and Optical Products
15	Leather	27	Electrical Equipment
16	Wood	28	Machinery and Equipment
17	Paper	29	Motor Vehicles
19	Petroleum Products	30	Transport Equipment
20	Chemical	31	Furniture
21	Pharmaceuticals	32	Other Manufacturing

2.8.1.2 Variable Construction

Gross Output: The gross value of products sold plus all other sources of revenue. The gross value of products sold includes distribution expenses, taxes, and subsidies. Other sources of revenue include the value of electricity sold, the value of own construction, the value of resales, the value of additions to the stock of finished goods and semi-finished goods, and receipts from industrial or non-industrial services rendered (e.g. contract or commission work).

Capital: The average of the opening and closing book value of fixed assets (net of depreciation). Fixed capital covers all type of assets, new or used, deployed for production, transportation, living or recreational facilities, hospitals, schools, etc. for factory personnel. It would include land, building, plant and machinery, transport equipment etc. It includes the fixed assets of the head office allocable to the factory and also the full value of assets taken on hire-purchase basis (whether fully paid or not) excluding interest element. It excludes intangible assets and assets solely used for post-manufacturing activities such as sale, storage, distribution, etc.

Labour Cost: The sum of total payments to labour over the year. These payments include wages and salaries, bonuses, contributions to old-age pension funds (and other funds), and all welfare expenses.

Labour: The average number of personnel in the plant over the year. Personnel include wage or salary workers, supervisory/managerial staff, administrative/custodial employees and all unpaid workers (including family members), in work connected directly or indirectly with the manufacturing process.

Intermediate Inputs: The sum of the value of materials and fuel consumed, and other intermediate expenses. Other intermediate expenses include repair and maintenance costs (plant/machinery, building, etc.), costs of contract and commission work, operating expenses (freight and transportation charges, taxes paid), non-operating expenses (communication, accounting, advertising), and insurance charges.

2.8.1.3 Data Cleaning

I proceed with the data cleaning process following the methodology outlined in Bils et al. [2021]. First, I exclude plants with missing or negative values for any of the main variables required to construct TFPR. In line with literature recommendations, I opt for gross output TFPR over value-added TFPR due to the frequent occurrence of negative value-added values in plant-level surveys. Furthermore, I exclude plants that do not adhere to a consistently defined manufacturing industry classification. I then winsorise the 1% tails of $\frac{TFPR_{si}}{TFPR_s}$ in each year, pooling all industries. This step ensures that extreme observations do not unduly influence the subsequent analysis. The resulting sample consists of 9,89,120 plant-year observations across 55 distinct 3-digit industries.

2.8.2 Regression Results: Robustness Checks

Table 2.11: Trade Liberalisation and Misallocation: Robustness Checks

	Parameter Values		Winsorisation		Post-2000 Period	
Std. Dev. of TFPR	(1)	(2)	(3)	(4)	(5)	(6)
TR_{st-1}	0.055***	0.075***	0.062***	0.079***	0.047***	0.064***
	(0.021)	(0.012)	(0.011)	(0.014)	(0.012)	(0.015)
EOU_{st}		0.130***		0.102***		0.154***
		(0.027)		(0.010)		(0.020)
$TR_{st-1} \times EOU_{st}$		-0.049***		-0.043***		-0.061***
		(0.018)		(0.012)		(0.017)
N	1,485	1,485	1,485	1,485	880	880
R-squared	0.122	0.147	0.112	0.154	0.089	0.101
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry FEs	Yes	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes

Note: The dependent variable is the standard deviation of $log(TFPR)$. TR_{st-1} is the lagged output tariff. EOU$_{st}$ equals 1 if the industry has an EOU plant. Columns (1)-(2) present results using parameter values equivalent to those of the US. Columns (3)-(4) present results after applying winsorisation to the 5% tails of $\frac{TFPR_{si}}{TFPR_s}$. Columns (5)-(6) specifically analyse the sub-period from 2000 to 2016. Standard errors are in parentheses. ***, **, and * are statistically significant at 1%, 5%, and 10% levels, respectively. All regressions include size, share of state-owned enterprises, and industry and year fixed effects.

Table 2.12: Trade Liberalisation and Misallocation: Alternative Measure of Trade Reform

DV: Std. Dev. of TFPR	(1)	(2)
IV_{st-1}	-0.048***	-0.087***
	(0.012)	(0.015)
EOU_{st}		0.098***
		(0.016)
$IV_{st-1} \times EOU_{st}$		0.052***
		(0.018)
N	1,485	1,485
R-squared	0.162	0.187
Controls	Yes	Yes
Industry FEs	Yes	Yes
Year FEs	Yes	Yes

Note: The dependent variable is the standard deviation of $log(TFPR)$. IV_{st-1} is the lagged import volume. EOU$_{st}$ equals 1 if the industry has an EOU plant. Standard errors are in parentheses. ***, **, and * are statistically significant at 1%, 5%, and 10% levels, respectively. All regressions include size, share of state-owned enterprises, and industry and year fixed effects.

3. Trade Reform and Plant-Level Distortions: A Longitudinal Analysis

3.1 Introduction

The misallocation of resources among plants can significantly impact aggregate productivity, as highlighted by studies such as Restuccia and Rogerson [2008] and Hsieh and Klenow [2009] (HK, hereafter). It is widely recognised that developing countries not only have fewer productive resources but also allocate them less efficiently. This inefficiency is often exacerbated by institutional factors and government policies that distort resource allocation. Notably, regulations that restrict free market entry are a major source of inefficiency in many developing economies. In India, industrial policy has historically protected incumbents from competitive pressures through regulatory entry barriers. However, the structural reforms implemented in 1991 significantly reduced these barriers.

Two key reforms played a pivotal role in lowering barriers to competition within India's manufacturing sector. Firstly, the government lifted restrictions on foreign direct investment (FDI), thereby facilitating entry for foreign plants. This aspect has been thoroughly examined by Bau and Matray [2023], who found that liberalisation of foreign capital reduces capital misallocation and enhances aggregate productivity in affected Indian industries. Secondly, tariff reductions were implemented across various industries, with some experiencing more substantial cuts, effectively lowering barriers to entry for foreign goods. This trade policy change is the central focus of this chapter. The Indian policy experiment presents an excellent opportunity to use micro-data for evaluating the impact of reducing trade barriers on plant-level characteristics.

Building on the empirical findings from Chapter 2, this paper conducts a longitudinal analysis to assess whether trade liberalisation effectively reduced markup-induced distortions, as predicted by Edmond et al. [2015] (EMX, hereafter). The analysis specifically tests the hypothesis of pro-competitive effect of trade, which suggests that post-reform reductions in markups are primarily observed among plants with initially high markups. To investigate the dynamics of plant-level distortions before and after trade liberalisation, I employ a balanced panel dataset covering the period 1998-2016, focusing solely on continuing plants. This approach contrasts with the cross-sectional survey data used in Chapter 2, which does not distinguish between continuing and exiting plants, and Chapter 4, which utilises an unbalanced panel specifically focusing on the analysis of exiting plants.

Prior to trade liberalisation, some plants significantly benefited from protectionist policies, such as high tariffs. This protected environment allowed them to maintain high markups, which, as discussed in Chapter 2, represent a form of output distortion. Plants with high markups typically operate below optimal scale, resulting in inefficient resource allocation. Post-liberalisation, tariff reductions alter this landscape. The increased competition from foreign imports puts pressure on domestic plants to lower their markups. This pressure is particularly acute for plants that previously enjoyed high markups under protection. As documented in the previous chapter, the hitherto dominant plants are likely to experience the most significant decline in markups following the reform, prompting a substantial expansion in their production scale. This pro-competitive effect compresses markup dispersion, reducing the gap between high and low markup plants. Consequently, we expect a heterogeneous impact of trade liberalisation on plant-level distortions, with initially high-markup plants experiencing a disproportionate increase in input utilisation and output production.

In the context of India, assuming that trade protection-induced distortion is the predominant factor in the total distortion (wedge) faced by plants, high markup plants exhibit high revenue productivity (high TFPR), indicating they operate at a scale lower than low markup plants (low TFPR). I evaluate how these dynamics unfolded following India's major trade reforms in the 1990s along two dimensions. First, I examine the relationship between changes in plant-level distortion, measured by TFPR, and initial distortion levels. Specifically, I investigate whether initially high markup plants (characterised by higher TFPR) are more likely to experience a proportionally larger decline in TFPR following liberalisation compared to those starting with lower TFPR levels. This would explain the observed decrease in the cross-sectional dispersion of TFPR in Chapter 2, driven by initially undersized plants improving at a faster rate. Consequently, in the second aspect, I examine whether plants with initially high TFPR show a relatively larger increase in input use and output production. This would reflect the expected effect of disproportionately large reduction in plant-level distortions induced by declining tariff rates.

To analyse the differential impact of trade liberalisation on plant-level distortions and its translation into improved input allocation within the industry, I employ panel data methods. Using data from the Indian Annual Survey of Industries (ASI), which offers a comprehensive survey of formal manufacturing plants, I define the industry-level trade liberalisation period as pre-reform (before 2001) and post-reform (after 2001). By combining this policy change with a panel dataset of Indian plants from 1998 to 2016, I find that trade liberalisation did disproportionately reduce distortions for plants initially characterised by high TFPR. These plants also showed notable increases in input usage and output production. For instance, a 10 percentage point decline in tariff rates prompted high-TFPR plants to increase output by 2.5%, wage bill by 1.61%, physical capital by 1.85%, and intermediate inputs by 4.23%, while reducing TFPR by 5.9% relative to low-TFPR plants, which experienced no significant changes.

The chapter is organised as follows. Section 3.2 provides a description of the data employed. Section 3.3.1 presents an overview of the conceptual framework for understanding misallocation, introduces the measurement expressions, and derives testable predictions for how inputs and output will change. Section 3.3.2 discusses the reduced-form empirical strategy. Section 3.4 reports the estimates of the heterogeneous effects on plants with high and low TFPR. Section 3.5 describes the policy impact of trade liberalisation on aggregate productivity. Section 3.6 concludes.

3.2 Plant-Level Data

This paper leverages the panel structure of the Indian Annual Survey of Industries (ASI) dataset, which provides comprehensive information on manufacturing plants across India. The data spans from 1998-99 to 2016-17, with each survey period running from April of one year to March of the following year. To maintain consistency, I refer to each survey by the earlier of the two years it covers. Industries are categorised using India's National Industry Classification (NIC) code, which are closely aligned with the International Standard of Industrial Classification (ISIC) codes. For continuity, I establish a common industry classification using official concordances, resulting in manufacturing industries that are consistently defined throughout the period.

The ASI serves as a comprehensive survey representative of formal manufacturing plants in India, covering establishments with a minimum of 10 workers utilising power or at least 20 workers in those without power. These plants fall into two categories: census and sample. Census plants are surveyed every year, while Sample plants are randomly selected each year. To address potential entry-exit effects induced by liberalisation and for robustness in the analysis, I restrict the dataset to plants observed throughout the entire period. This approach results in a balanced panel dataset comprising 1,661 distinct plants across 55 distinct 3-digit industries, for a total of 31,559 observations. In this paper focusing on continuing plants, approximately 5% of the plants studied are Sample plants. The variables of interest include the plant's industry code, export status, gross output, labour compensation, capital, and intermediate inputs. Table 3.5 of Appendix Section 3.7 documents summary statistics for the final plant-level sample used in the analysis. To ensure the quality of the data, I focus on plants with non-missing and positive values for quantitative variables, applying official sampling weights in all calculations. Additionally, to mitigate the influence of extreme outliers, I employ winsorisation by capping the top and bottom 1% tails of the outcome variable of interest. The data cleaning and variable construction is done the same way as in Chapter 2.

Although trade liberalisation efforts began in 1991, I focus on the period from 1998 onwards due to the availability of official panel identifiers. This later period captures the last wave of the Indian trade liberalisation episode, during which the average tariff rate declined from approximately

40% in the late 1990s to 20% in 2002, further decreasing to around 10% by 2009 before stabilising. Therefore, I designate the period from 1998 to 2001 as a pre-policy period to calculate plant's revenue productivity (TFPR) and classify them as high or low. TFPR is measured in the same way as in Chapter 2. These pre-reform measures are essential for estimating the effects of the trade policy on misallocation. In the Indian context, a key feature of the trade reform was that it not only reduced the average level of tariffs, but also significantly diminished the variation in tariffs across industries. With this in mind, the empirical strategy takes advantage of cross-sectoral variability in tariffs to assess the heterogeneous effect of the policy changes on plant-level distortions, as well as input utilisation and output production.

Similar to Chapter 2, I supplement the plant-level data with yearly output tariff data at the six-digit level of the Indian Trade Classification Harmonised System (HS) code. The tariff data is obtained from the World Integrated Trade Solutions (WITS). To integrate this tariff data with the ASI database, I use the concordance provided by Debroy and Santhanam [1993], which links HS code items with NIC codes. This matching process covers over 5,000 product lines, allowing for the calculation of average industry-level output tariffs.

3.3 Methodology

3.3.1 Theoretical Motivation

The basic intuition underlying the static misallocation idea is formalised in HK. In their standard framework, plants exhibit heterogeneous productivities and face wedges that alter the effective prices of inputs, leading to an inefficient allocation of resources across plants. These distortions can be viewed as wedges that rationalise the observed input usage by profit-maximising plants.

Setup: I reproduce here the main elements of the HK framework in Chapter 2. I assume each plant produces a different variety and the output of the industry in which the plant operates faces a CES demand. All misallocation occurs within industry, thus, for simplicity, the industry index is omitted. Each plant-i, seeks to maximise its profits while facing taxes or subsidies, τ:

$$\max_{L_i,K_i,M_i} \quad \pi_i = (1-\tau_{y_i})P_iY_i - wL_i - (1-\tau_{k_i})rK_i - (1-\tau_{m_i})p_mM_i \tag{3.1}$$

Here, τ_{y_i} represents a plant-specific implicit output tax that reduces plant-level revenue, capturing the production scale effect of trade protection-induced markups (Chapter 2). τ_{k_i} and τ_{m_i} denote plant-specific implicit input subsidies selectively allocated to some Indian plants, reflecting the impact of the Export Oriented Unit (EOU) input subsidy scheme. P_iY_i is the plant revenue. L_i, K_i, and M_i represent the quantities of labour, capital, and raw materials used by plant-i, respectively, while w, r, and p_m denote the common and exogenous costs of these inputs.

Assuming a Cobb-Douglas production function, $Y_i = A_iK_i^{\alpha_k}L_i^{\alpha_l}M_i^{\alpha_m}$, where α is the input share, the plant's optimal labour, capital, and raw material allocation satisfy:

$$MRPL_i = w\frac{1}{1-\tau_{y_i}} \tag{3.2}$$

$$MRPK_i = r\frac{1-\tau_{k_i}}{1-\tau_{y_i}} \tag{3.3}$$

$$MRPM_i = p_m\frac{1-\tau_{m_i}}{1-\tau_{y_i}} \tag{3.4}$$

where $MRPL_i \propto \frac{P_iY_i}{L_i}$, $MRPK_i \propto \frac{P_iY_i}{K_i}$, and $MRPM_i \propto \frac{P_iY_i}{M_i}$. A profit-maximizing plant ensures that the marginal revenue product (MRP) of inputs equals their respective costs. The plant's MRP indicates the direction of misallocation, with a high MRP reflecting high combined implicit taxes, which render the plant to be undersized. These measures can be summarised using plant's revenue productivity, $TFPR_i$:

$$TFPR_i = \frac{P_iY_i}{K_i^{\alpha_k}L_i^{\alpha_l}M_i^{\alpha_m}} \propto \frac{(1-\tau_{k_i})^{\alpha_k}(1-\tau_{m_i})^{\alpha_m}}{1-\tau_{y_i}} \tag{3.5}$$

Plant TFPR is proportional to the geometric average of the plant's MRPs, reflecting the overall impact of distortions on the plant's revenue productivity. In India, assuming trade protection-induced distortion is the predominant factor in the total distortion faced by plants, high-markup plants display high TFPR, suggesting they operate on a smaller scale compared to low-markup plants (low TFPR). A reduction in misallocation occurs when the combined wedge decreases for a plant with a relatively high ex-ante wedge compared to other plants.

Trade Liberalisation and Misallocation: As discussed in Chapter 2, trade liberalisation tends to reduce markups disproportionately more for previously dominant plants. Consequently, the disproportionate decline in wedges for plants initially bearing high τ_{y_i} values will have several effects. Firstly, with the decrease in τ_{y_i}, the measured MRP should also decline for these plants. Secondly, plants with initially high wedges are incentivised to increase their use of inputs. As a result, these plants expand their production and earn higher revenues. Therefore, as trade barriers decrease, one would expect to observe an increase in input utilisation and output, along with a decline in TFPR for plants initially characterised by high TFPR values.

3.3.2 Empirical Framework

I evaluate whether trade liberalisation induced a larger reduction in markups for plants with higher market power in the pre-reform period. I follow the predictions from the theoretical framework and examine if the reform had a differential impact on plants with ex-ante high versus low TFPR. To identify plants with high or low TFPR prior to the last wave of reform, I calculate the average TFPR for each plant over the period 1998–2001 and then classify a plant as having high pre-reform TFPR if its average TFPR exceeds the 4-digit industry-level mean.

To measure the effect of liberalisation on the allocation of resources across plants within industries, I estimate the following equation:

$$Outcome_{ist} = \beta_1 TR_{st-1} + \beta_2 TR_{st-1} \times I_i^{\text{High TFPR}} + \Gamma \mathbf{X_{ist}} + \gamma_i + \eta_t + \epsilon_{ist} \tag{3.6}$$

where i denotes a plant, s denotes an industry, t denotes a year, and $Outcome_{ist}$ is the outcome variable of interest, consisting of the logs of TFPR, total wage bill, physical capital, raw material, and gross output. TR_{st-1} is a measure of lagged output tariff rate at the 3–digit NIC level; and $I_i^{\text{High TFPR}}$ is an indicator variable equal to 1 if a plant has a pre-reform TFPR above the industry-level mean. This dummy approach simplifies interpretation by directly estimating the average effect of belonging to the high TFPR group on the outcome variable. $\mathbf{X_{ist}}$ consists of plant age and its squared term, accounting for nonlinear age effects; γ_i and η_t are plant and year fixed effects, respectively. γ_i removes time invariant unobserved plant-level heterogeneity, while η_t controls for aggregate fluctuations.

The coefficient of interest is β_2 as it captures the differential effect of the trade reform on ex-ante high TFPR plants relative to low TFPR plants. A positive β_2 implies that the dependent variable decreases for high TFPR plants relative to low TFPR plants when tariffs are reduced. On the other hand, β_1 quantifies the changes in outcomes for low TFPR plants. The sum $\beta_1 + \beta_2$ measures the average overall effect of tariff reductions on the plant's outcome variable of interest.

The categorisation of plants as above or below the industry-level mean TFPR may be influenced by outliers, potentially leading to misclassification. This could result in some plants with genuinely high TFPR being incorrectly classified as low TFPR. However, if the true effect of the policy is to reduce TFPR more for ex-ante high TFPR plants, this misclassification could introduce attenuation bias. Specifically, since β_2 captures the change in wedges for high TFPR plants, underestimation of this change may occur due to misclassification induced by outliers. To address this concern, I revisit this issue in Section 3.4, where I demonstrate that the reduced-form estimates remain robust even when considering alternative approaches such as winsorising extreme values and adjusting cutoff points like to the median.

3.4 Empirical Results

3.4.1 Heterogeneous Effect by Ex-ante TFPR

I investigate the relationship between output tariff reduction and resource misallocation using the method outlined in the preceding section. If the pro-competitive effect of trade liberalisation is associated with an improvement in resource allocation, then we expect TFPR for ex-ante high TFPR plants to decline more with the reduction in tariff rates. This hypothesis is further motivated by the findings of Loecker et al. [2016], who observe in their study on India that reduced output tariffs decrease markups, with a more pronounced effect on products initially exhibiting high markups.

Table 3.1 presents the estimates of the heterogeneous effects of tariff cuts from Equation 3.6, which is the main estimating equation used in the analysis.

Table 3.1: Heterogeneous Effect by Plant's Ex-ante TFPR

	TFPR	Wages	Capital	Raw Materials	Output
$TR_{st-1} \times I_i^{\text{High TFPR}}$	0.587***	-0.161***	-0.185***	-0.423***	-0.251***
	(0.087)	(0.059)	(0.056)	(0.071)	(0.064)
TR_{st-1}	0.087	-0.111**	-0.125*	-0.058	-0.154***
	(0.092)	(0.051)	(0.070)	(0.055)	(0.059)
N	29,889	29,889	29,889	29,889	29,889
R-Squared	0.107	0.063	0.071	0.044	0.096
Controls	Yes	Yes	Yes	Yes	Yes
Plant FEs	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes

Note: All dependent variables are in logs. TR_{st-1} is the lagged output tariff rate. The indicator variable $I_i^{\text{High TFPR}}$ is set to 1 if the plant's TFPR in the pre-reform period from 1998 to 2001 is above the industry mean. Standard errors are in parentheses. ***, **, and * are statistically significant at 1%, 5%, and 10% levels, respectively. All regressions include age, age squared, and plant and year fixed effects.

The coefficient of our main variable of interest, $TR_{st-1} \times I_i^{\text{High TFPR}}$, is statistically significant across all specifications. The positive coefficient on TFPR indicates that the reduction in tariff rates led to a decline in TFPR for plants with high pre-reform TFPR, relative to plants with low pre-reform TFPR. Additionally, the negative coefficient on input and output variables indicates that in response to increased competition, these plants expanded more relative to ex-ante low TFPR plants. That is, in response to a 10 percentage point reduction in lagged output tariffs, ex-ante high TFPR plants generate higher output by 2.5% (column 5) relative to low TFPR plants. This expansion is facilitated by a differential increase in input usage, with their wage bill rising by 1.61% (column 2), physical capital by 1.85% (column 3), and intermediate inputs by 4.23% (column 4). These findings also suggest significant complementarities between the inputs. Additionally, among ex-ante high TFPR plants, liberalisation led to a relative reduction in TFPR by 5.9% (column 1). While the signs of the coefficients on TR_{st-1} align with expectations, the lack of significant results for ex-ante low TFPR plants reinforces the prediction that growth is concentrated in ex-ante high TFPR plants. This observation suggests that the reduction in TFPR dispersion is primarily influenced by plants in the right tail of the TFPR distribution.

The economic intuition is that prior to liberalisation, plants with high TFPR (i.e., operating below optimal scale) benefited significantly from protectionist policies such as high tariffs. These tariffs acted as barriers to foreign competition, allowing them to operate with inefficiencies and still be profitable. However, with the reduction in tariffs, these plants faced relatively more competition from foreign imports because of their ex-ante high market share. Consequently, they were compelled to reduce their markups to stay competitive in the market. As a result, their measured TFPR declined, signaling a reduction in misallocation, and prompting an expansion in input utilisation. This adjustment reflects a shift towards a more efficient allocation of resources within the industry.

In the framework described by EMX, plants facing increased competition reduce their markups due to shrinking market shares. My findings suggest that high-TFPR plants reduce their markups while expanding their inputs, which may initially seem counterintuitive. This can be reconciled by considering that trade liberalisation not only introduces competition but also expands the overall market size. As tariffs are lowered, domestic plants often gain access to larger export markets, while foreign competition entering the domestic market contributes to an overall expansion in market size. In this context, high-TFPR plants, despite experiencing reduced market shares domestically, benefit from an expanded market size that allows them to increase production by utilising more inputs. This behaviour suggests that plants are adjusting towards their optimal scale, even as their relative market share decreases. Consequently, they reduce their markups in response to heightened competition but are still able to expand both inputs and production due to the broader market opportunities. This is consistent with the view of Melitz [2003], where the most productive plants benefit disproportionately from trade liberalisation, increasing their export activity and production volumes despite greater competition.

3.4.2 Heterogeneous Effect by EOU Status

To assess whether these heterogeneous effects are influenced by a plant's Export Oriented Unit status, I categorise plants into two groups: EOUs and Non-EOUs. This classification is motivated by insights from Chapter 2, which indicate that plants potentially identified as EOUs tend to apply higher markups and exhibit high TFPR. The hypothesis tested here is that, with reduced trade barriers, exporting plants will experience a more pronounced decline in TFPR, along with increased input usage and output production. EOUs are specifically defined as plants that export more than 50% of their production and have made an initial investment in plant and machinery exceeding Rs. 10 million. Thus, the indicator I_i^{EOU} is assigned a value of 1 if a plant meets the EOU criteria, and 0 otherwise. Overall, this indicator captures plants that are large and primarily focused on exporting their output. This analysis benefits from a comprehensive dataset that provides a richer indicator of EOUs compared to the plant-level EOUs defined in Section 2.6 of Chapter 2. The corresponding results of this analysis are presented in Table 3.2.

Table 3.2: Heterogeneous Effect by Plant's EOU Status

	TFPR	Wages	Capital	Raw Materials	Output
$TR_{st-1} \times I_i^{\text{EOU}}$	0.481***	-0.178***	-0.245***	-0.387***	-0.415***
	(0.092)	(0.065)	(0.071)	(0.075)	(0.081)
TR_{st-1}	0.276***	-0.142**	-0.156***	-0.141**	-0.278***
	(0.062)	(0.071)	(0.058)	(0.068)	(0.076)
N	29,889	29,889	29,889	29,889	29,889
R-Squared	0.366	0.043	0.054	0.042	0.075
Controls	Yes	Yes	Yes	Yes	Yes
Plant FEs	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes

Note: All dependent variables are in logs. TR_{st-1} is the lagged output tariff rate. The indicator variable I_i^{EOU} is set to 1 if the plant is export-oriented. Standard errors are in parentheses. ***, **, and * are statistically significant at 1%, 5%, and 10% levels, respectively. All regressions include age, age squared, and plant and year fixed effects.

The results suggest that trade liberalisation had a similar effect on both exporting and non-exporting plants in terms of reducing misallocation and input use. However, the statistically significant and relatively larger coefficients on the interaction term, $TR_{st-1} \times I_i^{\text{EOU}}$, indicates that tariff reduction had a more pronounced impact on resource allocation for exporting plants compared to their non-exporting counterparts. This finding is consistent with prior research, such as the findings of Loecker and Warzynskia [2012] for the Slovenian manufacturing sector. In their study, they observed that exporters typically charge higher markups on average, likely due to their ability to produce at lower marginal costs. Therefore, when tariffs are reduced, exporters may experience a larger decline in their markups, leading to a more substantial increase in their input use and output production. This highlights that export-oriented plants may have been particularly responsive to the incentives created by trade liberalisation, further enhancing their efficiency and production levels.

3.4.3 Heterogeneous Effect by Market Concentration

I examine the differential impact of trade liberalisation based on the plant being in an industry with high pre-reform market concentration, which is indicative of limited competition prior to liberalisation. Plants less exposed to foreign competition benefit more from market power. Market concentration is measured using the Herfindahl-Hirschman Index (HHI), with an industry classified as having high market concentration if its HHI exceeds the cross-industry average. Accordingly, the dummy variable takes the value of 1 in such instances and 0 otherwise. I then regress my outcome variable on tariffs, its interaction with the dummy for plant-level TFPR, and the HHI metric, along with its interaction with the other two variables. Table 3.3 presents the results.

The triple interaction term, $TR_{st-1} \times HHI_{s,98} \times I_i^{\text{High TFPR}}$, shows a positive and statistically significant coefficient for TFPR. This indicates that the reduction in TFPR for plants with high pre-reform TFPR was more pronounced in industries with high pre-reform market concentration. Industries with greater concentration likely had fewer domestic competitors, allowing plants to operate with higher inefficiency before trade liberalisation. The entry of foreign imports after tariff reductions posed a significant challenge to these plants, compelling them to reduce their markups. This is evident in the larger decline in TFPR (indicating a greater reduction in misallocation) for high pre-reform TFPR plants in highly concentrated industries. Additionally, the results suggest that changes in input and output for these plants are more substantial in industries with higher pre-reform concentration.

Table 3.3: Heterogeneous Effect by Pre-Reform Market Concentration in the Industry

	TFPR	Wages	Capital	Raw Materials	Output
$TR_{st-1} \times HHI_{s,98} \times I_i^{\text{High TFPR}}$	0.238***	-0.141***	-0.148***	-0.292***	-0.238***
	(0.061)	(0.044)	(0.041)	(0.067)	(0.071)
$TR_{st-1} \times I_i^{\text{High TFPR}}$	0.158***	-0.119***	-0.134***	-0.199***	-0.196***
	(0.049)	(0.042)	(0.044)	(0.073)	(0.055)
TR_{st-1}	0.062	-0.081*	-0.114*	-0.057	-0.121**
	(0.081)	(0.042)	(0.0.65)	(0.061)	(0.058)
N	29,889	29,889	29,889	29,889	29,889
R-Squared	0.165	0.048	0.041	0.039	0.073
Controls	Yes	Yes	Yes	Yes	Yes
Plant FEs	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes

Note: All dependent variables are in logs. TR_{st-1} is the lagged output tariff rate. The indicator variable $I_i^{\text{High TFPR}}$ is set to 1 if the plant's TFPR in the pre-reform period from 1998 to 2001 is above the industry mean. $HHI_{s,98}$ takes the values of 1 if Herfindahl-Hirschman Index in 1998 is above the average across industries. Standard errors are in parentheses. ***, **, and * are statistically significant at 1%, 5%, and 10% levels, respectively. All regressions include age and age squared, and plant and year fixed effects.

3.4.4 Heterogeneous Effect by Initial Tariff Level

To examine the impact of trade protection-induced market power, I analyse how tariff reductions differentially affect plants based on their operation in industries with high pre-reform tariff levels. While market concentration can result from various non-trade factors (e.g., regulatory constraints), focusing on industries with high pre-reform tariffs isolates the effect of trade protection on market dynamics. I create an industry-level indicator, $ITR_{s,98}$, which equals 1 if the average industry-tariff in 1998 exceeds the cross-industry mean tariff, and 0 otherwise. This indicator captures the differential impact on plants facing little competitive pressure before the last wave of liberalisation. I then regress my outcome variable on tariffs, the interaction between tariffs and plant-level TFPR dummy, and the high tariff indicator and its interactions. Table 3.4 presents the findings.

Table 3.4: Heterogeneous Effect by Pre-Reform Tariff Level in the Industry

	TFPR	Wages	Capital	Raw Materials	Output
$TR_{st-1} \times ITR_{s,98} \times I_i^{\text{High TFPR}}$	0.198***	-0.152***	-0.158***	-0.271***	-0.231***
	(0.055)	(0.049)	(0.042)	(0.061)	(0.058)
$TR_{st-1} \times I_i^{\text{High TFPR}}$	0.129***	-0.115***	-0.144***	-0.173***	-0.162***
	(0.047)	(0.039)	(0.040)	(0.051)	(0.046)
TR_{st-1}	-0.079	-0.088**	0.117*	-0.049	-0.131**
	(0.078)	(0.044)	(0.061)	(0.058)	(0.059)
N	29,889	29,889	29,889	29,889	29,889
R-Squared	0.064	0.049	0.051	0.041	0.056
Controls	Yes	Yes	Yes	Yes	Yes
Plant FEs	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes

Note: All dependent variables are in logs. TR_{st-1} is the lagged output tariff rate. The indicator variable $I_i^{\text{High TFPR}}$ is set to 1 if the plant's TFPR in the pre-reform period from 1998 to 2001 is above the industry mean. $ITR_{s,98}$ takes the values of 1 if the average output tariff in the industry in 1998 exceeds the mean tariff level estimated across all industries. Standard errors are in parentheses. ***, **, and * are statistically significant at 1%, 5%, and 10% levels, respectively. All regressions include age and age squared, and plant and year fixed effects.

The triple interaction term, $TR_{st-1} \times ITR_{s,98} \times I_i^{\text{High TFPR}}$, is statistically significant and positive for TFPR and negative across all other specifications, including wages, capital, raw materials, and output. These results collectively indicate that the reduction in trade protection-induced output distortions was more pronounced for plants with high TFPR operating in industries that were relatively more protected before the reform. This result underscores the nuanced interplay between trade policy changes and pre-existing market conditions in shaping the outcomes of tariff reductions on resource allocation and economic performance.

3.4.5 Robustness Checks

The robustness checks presented below further validate the main findings, affirming the stability and reliability of the observed heterogeneous effects of trade liberalisation on ex-ante high TFPR plants in Indian manufacturing. Controlling for concurrent reforms, winsorising outliers, using alternative cut-offs for ex-ante TFPR, and employing alternative measures of trade protection, all yield consistent results. These checks provide additional confidence in the robustness of the findings and highlights the role of trade liberalisation in driving efficiency improvements and resource allocation in the manufacturing sector.

3.4.5.1 Controlling for Concurrent Reforms

To account for the possibility that concurrent economic policy changes alongside trade liberalisation may have impacted resource allocation, I re-estimate the model including control variables for relevant reforms occurring simultaneously. These include the de-reservation of small-scale industries (SSI), liberalisation of foreign direct investment (FDI), and de-licensing, constructed in a manner similar to Chapter 2. By integrating these variables into the main estimating Equation 3.6, I aim to isolate the distinct effect of tariff reduction on TFPR, as well as input and output decisions of plants. In all cases, as reported in Table 3.6 - 3.8 of Appendix Section 3.7.2, the pattern of the point estimates are largely unchanged.

3.4.5.2 Winsorising Outliers

To address the potential influence of extreme data points, which can sometimes skew regression results, I re-estimated the model after winsorising the data. Winsorisation replaces upper and lower 5% tails of the sample for each outcome variable of interest, ensuring that outliers don't disproportionately influence the coefficients. The results, presented in Table 3.9 of Appendix Section 3.7.2, demonstrate that the estimates remain consistent with those obtained in the main analysis.

3.4.5.3 Alternative Cut-off for Ex-ante TFPR

The primary analysis categorised plants as pre-reform high TFPR based on the average industry-level TFPR as a specific cutoff point. To assess the sensitivity of the results to this choice, I re-estimated the model using an alternative cut-off point, the median, for classifying high and low TFPR plants. As detailed in Table 3.10 of Appendix Section 3.7.2, the results consistently mirror those of the primary analysis. This indicates the robustness of the observed patterns to variations in classification criteria.

3.4.5.4 Alternative Measure of Trade Protection

The analysis relied on output tariff reductions as the primary measure of trade liberalisation. To ensure the results are not dependent on this specific measure, I re-estimated the model using an alternative measure of trade protection, such as import volume, which reflects the extent of import penetration within the industry. The results, summarised in Table 3.11 of Appendix Section 3.7.2, demonstrate the robustness and consistency of this paper's findings across different metrics of trade protection. This consistency lends further support to the reliability of the conclusions, suggesting that the observed effects are not driven by the choice of a particular measure.

3.5 Aggregate Effect

While the reduced-form estimates suggest a reduction in misallocation, it does not tell us whether this had significant economic implications for output growth. The HK misallocation model describes how a higher variance in TFPR can reduce aggregate TFP. To assess the impact of trade policy, I estimate the effect of misallocation on the Solow residual using the HK framework[1]:

[1] As shown in HK, when plant-level physical productivity A_{si} ($\equiv$ TFPQ) and TFPR are jointly log-normally distributed, there is a simple closed form expression for aggregate TFP:

$$\log TFP_s = \frac{1}{\sigma - 1} \log \left(\sum_{i=1}^{M_s} A_{si}^{\sigma-1} \right) - \frac{\sigma}{2} \operatorname{var}(\log TFPR_{si})$$

where M_s differentiated products are produced in industry-s. In this special case, the negative effect of distortions on aggregate TFP can be summarised by the variance of log TFPR. To quantify the aggregate effects of trade policy changes through the misallocation channel, I focus on the contribution of the second component.

$$\Delta \log TFP_s \approx -\frac{\sigma}{2}\Delta \text{var}(\log TFPR_{si}) \tag{3.7}$$

where σ is assumed to be 3. This framework translates changes in the variance of (log TFPR) into changes in aggregate TFP using the reduced-form estimates. To evaluate the policy impact of liberalisation on the continuing plants, I utilise the regression estimates to predict the change in $log(TFPR_{si})$ for plant-i in industry-s following liberalisation. This prediction captures the expected shifts in revenue productivity as a result of the policy change. Next, I add the predicted change ($\Delta logTFPR_{si}$) to the pre-liberalisation $log(TFPR_{si})$ values, yielding estimates of post-liberalisation TFPR. Finally, I estimate the change in variance (Δvar($logTFPR_{si}$)) to assess its impact on aggregate TFP. This analysis describes how changes in misallocation among plants, in response to the trade reform, influence overall productivity.

After estimating all components of Equation 3.7, I find that the reduction in misallocation induced by trade liberalisation, on average, leads to an approximate 3.2% increase in the industries' Solow residual. This suggests that the decrease in distortions among plants, driven by trade reforms, has positive implications for overall economic efficiency and productivity growth. While direct comparisons for this specific estimate are lacking, the positive outcome aligns with broader findings in the literature. For example, Sivadasan [2009] and Harrison et al. [2013] observed significant increases in aggregate productivity growth following India's 1991 trade reforms, attributing these gains primarily to improvements in within-plant productivity. However, Nishida et al. [2017] argue that their decompositions may underestimate the contribution of reallocation to productivity growth. Thus, while the exact mechanisms driving aggregate productivity effects may vary, the overall direction of the impact of trade liberalisation on productivity appears consistent with existing literature and expected outcomes. In complement, research by Bau and Matray [2023] on FDI liberalisation in India aggregates reduced-form estimates and find economically meaningful effects of lower misallocation. This includes an increase in the Solow residual of treated industries by 3% to 16%.

Furthermore, as detailed in Chapter 2, it is important to note that despite efforts towards trade openness, persistent distortions in factor markets, such as targeted input subsidies to select plants in India, may have attenuated some of the anticipated benefits from reduced misallocation. These subsidies, while intended to support certain industries, can distort resource allocation and reduce the overall gains in aggregate TFP. This observation reiterates the nuanced interaction between policy reforms and existing market distortions, illustrating that improvements in efficiency from trade liberalisation can be undermined by pre-existing inefficiencies in the market.

3.6 Conclusion

In this chapter, I conduct a longitudinal analysis to determine whether trade liberalisation effectively reduced markup-induced distortions, as predicted by Edmond et al. [2015]. Specifically, I examine the pro-competitive effect of trade, which posits that post-reform reductions in markups are mainly observed in plants with initially high markups. Assuming that the markup distortion dominates amidst other market distortions, a high markup renders the plant relatively undersized, characterised by high revenue productivity (TFPR). My research findings show that the pro-competitive effect has greatly improved resource allocation efficiency, particularly due to the improvements in plants with high TFPR (markup).

Using a rich panel dataset and a comprehensive empirical framework, I find that lower trade barriers disproportionately decrease TFPR for plants that have high pre-reform TFPR, resulting in increased input utilisation and output expansion. Specifically, a 10 percentage point reduction in tariff rates led high-TFPR plants to increase output by 2.5%, their wage bill by 1.61%, physical capital by 1.85%, and intermediate inputs by 4.23%, while decreasing TFPR by 5.9% compared to low-TFPR plants, which saw no significant changes. Consequently, the improvements and growth effect is concentrated among plants with high TFPR prior to the reforms. This shift towards more efficient resource allocation highlights the role of trade policy changes in driving productivity gains within the manufacturing sector.

Furthermore, the analysis identifies several plant-level characteristics that affect how plants respond to trade policy changes. Export-oriented plants show more substantial expansions in input utilisation and production, indicating their heightened responsiveness to changes in trade policy.

Moreover, the response to trade liberalisation is influenced by factors such as market concentration and initial tariff levels in the industry, which indicate the level of competition faced by the plants. Industries with high pre-reform market concentration and tariff levels tend to exhibit more significant post-liberalisation declines in TFPR for plants with initially high TFPR, reflecting the pro-competitive effects of trade policy reforms. The robustness checks conducted in this chapter further validate the main findings, demonstrating the stability and reliability of the observed patterns across different specifications and control variables. Incorporating controls for concurrent reforms, addressing outliers, testing alternative TFPR cutoff points, and employing alternative measures of trade protection consistently reaffirm the significance of trade liberalisation in driving heterogeneous improvements in efficiency within the manufacturing sector.

Overall, this chapter contributes to the growing literature on the impact of trade reforms on improving plant-level efficiency. By unraveling the complex interactions between trade policy changes, plant characteristics, and broader industry dynamics, this analysis provides crucial insights for policymakers aiming to leverage trade liberalisation as a catalyst for sustainable economic growth and development. The findings underscore the importance of tailored policies that consider both industry nuances and plant-level capabilities to maximise the benefits of trade openness on resource allocation.

A bridge to the next chapter. This chapter demonstrated how trade liberalisation predominantly reduced distortions among plants facing high trade protection-induced markup distortions in the pre-reform period. These plants also experienced notable increases in their input use and output production, contrasting with plants characterised by low trade protection-induced distortions, which showed no significant changes. These findings are consistent with theoretical expectations, suggesting that the reduction in distortion dispersion primarily results from improvements among plants initially burdened by high trade protection-induced distortions. However, the analysis in this chapter is limited to continuing plants, thus neglecting the role of plant exit in improving allocative efficiency. Plant exit, influenced by competitive pressures from reduced trade barriers, is a significant selection mechanism that has been well-documented in the literature.

In the next chapter, I extend beyond the previous chapters by delving into plant selection dynamics, with a particular focus on exiting plants in the longitudinal sample. I aim to explore whether reduced trade barriers amplify the exit of plants that faced low trade protection-induced distortions and likely survived only because of these minimal distortions. In contrast to the pro-competitive effect discussed earlier, which reduces distortions in dominant plants facing high trade protection-induced distortions, the selection effect targets plants with low trade protection-induced distortions. Their exit would improve allocative efficiency by addressing cross-sectional misallocation. Therefore, overlooking the plant-exit behaviour risks underestimating the impact of trade liberalisation on resource misallocation. The next chapter addresses this gap by assessing plants at the other end of the distortion distribution, providing a comprehensive understanding of which plants potentially contribute to improvements in resource allocation.

3.7 Appendix

3.7.1 Descriptive Statistics

Table 3.5: Summary Statistics: Plant-Level Characteristics

Variable	Pre-Reform	Post-Reform
ln($Labour$)	5.62	5.95
ln($Capital$)	17.94	18.53
ln($Raw\ Materials$)	18.94	19.61
ln($Output$)	19.41	20.04

Note: This table presents the mean of the variables, averaged across the years included in the analysis. The pre-reform period covers 1998-2001, while the post-reform period spans 2002-2016.

3.7.2 Regression Results: Robustness Checks

Table 3.6: Heterogeneous Effect by Plant's Ex-ante TFPR: Controlling for Deservation

	TFPR	Wages	Capital	Raw Materials	Output
$TR_{st-1} \times I_i^{\text{High TFPR}}$	0.458***	-0.159***	-0.171***	-0.403***	-0.232***
	(0.091)	(0.054)	(0.061)	(0.075)	(0.061)
TR_{st-1}	0.049	-0.088**	-0.097	-0.107*	-0.137**
	(0.078)	(0.041)	(0.069)	(0.059)	(0.064)
N	29,889	29,889	29,889	29,889	29,889
R-Squared	0.081	0.062	0.077	0.065	0.079
Controls	Yes	Yes	Yes	Yes	Yes
Plant FEs	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes

Note: All dependent variables are in logs. TR_{st-1} is the lagged output tariff rate. The indicator variable $I_i^{\text{High TFPR}}$ is set to 1 if the plant's TFPR in the pre-reform period from 1998 to 2001 is above the industry mean. Standard errors are in parentheses. ***, **, and * are statistically significant at 1%, 5%, and 10% levels, respectively. All regressions include age, age squared, and plant and year fixed effects. The regression includes a variable SSI_{st-1} that is equal to 1 if a product in the industry has been de-reserved.

Table 3.7: Heterogeneous Effect by Plant's Ex-ante TFPR: Controlling for FDI Liberalisation

	TFPR	Wages	Capital	Raw Materials	Output
$TR_{st-1} \times I_i^{\text{High TFPR}}$	0.415***	-0.140***	-0.163***	-0.298***	-0.228***
	(0.078)	(0.049)	(0.057)	(0.065)	(0.051)
TR_{st-1}	0.081	-0.101	-0.107**	-0.089*	-0.109**
	(0.078)	(0.062)	(0.051)	(0.047)	(0.053)
N	29,889	29,889	29,889	29,889	29,889
R-Squared	0.104	0.074	0.081	0.076	0.092
Controls	Yes	Yes	Yes	Yes	Yes
Plant FEs	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes

Note: All dependent variables are in logs. TR_{st-1} is the lagged output tariff rate. The indicator variable $I_i^{\text{High TFPR}}$ is set to 1 if the plant's TFPR in the pre-reform period from 1998 to 2001 is above the industry mean. Standard errors are in parentheses. ***, **, and * are statistically significant at 1%, 5%, and 10% levels, respectively. All regressions include age, age squared, and plant and year fixed effects. The regression includes a variable FDI_{st-1} that is equal to 1 if FDI is permitted up to 51% in the industry.

Table 3.8: Heterogeneous Effect by Plant's Ex-ante TFPR: Controlling for De-Licensing

	TFPR	Wages	Capital	Raw Materials	Output
$TR_{st-1} \times I_i^{\text{High TFPR}}$	0.471***	-0.155***	-0.175***	-0.308***	-0.266***
	(0.081)	(0.058)	(0.049)	(0.065)	(0.061)
TR_{st-1}	0.073	-0.097**	-0.118*	-0.065	-0.132**
	(0.081)	(0.042)	(0.063)	(0.048)	(0.055)
N	29,889	29,889	29,889	29,889	29,889
R-Squared	0.082	0.068	0.073	0.066	0.075
Controls	Yes	Yes	Yes	Yes	Yes
Plant FEs	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes

Note: All dependent variables are in logs. TR_{st-1} is the lagged output tariff rate. The indicator variable $I_i^{\text{High TFPR}}$ is set to 1 if the plant's TFPR in the pre-reform period from 1998 to 2001 is above the industry mean. Standard errors are in parentheses. ***, **, and * are statistically significant at 1%, 5%, and 10% levels, respectively. All regressions include age, age squared, and plant and year fixed effects. The regression includes a variable LIC_{st-1} that is equal to 1 if the licensing requirement was removed for any product in the industry.

Table 3.9: Heterogeneous Effect by Plant's Ex-ante TFPR: Winsorising Outliers

	TFPR	Wages	Capital	Raw Materials	Output
$TR_{st-1} \times I_i^{\text{High TFPR}}$	0.382***	-0.121***	-0.168***	-0.398***	-0.297***
	(0.061)	(0.047)	(0.041)	(0.062)	(0.061)
TR_{st-1}	0.074	-0.132**	-0.143**	-0.081	-0.182***
	(0.065)	(0.061)	(0.061)	(0.063)	(0.065)
N	29,889	29,889	29,889	29,889	29,889
R-Squared	0.112	0.072	0.075	0.071	0.093
Controls	Yes	Yes	Yes	Yes	Yes
Plant FEs	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes

Note: All dependent variables are in logs. TR_{st-1} is the lagged output tariff rate. The indicator variable $I_i^{\text{High TFPR}}$ is set to 1 if the plant's TFPR in the pre-reform period from 1998 to 2001 is above the industry mean. Estimates are reported after winsorising the top and bottom 5% of the sample for each outcome. Standard errors are in parentheses. ***, **, and * are statistically significant at 1%, 5%, and 10% levels, respectively. All regressions include age, age squared, and plant and year fixed effects.

Table 3.10: Heterogeneous Effect by Plant's Ex-ante TFPR: Alternative TFPR Cutoff

	TFPR	Wages	Capital	Raw Materials	Output
$TR_{st-1} \times I_i^{\text{High TFPR}}$	0.389***	-0.172***	-0.201***	-0.381***	-0.232***
	(0.088)	(0.064)	(0.071)	(0.072)	(0.063)
TR_{st-1}	0.103	-0.121*	-0.148**	-0.080	-0.187***
	(0.082)	(0.068)	(0.071)	(0.059)	(0.064)
N	29,889	29,889	29,889	29,889	29,889
R-Squared	0.095	0.073	0.078	0.071	0.084
Controls	Yes	Yes	Yes	Yes	Yes
Plant FEs	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes

Note: All dependent variables are in logs. TR_{st-1} is the lagged output tariff rate. The indicator variable $I_i^{\text{High TFPR}}$ is set to 1 if the plant's TFPR in the pre-reform period from 1998 to 2001 is above the industry median. Standard errors are in parentheses. ***, **, and * are statistically significant at 1%, 5%, and 10% levels, respectively. All regressions include age, age squared, and plant and year fixed effects.

Table 3.11: Heterogeneous Effect by Plant's Ex-ante TFPR: Alternative Measure of Trade Reform

	TFPR	Wages	Capital	Raw Materials	Output
$IV_{st-1} \times I_i^{\text{High TFPR}}$	-0.402***	0.182***	0.169***	0.329***	0.389***
	(0.072)	(0.062)	(0.061)	(0.013)	(0.081)
IV_{st-1}	-0.087	0.118**	0.101**	0.110	0.204***
	(0.063)	(0.052)	(0.049)	(0.085)	(0.073)
N	29,889	29,889	29,889	29,889	29,889
R-Squared	0.106	0.065	0.075	0.058	0.092
Controls	Yes	Yes	Yes	Yes	Yes
Plant FEs	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes

Note: All dependent variables are in logs. IV_{st-1} is the lagged import volume. The indicator variable $I_i^{\text{High TFPR}}$ is set to 1 if the plant's TFPR in the pre-reform period from 1998 to 2001 is above the industry mean. Standard errors are in parentheses. ***, **, and * are statistically significant at 1%, 5%, and 10% levels, respectively. All regressions include age, age squared, and plant and year fixed effects.

4. Trade Reform, Plant Exit, and Misallocation

4.1 Introduction

Trade theory emphasises the significance of market-share reallocation in boosting aggregate productivity post-trade liberalisation (Bernard et al. [2003], Melitz [2003], and others). These trade models highlight that reallocating market shares to more efficient producers is a key mechanism driving aggregate productivity gains, whether through shifts among existing plants or through the entry and exit of plants. Due to heightened competition from reduced trade barriers, low-productivity plants are less likely to survive and prosper compared to their more efficient counterparts. Pavcnik [2002] found that exiting plants in Chile were, on average, 8% less productive than those that continued, while Eslava et al. [2013] observed that lower productivity plants were more likely to exit during the Colombian trade liberalisation episode. This selection-driven increase in average plant-level productivity increases overall industry productivity. Consequently, this theory underscores the productivity-survival link as a vital driver of productivity growth.

A less studied mechanism that enhances aggregate productivity involves lower resource misallocation resulting from the exit of distorted plants following trade reforms. This chapter focuses on this selection process, which is driven by distortions from trade protection-induced markups. As competition intensifies, domestic plants are forced to reduce their markups to stay competitive. Consequently, some plants struggle to maintain profitability and eventually close down. For instance, plants with lower markups might initially sustain themselves marginally due to their modest markups. However, heightened competition can undermine this profitability, leading to their eventual exit from the market. This exit reallocates resources to high-markup plants, reducing the dispersion in plant-level distortions within the industry and thereby improving allocative efficiency (Hsieh and Klenow [2009], HK hereafter).

It is crucial to distinguish between the two reallocation effects: Firstly, reallocating resources from less efficient to more efficient plants represents a Melitz-type effect that enhances average plant-level productivity and consequently aggregate productivity, independent of misallocation effects. Secondly, the exit of low-markup plants results in a transfer of resources to the surviving high-markup plants, thereby compressing markup dispersion and reducing resource misallocation. This second effect can also positively impact the average plant-level productivity, strengthening the Melitz-type effect. Under the assumption that trade protection-induced distortion dominates in the overall wedge faced by plants, low-markup plants can be identified as having low plant-level revenue productivity (TFPR). Thus, despite facing other market distortions such as high effective input costs, these low markup plants tend to be oversized relative to their productivity. Additionally, as highlighted in Chapter 2, plants with low markups (TFPR) also exhibit low plant-level physical productivity (TFPQ). Consequently, the exit of low TFPR plants results in a remaining group of plants that are more homogeneous, characterised by higher markups and greater productivity. This homogeneity in markups improves resource allocation by reducing markup dispersion and the survival of more productive plants enhances average plant-level productivity, leading to an overall improvement in aggregate productivity. However, it is important to note that while these outcomes enhance economic efficiency, they may not always align with social optimality: the relatively higher average markups resulting from the exit of low-markup plants could pose social challenges despite the efficiency gains.

The misallocation impact of the markup-driven selection channel can be linked to the "Darwinian Effect" described by Baqaee et al. [2024]. This effect refers to the reallocation of resources from plants with elastic demand (and low markups) to plants with inelastic demand (and high markups), thereby alleviating cross-sectional misallocation. Within the context of plant exit in the misallocation literature, HK's findings suggest that plants with low TFPR are more likely to exit in India, indicating TFPR as a robust indicator of profitability. A similar observation was reported by Casacuberta and Gandelman [2015] in their study on the Uruguay financial crisis. Therefore, this paper investigates the hypothesis that increased competition from reduced trade barriers amplifies the exit of low TFPR (low markup) plants, thereby reducing misallocation.

The trade-induced selection channel of plant exit differs from the pro-competitive channel discussed in Chapter 3. The pro-competitive effect of trade leads to a reduction in markups, with the decline being more pronounced for plants initially charging higher markups. This compresses the markup dispersion, driven primarily by changes in the right tail of markup distribution. In contrast, the selection effect of trade causes the exit of low-markup plants, reducing markup dispersion by changes in the left tail. The pro-competitive effect poses challenges for low-markup plants, which may struggle to sustain profitability with significantly reduced markups, thereby driving this selection effect. Thus, the exit of low-markup plants amplifies the positive impact of the pro-competitive effect. Consequently, it is crucial to acknowledge that overlooking plant exit behavior could lead to underestimating the effect of trade liberalisation on resource misallocation.

This chapter aims to examine the impact of lower trade barriers on the Indian manufacturing sector, offering new insights into two key areas: First, analysing how the interaction between tariff reductions and plant-level distortions influence plant exit; and Second, exploring the subsequent effects of these exits on resource misallocation. Understanding the determinants of plant exit and its impact on resource misallocation is particularly significant for developing economies, where improving institutions and market structures plays a crucial role in enhancing allocative efficiency. The case of India is particularly relevant due to the substantial trade reforms initiated in the 1990s. These reforms aimed to increase market competitiveness, which is expected to result in the closure of less efficient and profitable plants. Thus, they provide a unique opportunity to evaluate how underlying plant fundamentals interact with market-oriented changes, influencing plant exits.

In contrast to earlier chapters, I now incorporate the role of plant selection by specifically examining exiting plants in the longitudinal analysis. I limit my study to a subset of Census plants surveyed annually within the panel data, ensuring consistency across years and excluding plants that may have been dropped due to changes in data collection methods year-on-year. I find that plants characterised by low TFPR are more likely to exit, emphasising the critical role of distortions in shaping plant survival outcomes. As expected, plants with lower physical productivity face higher exit probabilities when trade barriers are reduced. The empirical evidence also suggests that higher initial tariffs correlate with lower exit probabilities, indicating that tariff reductions directly influence the likelihood of plant exit. This underscores how trade liberalisation promotes market selection by favouring the survival of high markup and more productive plants.

In applying a standard HK misallocation framework, I argue that plant exits contribute to reducing distortion dispersion, although other market distortions unaffected by trade reforms in India may dampen these gains. The exit of low TFPR plants implies the departure of plants that face low markups and high effective input costs, influencing changes at the upper tail of the input cost distribution. Revisiting the cross-sectional survey data from Chapter 2, I analyse changes in input distortions pre- and post-reform. The findings show significant reductions in effective input costs at the higher percentiles, suggesting that trade liberalisation benefits relatively high-markup (and more productive) plants. Although these plants must also substantially lower their markups (as discussed in Chapter 3), it is the less competitive plants that are phased out due to reduced trade barriers. This dynamic improves allocative efficiency and boosts overall productivity in the industry.

The chapter is structured as follows: Section 4.2 outlines the dataset employed in the analysis. Section 4.3 presents the empirical framework that explores the relationship between plant exits and trade protection-induced distortions at the plant level, offering evidence of market selection driven by tariff reductions. Section 4.4 examines the implications of these findings for resource misallocation. Finally, Section 4.5 concludes the paper.

4.2 Data Description

The Annual Survey of Industries (ASI), carried out by the Indian Ministry of Statistics, is the only annual survey of manufacturing plants in India. Similar to Chapter 3, I leverage the panel structure of the plant-level microdata spanning from 1999–2000 to 2016–2017. It includes all registered plants with at least 10 workers using power or 20 workers without power. The relatively larger plants, referred to as the Census sample, are surveyed every year. The size threshold for inclusion in the Census sample varied between 50 and 100 workers over this period, but plants with 100 or more workers were consistently included. The remaining plants are randomly sampled and referred to as Sample plants. As this paper investigates the effect of trade liberalisation on plant exit, I exclude Sample plants and any plants that might be excluded due to data collection changes. I focus exclusively on Census plants with over 100 workers.[1] I consider a plant to have exited if the plant leaves the sample the following year and does not ever return to the sample. It is important to note that censoring (at 100 employees) means that a plant identified as exiting could also include those that contracted below the 100-employee threshold.[2] Therefore, as is common in studies of plant exit, statements regarding exit should be interpreted broadly, referring to true exit or shrinking (downsizing) of plant below the threshold level.

The key plant-level variables of interest include the plant's industry code, gross output, labor compensation, capital, and intermediate inputs. Additionally, I construct a measure of age, defined as the number of years since the plant's initial year of production. To maintain data quality, I concentrate on plants that have non-missing and positive values for quantitative variables. Furthermore, to reduce the impact of extreme outliers, I apply winsorisation by capping the top and bottom 1% tails of TFPR and TFPQ. Table 4.2 of Appendix Section 4.6 documents summary statistics for the final plant-level sample used in the analysis. Data cleaning and variable construction are carried out in the same manner as described in Chapter 2.

For data on Indian trade liberalisation, I use yearly output tariff data used in the previous chapters that is sourced from World Integrated Trade Solutions (WITS). To ensure consistency between plant-level manufacturing data and tariff data, I employ the concordance provided by Debroy and Santhanam [1993] to align tariff codes with industry codes across more than 5,000 product lines. This matching enables the calculation of average industry-level output tariffs.

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[1] To maintain consistency with the Census definition, this study excludes the year 1998 due to the threshold being set at 200 workers, a methodology also discussed in Aggarwal and Sato [2011], Bollard et al. [2013], and Kathuria and Raj S.N. [2024].

[2] A Census plant that falls below the Census threshold in a given year may still be surveyed, but its status will be altered and data will be collected as part of the Sample plants dataset when the frame is revised. About 3% of plants in the raw unbalanced panel have transitioned from Census to Sample classification.

4.3 Plant-Level Distortions and the Likelihood of Exit

In this section, I empirically investigate how trade liberalisation and plant-level distortions influence the likelihood of plant exit. The hypothesis to test is the selection channel: whether trade liberalisation causes low TFPR plants, potentially characterised by low markups, to exit. This mechanism, akin to the "Darwinian Effect" (Baqaee et al. [2024]), would reallocate resources towards high-markup plants and alleviate misallocation driven by trade protection-induced markups. Examining the exit behaviour of low TFPR plants in the context of reduced trade barriers will determine if heightened competition triggers this selection effect, contributing to efficiency gains distinct from the pro-competitive channel described earlier.

Following Foster et al. [2008], I distinguish between two different measures of productivity studied in the literature: physical productivity, TFPQ (indicative of plant efficiency), and revenue productivity, TFPR (indicative of plant-specific distortions, like markups). They are measured in the data using the approach of HK:

$$TFPR_{si} \triangleq P_{si}A_{si} = \frac{P_{si}Y_{si}}{K_{si}^{\alpha_{k_s}} L_{si}^{\alpha_{l_s}} M_{si}^{\alpha_{m_s}}} \tag{4.1}$$

$$TFPQ_{si} \triangleq A_{si} = \kappa_s \frac{(P_{si}Y_{si})^{\frac{\sigma}{\sigma-1}}}{K_{si}^{\alpha_{k_s}} L_{si}^{\alpha_{l_s}} M_{si}^{\alpha_{m_s}}} \tag{4.2}$$

where α is the industry-specific revenue factor share of output, estimated the same way as in Chapter 2. Since true productivity, A_{si}, is not directly observable in the data, it is derived from revenue productivity using the elasticity of substitution, σ, which is set to 3. The term κ_s serves as an industry deflator. Given that relative productivities are unaffected by κ_s, its value is set to 1.

The distinction between TFPR and TFPQ is crucial as this paper aims to examine the effect of trade liberalisation and plant-level distortion on plant exit and its implications for misallocation. As discussed earlier, plants with higher markups are relatively undersized compared to those with lower markups. Consequently, the exit of low-markup plants (low TFPR) following tariff reductions, and the subsequent reallocation of resources from these plants to high-markup ones (high TFPR), improves allocative efficiency. In this context, the emphasis is on TFPR, where the comparison of distortions rather than productivities (TFPQ) determines the optimal plant size. When distortions like markups are positively correlated with productivity (as discussed in Chapter 2 and Bernard et al. [2003]), then the expansion of more productive plants increases efficiency, indicating that high productivity serves as a signal of high markups.

4.3.1 Empirical Framework

To examine the impact of tariff rate changes on plant exits, I adopt an empirical framework similar to that used by Eslava et al. [2013]. They analyse how a plant's physical productivity (TFPQ) influenced its likelihood of closure in Colombian manufacturing plants following tariff reductions. In contrast, my research investigates how plant-level distortions affect plant closures when trade barriers decrease. My period of study begins in 1999, marking the tail end of the second wave of liberalisation, before which the major portion of tariff reductions occurred. This positions my analysis primarily within the post-reform era, which did observe a continued decline in tariffs until 2009, as depicted in Figure 2.3 in Chapter 2. Thus, I leverage the cross-sectional variations in tariff rates and focus on how they affect the probability of exit of low TFPR plants.

To conduct this analysis, I use a probit model, where the probability of exit between t and $t+1$ is modeled as a function of plant fundamentals. Such a specification would take the following form:

$$\begin{aligned} Pr(e_{ist} = 1) = {} & \beta_1 TR_{st-1} + \beta_2 TFPR_{ist-1} + \beta_3 TR_{st-1} \times TFPR_{ist-1} + \beta_4 TFPQ_{ist-1} \\ & + \beta_5 X_{ist} + \delta_s + \eta_t + \epsilon_{ist} \end{aligned} \tag{4.3}$$

where e_{ist} takes the value of 1 if plant-i in industry-s exits between periods t and $t+1$; TR_{st-1} is a measure of lagged output tariff rate at the 3–digit NIC level; $TFPR_{ist-1}$ measures the revenue productivity and is indicative of plant-level distortions in $t-1$; $TFPQ_{ist-1}$ measures physical productivity in period $t-1$ and is also indicative of plant size (Hopenhayn [1992] and Melitz [2003]). $\mathbf{X_{ist}}$ consists of plant age and its squared term; δ_s are industry effects; η_t are time effects.

This empirical specification uses variables from time $t-1$ to predict exits from t to $t+1$. This approach addresses potential issues of incomplete measurement and endogeneity in period-t, which is just before the exit. There may be mid-year exits that could introduce measurement errors for plants that operate only part of the year. Additionally, the exit process might affect plant characteristics as the plant shuts down, potentially leading to reverse causality. To account for fixed factors that vary across industries, 3-digit industry effects are included, while time effects control for unobserved time-specific factors.

The interaction between tariffs and plant-level TFPR is the focal point of this paper, highlighting how trade protection-induced distortions influence plant exit decisions. Specifically, I examine whether plants with lower TFPR values are more likely to exit with tariff reductions. This would suggest that disadvantaged plants — potentially those with low markups and high effective input costs — are driven out of the market by increased competition. The exit of these plants reallocates resources from low-markup (oversized) to high-markup (undersized) plants. One significant implication of this process is a reduction in distortion dispersion, which improves resource allocation efficiency. This outcome will be explored in detail in Section 4.4.

4.3.2 Plant-Level Evidence

Table 4.1 reports the results of estimating Equation (4.3). Each row of the table reports the marginal effects at the sample mean of the corresponding variable. Given the presence of interaction terms, the marginal effect of $TFPR_{ist-1}$ can be expressed as follows:

$$\frac{\partial Pr(e_{ist}=1)}{\partial TFPR_{ist-1}} = \phi(Z_{ist}) \cdot (\beta_2 + \beta_3 TR_{st-1}) \tag{4.4}$$

where ϕ is the probability density function of the normal distribution, and Z_{ist} includes all covariates and coefficients in Equation 4.3. Similar expressions describe the marginal effects of other variables. Following the approach in Eslava et al. [2013], the marginal effects reported in Table 4.1 are calculated at the mean values for all variables, except for output tariffs, which vary across columns. In column (1), tariffs are set at 60%, while in column (2), they are set at 20%. Since the average tariff value over the entire period is 17.43%, the effects in column (2) closely approximate those obtained when tariffs are set at their mean value.

The rationale for using 60% and 20% tariff rates is to understand how an average plant behaves in different tariff environments. Due to data limitations, my analysis covers the final phase of the second wave of liberalisation and the subsequent third wave. In contrast, earlier years saw more substantial reductions, starting from higher tariff values. Thus, by examining high and low tariff scenarios, I can assess how plant exit decisions were influenced by varying levels of trade protection in India, enabling a comparison with the discrete tariff changes that occurred in the country. Furthermore, given that Equation (4.4) incorporates both the direct effect of $TFPR_{ist-1}$ and its interaction with TR_{st-1}, through coefficients β_2 and β_3, the column comparison in Table 4.1 provides insight into how the likelihood of exit is affected when plants with low TFPR interact with varying tariff rates.

As expected, the direct effect confirms the dynamics of market selection, where plant exit is influenced by TFPR: plants with lower TFPR show a higher likelihood of exit. Additionally, plants with lower physical productivity (TFPQ) are also more likely to exit. These findings are consistent with insights from HK in their study on India, where they observe a significantly negative relationship between exit and both TFPR and TFPQ. Moreover, Kathuria and Raj S.N. [2024] compare continuing plants to exiting units in India and find that the exiting units tend to be younger, less productive, and less profitable on average than the continuing plants. Furthermore, I find direct evidence of the impact of tariff reductions on plant exit. Higher tariffs are associated with a lower probability of plant exit, indicating that reduced competition under higher tariffs support plant survival.

Apart from the direct impact of tariffs on plant exit, I find that trade liberalisation significantly influences the role of TFPR in market dynamics, as detailed in Table 4.1. The absolute marginal effect shows a notable increase as average tariffs decline from 60% to 20%. In terms of economic significance, a one standard deviation decline in TFPR raises the probability of plant exit by 1.03 percentage points at a 60% tariff level and by 1.70 percentage points at a 20% tariff level.[3]

[3] This is obtained by evaluating the probability of exit when one variable is one standard deviation away from its mean, while keeping the other variables at their mean values. The difference between this probability and the probability of exit when all regressors are at their means is then calculated.

Table 4.1: Trade Reform, Plant-Level Distortions, and Exit Probability (Marginal Effects)

DV: $Pr(e_{ist} = 1)$	Tariff = 60%	Tariff = 20%
TR_{st-1}	-0.0145***	-0.0187***
	(0.0034)	(0.0056)
$TFPR_{ist-1}$	-0.0215***	-0.0319***
	(0.0037)	(0.0041)
$TFPQ_{ist-1}$	-0.0572***	-0.0715***
	(0.0011)	(0.006)
Age	-0.0252***	-0.0315***
	(0.0070)	(0.0071)
Age^2	0.0012***	0.0015***
	(0.0060)	(0.0083)
Sector Effects	Yes	
Time Effects	Yes	
Pseudo-R2	0.1372	
N	238,897	

Note: This table reports the marginal effects and standard errors (in parentheses) from a probit estimation of the probability of exit, where exit is 1 for plant-i in year t if the plant produced in year t but not in $t+1$. TR_{st-1} is a measure of lagged output tariff rate. $TFPR_{ist-1}$ measures the revenue productivity and is indicative of distortions; $TFPQ_{ist-1}$ measures physical productivity. This estimation includes the interaction between the tariff rate and revenue productivity. Regression includes industry and year effects. Marginal effects are evaluated at mean values of all variables, except for tariffs. In column (1), tariffs are set at a value of 60%, while in column (2), at 20%. ***, **, and * are statistically significant at 1%, 5%, and 10% levels, respectively.

This empirical evidence aligns with the initial hypothesis that reducing trade barriers improves resource allocation by increasing the likelihood of exit for low TFPR (oversized) plants.[4] Therefore,

[4] To better understand the impact of trade liberalisation on plant exit, particularly among low TFPR plants, I estimate a probit model similar to Equation 4.3, replacing the TFPR level with an indicator variable set to 1 if a plant's TFPR in the previous period was below the industry mean. The analysis reveals that the absolute marginal effect for these low TFPR plants increases from -0.041 at a mean tariff rate of 60% to -0.065 at 20%. These findings confirm that

trade liberalisation not only increases overall exit rates but also strengthens market selection processes. As previously discussed, plants with low TFPR may operate with narrow profit margins due to low markups and high effective input costs, making them more vulnerable to exiting under increased competitive pressures. Thus, the high TFPR plants, which are likely favoured due to their high markups and potential benefits from Export Oriented Unit (EOU) scheme (as discussed in Chapter 2), exhibit a relatively higher probability of survival. This observation is consistent with findings from studies like Goldar and Mukherjee [2016] on India, indicating that exporting reduces the likelihood of plant exit compared to non-exporting plants.

Furthermore, in line with the natural selection hypothesis proposed by Melitz [2003] and related theories, I find that the marginal effect of plant-level TFPQ is negative and statistically significant, indicating that low-productivity plants are more likely to exit. Additionally, these plants are more prone to exiting the market following tariff reductions. This highlights the critical role of plant efficiency in determining both plant survival and market competitiveness. Additionally, the analysis shows that older plants have a reduced probability of exiting. This suggests that older plants, benefiting from accumulated experience and established market relationships, exhibit greater resilience to market shocks compared to younger plants, aligning with existing literature (Evans [1987], Sönmez [2013], Fackler et al. [2013], and others). Overall, these results empirically substantiate theoretical frameworks that emphasise how plant-level characteristics collectively influence the likelihood of exit, particularly in response to changes in trade policy such as tariff reductions.

To develop a more nuanced understanding of the interplay between trade reforms, productivity measures, and plant exit, I incorporate the interaction of TFPQ with tariff rates and TFPR in the baseline regression (Equation 4.3). This approach allows for an exploration of how the impact of trade reforms on plant exit varies with physical productivity and how the relationship between physical and revenue productivity influences plant exit. The marginal effects are reported in Table 4.3 of Appendix Section 4.6. The direct effect indicates that plants with low TFPR and low TFPQ are

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low TFPR plants are more prone to exiting as trade liberalisation progresses, highlighting that the decrease in TFPR dispersion is also influenced by the exit of distorted plants at the left tail of the TFPR distribution.

more likely to exit when tariffs are reduced. Additionally, the negative coefficient on the interaction term between TFPR and TFPQ suggests that high productivity in both dimensions strengthens a plant's ability to survive, making it more resilient to external pressures and market dynamics. Thus, plants with higher markups and greater productivity are better able to withstand the exit-inducing effects of trade reforms.

4.4 Implication for Misallocation

The analysis of plant exit suggests that trade reform accentuated the role of distortions and other plant characteristics in determining which plants continue to operate. These results indicate that trade liberalisation raises the likelihood of exit for plants with low TFPR, who are likely those charging lower markups relative to others in the industry. Moreover, if they operate within industries benefiting from schemes like the EOU, which provide subsidised access to factor inputs, these plants face higher "effective" input costs (Chapter 2). Therefore, the exit of these low TFPR plants, which represents a compression of the left tail of the TFPR distribution, may contribute to reducing the dispersion in input and output distortions. This effect of trade liberalisation complements (and amplifies) the pro-competitive effect discussed in earlier chapters.

As illustrated in the model in Chapter 2, trade liberalisation induces plants to lower their markups to remain competitive, where this reduction is more pronounced for hitherto dominant and ex-ante high markup plants. This process reduces the variation in markups across domestic plants. In the HK misallocation framework, this implies a reduction in the dispersion of output distortions. Recall, the expression of misallocation as follows:

$$\mathbf{V} = \alpha_{k_s}^2 \overline{\sigma}_k^2 + \alpha_{m_s}^2 \overline{\sigma}_m^2 + \sigma_y^2 + 2\left(\alpha_{k_s}\alpha_{m_s}\rho_{km}\overline{\sigma}_k\overline{\sigma}_m - \alpha_{k_s}\rho_{ky}\overline{\sigma}_k\sigma_y - \alpha_{m_s}\rho_{my}\overline{\sigma}_m\sigma_y\right) \tag{4.5}$$

where **V** is the variance of log TFPR, σ_k and σ_m are the dispersion in capital and raw material distortion, respectively, and σ_y is the dispersion in output distortion (capturing the effect of markup dispersion).[5] The correlation between the distortions is given by ρ_{ky}, ρ_{my}, and ρ_{km}, which are

[5] For the full model, please refer to Section 2.3 in Chapter 2.

observed to be positive in India. This indicates that plants charging higher markups tend to encounter lower effective input costs. Through the pro-competitive channel, trade liberalisation reduces the dispersion of output distortions, σ_y, while $\overline{\sigma}_k$ and $\overline{\sigma}_m$ remain unchanged in Equation 4.5.

The selection mechanism examined in this chapter implies the exit of low TFPR plants, which likely operate with low markups and high effective input costs. This process of selection has two effects: Firstly, it compresses the right tail of the "effective" output distortion distribution (which is inversely related to markups), thereby contributing to a further decline in σ_y in Equation 4.5; Secondly, it compresses the right tails of the "effective" input cost distortion distribution. With these plants exiting, the model predicts a simultaneous reduction in σ_k and σ_m, even in the absence of policy changes affecting input prices. This finding weakens the earlier effect in Chapter 2 of a mitigated impact of trade liberalisation on dispersion in input distortions, implying:

$$\mathbf{V} = \alpha_{k_s}^2\sigma_k^2 + \alpha_{m_s}^2\sigma_m^2 + \sigma_y^2 + 2\left(\alpha_{k_s}\alpha_{m_s}\rho_{km}\sigma_k\sigma_m - \alpha_{k_s}\rho_{ky}\sigma_k\sigma_y - \alpha_{m_s}\rho_{my}\sigma_m\sigma_y\right) \tag{4.6}$$

It is important to highlight that the positively correlated distortions that offset production scale effects in the pre-reform period now contribute to a dampening effect, as indicated by the last two terms on the right-hand side of Equation 4.6. This effect potentially occurs because the exit of low TFPR plants reallocates resources toward high TFPR plants, which initially operated with high markups and benefited from subsidised input costs. Post-reform, these subsidies, which previously mitigated the production scale effects of high markups, now lead to a relative overutilisation of resources by these plants. Overall, the results from Chapter 2 still hold, but the selection mechanism now further improves resource allocation and reduces the dampening effect of pre-existing distortions. Therefore, despite the lack of aggregate improvement in resource allocation in India (Figure 2.2), it can be inferred that Indian trade policy changes did positively impact allocative efficiency. However, other economic factors counteracted these positive effects, thus preventing a noticeable overall improvement in resource allocation.

In contrast to Chapter 2, we now expect reductions not only in σ_y but also in σ_k and σ_m. To examine the model implications of reduced dispersion in input distortions and evaluate whether the selection mechanism impacts the right tail of effective input costs, I measure distortions as before:

Effective Capital Cost:

$$1 - \tau_{k_{si}} = \frac{\alpha_{k_s}}{\alpha_{l_s}} \frac{wL_{si}}{rK_{si}} \tag{4.7}$$

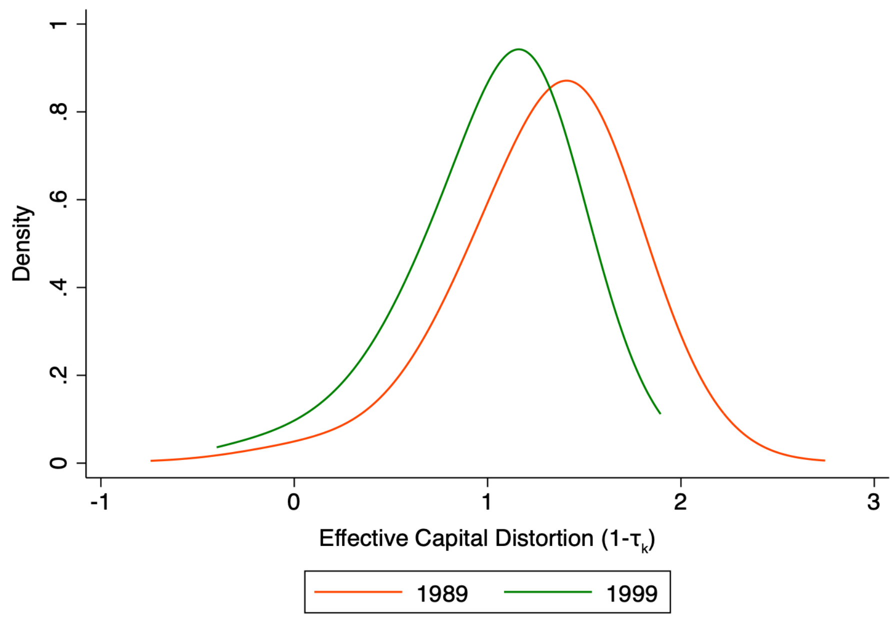
Effective Raw Material Cost:

$$1 - \tau_{m_{si}} = \frac{\alpha_{m_s}}{\alpha_{l_s}} \frac{wL_{si}}{p_m M_{si}} \tag{4.8}$$

Since the panel data used in this chapter doesn't cover the full period during which substantial reductions in output tariffs were implemented (1991-2000), I return to the repeated cross-sectional survey data analysed in Chapter 2. I compare the distribution of input distortions in EOU industries before trade liberalisation (1989) and after (1999), as I argue that these industries face both input and output distortions. Although this cross-sectional survey lacks information on plant exit, the regression result reported in Table 4.1 comparing high and low tariff scenarios suggest that reduced trade barriers likely influenced plant exits. Figure 4.1 illustrates the distribution of capital distortions, while Figure 4.2 presents the distribution for raw material distortions. The plots show the sales-weighted plant-level distortions for Census plants across all EOU industries.

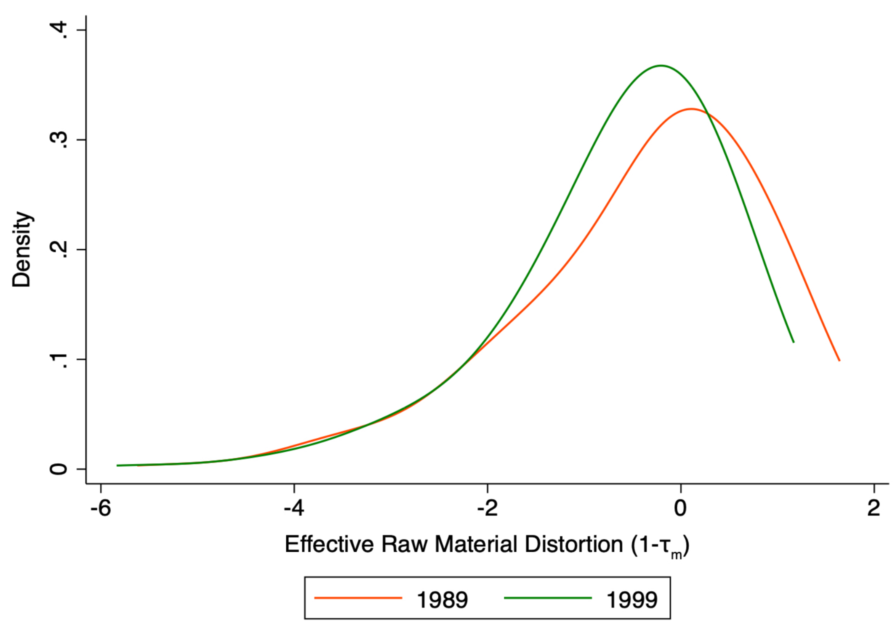
When analysing changes in the distribution of distortions among plants between 1989 (before) and 1999 (after), I focus on three key metrics: the mean, standard deviation, and the distance between the quantile and the mean. I find a noticeable leftward shift and a narrower distribution of these distortions among plants. Figure 4.1 illustrates a reduction in both the mean and dispersion of these distortions over this period. The average effective capital cost $(1 - \tau_k)$ decreased by 21%, and the spread decreased by 10%. Notably, the distance between the plant-level distortions at the 95th and 90th percentiles and the mean reduced by 16% each. In contrast, at the 5th and 10th percentiles, the reduction was modest, at 5% and 7%, respectively. A similar trend is observed for the distribution of raw material distortions, as shown in Figure 4.2. There has been a reduction in both the mean and dispersion of these distortions over this period. Specifically, the average effective raw material cost $(1 - \tau_m)$ declined by 35%, and the spread reduced by 11%. The reduction in the distance between the percentile value and the mean distortions is most pronounced at the higher percentiles. For instance, there was a 17% decrease at the 95th and 90th percentiles, compared to around a 10% decrease at the 5th and 10th percentiles.

Figure 4.1: Distribution of Capital Distortion



Note: The plot shows the kernel density of $log(1 - \tau_k)$, using a Gaussian kernel smoother.

Figure 4.2: Distribution of Raw Material Distortion



Note: The plot shows the kernel density of $log(1 - \tau_m)$, using a Gaussian kernel smoother.

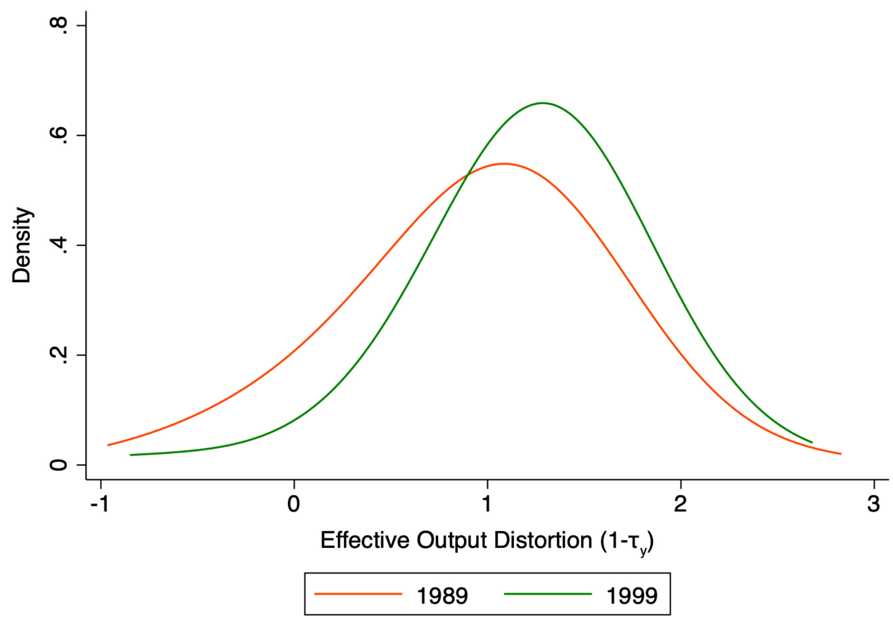
The observed patterns in the right tail of input distortion distributions align with the anticipated outcomes of the exit of low TFPR plants prompted by the selection mechanism under trade liberalisation. This suggests that the dispersion of distortions shrink as a result of potential exits among low TFPR plants, leaving behind plants that tend to have artificially low input costs. The significant reductions in effective input costs at the upper percentiles of capital and raw material distortions were pivotal in reshaping the distribution and narrowing their variance. These plants, which likely operate with lower markups and higher effective input costs, could be categorised as non-EOUs. Such disadvantaged plants may struggle more to cope with increased market competition. Moreover, the relatively modest shifts in the left tail of the input cost distribution may be attributed to the increase in operational EOU plants that benefit from subsidised inputs. According to data from Chapter 2, the number of functional EOUs increased from 174 to 1,438 between 1989 and 1999. This increase likely intensified the presence of plants facing lower effective input costs.

In addition to the newly identified effect of selection mechanism on input distortions, the exit of low TFPR plants is expected to influence the distribution of output (markup) distortions, complementing the pro-competitive effect examined in Chapter 3. This distribution will likely reflect adjustments in the right tail due to the selection effect and in the left tail due to the pro-competitive effect. Although it is challenging to predict which effect will dominate in each tail, significant changes are anticipated in both. To evaluate this change, I measure output distortion as follows:

$$1 - \tau_{y_{si}} = \frac{\sigma}{\sigma - 1} \frac{wL_{si}}{\alpha_{l_s} P_{si} Y_{si}} \tag{4.9}$$

As discussed in Chapter 2, the effective output distortion represents the inverse of markups: a higher value of $1 - \tau_{y_{si}}$ indicates lower levels of markups. Figure 4.3 illustrates the distribution of output distortions among plants in 1989 and 1999, highlighting a significant change. The analysis shows a rightward shift and a narrower distribution of distortions. This implies an increase in the average $1 - \tau_{y_{si}}$ that indicates a potential decline in average markups, accompanied by a narrower spread of distortions. Particularly striking is the substantial decline in the distance between the 5th and 10th percentiles and the mean, amounting to nearly 34% and 46% respectively. This indicates that plants in the left tail now have reduced markups compared to before, reflecting the influence of the pro-competitive effect. In contrast, the distance declined by 22% and 40% at the 95th and 90th percentiles, respectively. This shift in the right tail suggests that following the exit of low-markup plants, the remaining plants in the right tail tended to exhibit relatively higher markups. Overall, this signifies that the lower tail of the distribution is converging towards the mean more rapidly than the upper tail, a pattern also observed in Chapter 3.

Figure 4.3: Distribution of Output Distortion



Note: The plot shows the kernel density of $log(1-\tau_y)$, using a Gaussian kernel smoother.

Therefore, due to the exit of low TFPR plants, among the surviving plants, there is now a predominant presence of those with higher markups and lower effective input costs. Although these plants face pressure to reduce markups to stay competitive, they have managed to sustain their market presence post-liberalisation. Interestingly, despite the departure of low-markup plants potentially induced by the selection mechanism, there has been an increase of 28% in the average $1-\tau_y$ (implying lower markups). This rise in effective output distortion suggests that, on average, the remaining plants now have lower markups than before, highlighting a significant pro-competitive effect. Due to significant shifts in both tails of the distribution, there has been a 23% reduction in the spread of output distortions. This reduction is primarily driven by changes in the left tail, which is converging more rapidly towards the mean, compared to the movements observed in the right tail.

This suggests that the pro-competitive effect examined in Chapter 3 predominates over the selection mechanism studied in this chapter. Furthermore, it is plausible that after the exit of low-markup plants, surviving plants that adjusted their markups downwards may have converged towards the levels of the departed plants. This adjustment in the right tail is challenging to disentangle amidst the presence of both effects.

In summary, the selection effect amplifies the pro-competitive effect of trade by favouring plants capable of competing effectively with higher markups. This potential phase-out of low-markup plants and increase in more efficient, high-markup plants enhances overall market efficiency through improved resource allocation. It highlights the combined influence of both pro-competitive and selection effects in shaping industry dynamics. Consequently, the period of reduced trade barriers can be linked to the survival and growth of plants that effectively manage their profit margins, thereby boosting overall industry productivity.

4.5 Conclusion

This study conducts a longitudinal analysis, specifically examining exiting plants, to investigate how trade liberalisation impacts plant exit dynamics in India's manufacturing sector. The aim is to understand how plant-level distortions affect both exit decisions and resource misallocation. Drawing on established theoretical frameworks of selection and pro-competitive effects of trade, this chapter highlights how reduced trade barriers reshape market dynamics, promoting the survival of high-markup and more productive plants.

Empirical findings indicate that trade liberalisation amplifies the role of plant-level distortions, measured by revenue productivity (TFPR), in determining plant exit outcomes. Plants characterised by lower TFPR, likely facing lower markups and higher effective input costs, exhibit a higher likelihood of exiting following tariff reductions. I also find increased likelihood of exit of plants with low physical productivity (TFPQ). This mechanism of natural selection potentially leads to a reallocation of resources towards more productive and high-markup plants. Additionally, the analysis highlights that older plants exhibit lower exit probabilities, suggesting resilience due to experience and established market relationships. This finding aligns with theories emphasising the role of plant age in shaping survival outcomes amidst shifts in trade policy.

Using a standard Hsieh and Klenow [2009] misallocation framework, I discuss the impact of low TFPR plant exits on industry-wide input and output distortion dispersion. I argue that these exits contribute to reducing the dispersion of distortions, although the gains are weakened by the presence of pre-existing market distortions that are unaffected by the trade reforms. Upon analysing changes in capital and raw material distortions before and after the reform, I observe a significant reduction in their dispersion. Notably, the upper tail of the distribution converges towards the mean more rapidly than the lower tail, indicating that the compression is primarily driven by decreased effective input costs at higher levels. Furthermore, the analysis of the distribution of output distortions reflects adjustments from both the pro-competitive effect, which primarily influences the left tail, and the selection effect, predominantly affecting the right tail. I note a substantial reduction in the dispersion of output distortions, particularly driven by larger changes at the 5th and 10th percentiles, contrasting with smaller changes at higher percentiles. This suggests that the pro-competitive effect prevails over the selection effect. These restructuring dynamics in input and output distortions translate into reduced misallocation and enhanced aggregate productivity. These findings align with theoretical predictions in the literature, underscoring the dual influence of pro-competitive and selection effects in shaping industry dynamics.

In conclusion, this study advances the understanding of how trade liberalisation influences plant selection and allocative efficiency in developing economies like India. Policymakers can leverage insights into the selection and pro-competitive mechanism to enhance economic efficiency through targeted reforms, taking into account the diverse effects of plant-level heterogeneity on plant exit. While the selection effect improves resource allocation, it is crucial to recognise that other market distortions unrelated to trade reforms could mitigate these benefits. Therefore, a comprehensive evaluation of the overall impact of trade policy is essential for designing effective reforms that maximise aggregate productivity.

4.6 Appendix

4.6.1 Descriptive Statistics

Table 4.2: Summary Statistics

Variable	All Years	1999-2001	2002-2009
ln($Labour$)	4.97	4.78	5.08
ln($Capital$)	16.92	16.46	16.97
ln($Raw\ Materials$)	18.04	17.51	18.10
ln($Output$)	18.49	17.95	18.56
Plant Age	22.57	19.39	22.64
Exit Rate	0.0814	0.0672	0.0943

Note: This table presents the mean of the variables, averaged across the years included in the analysis. The exit rates are calculated as the number of exiting plants divided by the total number of plants, where a plant is considered to have exited in year t if it is present in t but not in $t + 1$. I report data for the entire study period (1999-2016), as well as for the sub-periods 1999-2001 and 2002-2009, which capture the second and third waves of liberalisation, respectively.

4.6.2 Additional Results

Table 4.3: Trade Reform, Productivity Measures, and Exit Probability (Marginal Effects)

DV: $Pr(e_{ist} = 1)$	Tariff = 60%	Tariff = 20%
TR_{st-1}	-0.0149***	-0.0192***
	(0.0031)	(0.0061)
$TFPR_{ist-1}$	-0.0231***	-0.0361***
	(0.0032)	(0.0055)
$TFPQ_{ist-1}$	-0.0551***	-0.0734***
	(0.0018)	(0.021)
Age	-0.0219***	-0.0337***
	(0.0056)	(0.0066)
Age^2	0.0011***	0.0014***
	(0.0056)	(0.0079)
Sector Effects	Yes	
Time Effects	Yes	
Pseudo-R2	0.1379	
N	238,897	

Note: This table reports the marginal effects and standard errors (in parentheses) from a probit estimation of the probability of exit, where exit is 1 for plant-i in year t if the plant produced in year t but not in $t + 1$. TR_{st-1} is a measure of lagged output tariff rate. $TFPR_{ist-1}$ measures the revenue productivity and is indicative of distortions; $TFPQ_{ist-1}$ measures physical productivity. This estimation includes the interaction of physical productivity with the tariff rate and revenue productivity. Regression includes industry and year effects. Marginal effects are evaluated at mean values of all variables, except for tariffs. In column (1), tariffs are set at a value of 60%, while in column (2), at 20%. ***, **, and * are statistically significant at 1%, 5%, and 10% levels, respectively.

5. Final Conclusion and Summary

Aggregate productivity is one of the major sources of economic growth and directly depends on how efficiently resources are allocated across plants. This thesis explores the effect of lower trade barriers on the allocation of inputs in the Indian manufacturing sector. It shows that trade liberalisation has the potential to promote better resource allocation by reducing trade protection-induced output distortions and encouraging the exit of distorted plants. These gains can be significantly enhanced when trade reforms are accompanied by targeted interventions to address other market distortions in the economy.

In Chapter 2, I use cross-sectional survey data to offer new empirical insights into the relationship between trade liberalisation and within-industry misallocation in a second-best environment. It highlights how other market distortions unaffected by trade reforms, such as selectively given input subsidies to some exporting plants, can weaken the positive effects of trade liberalisation on resource allocation. Despite significant reductions in trade barriers during the 1990s, pre-existing input market distortions hindered the full benefits of these reforms. The plant-level data reveals that while trade liberalisation improved the overall resource allocation, industries with substantial input distortions experienced less benefit. This reflects a second-best environment where trade protection-induced distortions and input distortions interacted in the pre-reform period.

The findings illustrate that pre-reform trade protection-induced distortions may have mitigated the impact of input subsidy distortions by shrinking production scales. Specifically, plants facing high trade protection-induced distortions operated below their optimal scale to benefit from high markups resulting from reduced competition, while input subsidies enabled them to operate at a larger-than-optimal scale. Following liberalisation, the decline in trade protection-induced distortions allowed input subsidies to dominate, leading to inefficient oversizing of subsidised plants and a worsening of resource misallocation. This underscores the need for concurrent reforms in input markets to maximise the benefits of trade liberalisation. The empirical analysis further suggests that these effects were independent of geographical or institutional factors, as well as other simultaneous reforms. Trade liberalisation itself significantly contributed to reducing resource misallocation within industries.

In Chapter 3, I conduct a longitudinal analysis to investigate whether trade liberalisation differentially reduced markup-induced distortions across plants, as predicted by Edmond et al. [2015]. Using a detailed panel dataset and focusing on continuing plants, I find that trade liberalisation significantly improved resource allocation efficiency, particularly for plants with high levels of pre-reform markups. These plants experienced increased input utilisation and output production, indicating that trade reforms concentrated growth in initially undersized plants. The analysis also reveals that plants in industries with high pre-reform market concentration or high initial tariffs saw more substantial expansions in production scales for pre-reform high markup plants, highlighting the pro-competitive effects of trade policy changes. This chapter contributes to the economic literature by supporting the role of pro-competitive channel in reducing misallocation and detailing how trade reforms can drive heterogeneous improvements in plant-level efficiency.

In Chapter 4, I extend the longitudinal analysis by examining exiting plants and provide novel empirical insights into the relationship between trade reforms, plant exit, and its impact on resource misallocation. My findings indicate that plants charging low markups are more likely to exit after liberalisation, supporting the observations of Hsieh and Klenow [2009] on the exit of relatively oversized plants in India. The economic rationale for the exit of low-markup plants is that high trade barriers allow them to sustain marginal profitability due to their modest markups. However, when trade protection is reduced, these plants must further decrease their markups to stay competitive, gradually eroding their profitability and leading to their eventual exit. This outcome aligns with the "Darwinian Effect" described by Baqaee et al. [2024], where the exit of low-markup plants reallocates resources to high-markup ones, thereby alleviating cross-sectional misallocation. Additionally, as predicted by trade theory (Melitz [2003] and others), trade liberalisation induces the exit of plants with lower physical productivity. Older plants, which likely benefit from experience and strong business connections, show lower exit probabilities. These results underscore the role of distortions and plant characteristics in determining plant survival, highlighting how tariff reductions drive market selection that favours more efficient and high markup plants.

In summary, trade reforms not only alter the production scale of existing firms but also impacts plant survival. While trade integration in developing economies can yield expected gains, it can also result in unintended adverse consequences. Understanding such economic features that prevent gains from trade remains challenging. This research suggests that comprehensive and coordinated reforms addressing other domestic market distortions alongside trade liberalisation can significantly enhance allocative efficiency. Testing these mechanisms in other economies would provide valuable insights into the nature of policy distortions that dampen allocative efficiency gains. Furthermore, the dual impact of trade liberalisation — through both pro-competitive and selection channels — underscores the importance of considering plant exit behaviour to fully grasp the effects of trade policy reforms on resource allocation and productivity. Future research could focus on decomposing the contribution of these individual channels on improvements in resource allocation. This nuanced understanding will help create more effective policies to optimise the benefits of trade liberalisation.

6. Discussion

This thesis contributes to understanding the impact of trade liberalisation on resource misallocation in Indian manufacturing but has certain theoretical and empirical limitations that warrant further exploration. This section addresses these concerns and suggests directions for future research.

In this work, I model the pro-competitive effects of trade liberalisation primarily through reductions in output distortions via lower markups. However, it is essential to acknowledge that input distortions may also evolve post-liberalisation. During the period of output tariff reductions, India simultaneously implemented input tariff liberalisation, granting plants access to cheaper and higher-quality imported inputs. In theory, this change puts pressure on plants' pricing decisions because they can no longer maintain high markups without facing competitive disadvantages. This dynamic is particularly relevant in previously protected industries where plants enjoyed market power in both input and output markets. Liberalisation disrupts this power, leading to a further reduction in distortions as competitive forces operate more strongly in both markets.

The relationship between input tariff liberalisation and market power in India has been modelled by MacKenzie [2021], who examines the effects of endogenous plant-level market power in both input and product markets. The paper shows that trade liberalisation reallocates resources toward larger plants with greater market shares, which in some cases can result in increased input market power. Despite this, the overall impact of trade liberalisation on resource misallocation in India remains positive, contributing to welfare gains. These findings underscore that trade reforms in India have a more significant effect on plants' product market markups than on their input market power (markdowns), demonstrating the complexity of how different types of distortions interact with trade liberalisation. Similarly, Xie et al. [2024] reinforces the importance of input tariff liberalisation in reducing misallocation, focusing on labour markets. Their study on China's WTO accession shows that reductions in input tariffs significantly lower the variance in labour market power, leading to increased production efficiency and reduced misallocation. While this analysis pertains to China, the broader insights apply to India: input market reforms, much like output market reforms, are essential to addressing resource misallocation by reducing distortions in factor markets.

However, a key concern remains that plants may not pass on the cost savings from lower input tariffs to consumers. Instead, they might raise markups, which could dampen the pro-competitive effects of output tariff reductions. This concern is highlighted by Loecker et al. [2016], who study India's liberalisation episode and find that input tariff reductions led to larger declines in marginal costs than in prices. Plants tend to respond to lower costs by increasing their relative markups, limiting the extent to which consumers benefit. To isolate the pro-competitive effects, they control for simultaneous shocks to marginal costs and provide direct evidence that output tariff liberalisation exerted pro-competitive pressure on markups. They also show that the ability of plant, especially those with high initial markups, to raise prices further is curbed by these pro-competitive forces. However, the imperfect pass-through of input cost reductions suggests that if plants respond differently to input tariffs, the expected benefits of output tariff reductions could be diminished, potentially weakening the improvements in resource allocation. My current illustrative model focuses primarily on output tariffs, simplifying the analysis to maintain tractability while still providing valuable insights into the effects of misallocation on the output side. Future research would expand this approach by incorporating the changes in input tariffs, offering a more comprehensive understanding of how both input and output market reforms impact resource allocation.

This complexity also ties into the correlation dynamics between input and output distortions. In the pre-liberalisation period, I find that these distortions were positively correlated, reflecting a second-best environment where multiple distortions coexisted. After liberalisation, as both input and output distortions evolve (due to input and output tariff changes and other reforms), their correlation may shift. While my findings continue to hold regarding the dampening effect from persistent distortions like EOUs, it is possible that the evolving correlation between input and output distortions may either amplify or reduce the gains from trade in terms of resource allocation. Future work would compare pre- and post-reform correlations to understand how simultaneous changes in input and output markets interact. Such a temporal comparison could provide deeper insights into how plants adjust to the reforms, thereby enhancing the model's predictive power regarding resource misallocation.

Empirically, this thesis primarily uses output tariffs as the key independent variable to assess the impact of trade liberalisation. However, as Topalova and Khandelwal [2011] suggests, the effective rate of protection (ERP) offers a better measure of trade protection-induced distortions as it accounts for the net effect of tariff changes on both input and output. Incorporating ERP would involve using India's industry-level input-output matrix. Although this more comprehensive approach was beyond the scope of this thesis, future research would prioritise ERP, particularly given the simultaneous reduction in input and output tariffs during the period studied. This could better capture the dual nature of tariff reforms, enriching the overall findings.

In Chapter 3, the empirical model uses plant-level TFPR as the dependent variable and industry-level tariff reductions as the key independent variable. However, plants may experience mean-reverting productivity shocks and face high adjustment costs, distorting the relationship between TFPR and tariff reductions. Adjustment costs can prevent plants from expanding in response to positive productivity shocks, leading to temporarily inflated TFPR. While plant fixed effects capture time-invariant factors, mean reversion raises the need for dynamic controls to account for short-term fluctuations in productivity. As highlighted by Asker et al. [2014], incorporating lagged productivity terms and adjusting the model specification could help better capture these short-term shocks. Future research would implement such adjustments to refine the empirical analysis.

Furthermore, high-TFPR plants can emerge for various reasons. Some may have high market power, while others might be productive but constrained by distortions such as limited access to inputs or financing. This thesis focuses primarily on the former, examining how trade liberalisation reduces distortions and allows high-TFPR plants to expand. However, not all high-TFPR plants are alike, and future research would explore the sources of high TFPR in more detail. Differentiating between plants with market power and those constrained by distortions would yield more nuanced insights into the welfare implications of trade liberalisation. If high-TFPR plants possess significant market power, reducing their markups would enhance welfare by reducing deadweight loss. Alternatively, if they are constrained by distortions, reducing their markups and allowing them to expand would also reduce misallocation, though the welfare impact might differ depending on the nature of the constraints.

While this thesis provides crucial evidence linking trade liberalisation to reduced resource misallocation, the causal interpretation remains underdeveloped. Currently, the results suggest correlation rather than causation, given the data limitations and the reduced-form econometric methods employed. A more rigorous identification strategy, such as an instrumental variable (IV) approach, would help strengthen the argument for causality. As discussed in the trade literature, exogenous instruments like multilateral trade agreements or external trade shocks could serve as valid instruments for tariff changes. For instance, trade agreements involving India and other countries, where tariff reductions are negotiated at the industry level, could provide exogenous variation. These agreements are often driven by external factors unrelated to domestic conditions, making them suitable instruments for isolating the effects of tariff changes. Furthermore, while industry fixed effects can capture the effect of political economy factors as long as these do not vary substantially across years, the IV approach would help deal with time-variant political economy factors where tariff reductions are endogenously determined by industry-specific factors such as lobbying or election cycles. Future work using external agreements as instruments would allow for a more robust causal interpretation of the relationship between tariff reductions and resource allocation, significantly strengthening the empirical findings.

Bibliography

A. Aggarwal and T. Sato. Firm Dynamics and Productivity Growth in Indian Manufacturing: Evidence from Plant Level Panel Dataset. *RIEB Discussion Paper Series*, No DP2011-07, 2011.

P. Aghion, R. Burgess, S. J. Redding, and F. Zilibotti. The Unequal Effects of Liberalization: Evidence from Dismantling the License Raj in India. *American Economic Review*, 98(4):1397–1412, 2008.

M. S. Ahluwalia. Economic Reforms in India Since 1991: Has Gradualism Worked? *Journal of Economic Perspectives*, 16(3):67–88, 2002.

R. Ahsan and D. Mitra. Trade Liberalization and Labor's Slice of the Pie: Evidence from Indian Firms. *Journal of Development Economics*, Vol. 108, Issue C:1–16, 2014.

L. Alfaro and A. Chari. Deregulation, Misallocation, and Size: Evidence from India. *Journal of Law and Economics*, 57(4):897–936, 2014.

C. Arkolakis, A. Costinot, D. Donaldson, and A. Rodríguez-Clare. The Elusive Pro-Competitive Effects of Trade. *The Review of Economic Studies*, 86(1):46–80, 2018.

J. Asker, A. Collard-Wexler, and J. D. Loecker. Dynamic Inputs and Resource (Mis)Allocation. *Journal of Political Economy*, 122(5):1013–63, 2014.

Y. Bai, K. Jin, and D. Lu. Misallocation Under Trade Liberalization. *American Economic Review*, 114(7):1949–85, 2024.

A. Banerjee and E. Duflo. Growth Theory Through the Lens of Development Economics. *Chapter 7 in the Handbook of Economic Growth*, 1(A), 2005.

D. R. Baqaee, E. Farhi, and K. Sangani. The Darwinian Returns to Scale. *The Review of Economic Studies*, 91(3):1373–1405, 2024.

N. Bau and A. Matray. Misallocation and Capital Market Integration: Evidence From India. *Econometrica*, 91(1):67–106, 2023.

A. B. Bernard, J. Eaton, J. B. Jensen, and S. Kortum. Plants and Productivity in International Trade. *American Economic Review*, 93(4):1268–1290, 2003.

T. Besley and R. Burgess. Can Labor Regulation Hinder Economic Performance? Evidence from India. *Quarterly Journal of Economics*, 119(1):91–134, 2004.

M. Bils, P. Klenow, and C. Ruane. Misallocation or Mismeasurement? *Journal of Monetary Economics*, Elsevier, Vol. 124(S):39–56, 2021.

A. Bollard, P. Klenow, and G. Sharma. India's Mysterious Manufacturing Miracle. *Review of Economic Dynamics*, 16(1):59–85, 2013.

F. J. Buera, J. P. Kaboski, and Y. Shin. Finance and Development: A Tale of Two Sectors. *American Economic Review*, 101(5):1964–2002, 2011.

W. Cao, X. Duan, and X. Niu. Access to Finance, Bureaucracy, and Capital Allocation Efficiency. *Journal of Economics and Business*, page 106125, 2023.

C. Casacuberta and N. Gandelman. Productivity, Exit, and Crisis in the Manufacturing and Service Sectors. *The Developing Economies*, 53(1):27–43, 2015.

F. Caselli. Chapter 9 Accounting for Cross-Country Income Differences. *Handbook of Economic Growth*, 1:679–741, 2005.

A. V. Chari. Identifying the Aggregate Productivity Effects of Entry and Size Restrictions: An Empirical Analysis of License Reform in India. *American Economic Journal*, 33(2):66–96, 2011.

D. K. Das. Trade Policy and Manufacturing Performance: Exploring the Level of Trade Openness in India's Organized Manufacturing in the Period 1990-2010. *Working Paper, id:9073 eSocialSciences*, 2016.

B. Debroy and A. T. Santhanam. Matching Trade Codes with Industrial Codes. *Foreign Trade Bulletin*, 24(1), 1993.

C. Edmond, V. Midrigan, and D. Y. Xu. Competition, Markups, and the Gains from International Trade. *American Economic Review*, 105(10):3183–3221, 2015.

C. Edmond, V. Midrigan, and D. Y. Xu. How Costly Are Markups. *Journal of Political Economy*, 131(7), 2023.

P. Epifani and G. Gancia. Trade, Markup Heterogeneity and Misallocation. *Journal of International Economics*, 83(1):1–13, 2011.

M. Eslava, J. Haltiwanger, A. Kugler, and M. Kugler. Trade and Market Selection: Evidence from Manufacturing Plants in Colombia. *Review of Economic Dynamics*, 16(1):135–158, 2013.

D. S. Evans. The Relationship Between Firm Growth, Size, and Age: Estimates for 100 Manufacturing Industries. *The Journal of Industrial Economics*, 35(4):567–581, 1987.

D. Fackler, C. Schnabel, and J. Wagner. Establishment Exits in Germany: The Role of Size and Age. *Small Business Economics*, 41(3):683–700, 2013.

R. C. Feenstra, R. Inklaar, and M. P. Timmer. The Next Generation of the Penn World Table. *American Economic Review*, 105(10):3150–3182, 2015.

L. Foster, J. Haltiwanger, and C. Syverson. Reallocation, Firm Turnover, and Efficiency: Selection on Productivity or Profitability? *American Economic Review*, 98(1):394–425, 2008.

M. Garcia-Santana and J. Pijoan-Mas. The Reservation Laws in India and the Misallocation of Production Factors. *Journal of Monetary Economics*, 66:193–209, 2014.

B. Goldar and S. Mukherjee. Export Orientation, Import Competition and Plant Survival in Indian Manufacturing. *Journal of International Trade*, 1:72–90, 2016.

R. E. Hall and C. I. Jones. Why Do Some Countries Produce So Much More Output per Worker than Others? *Quarterly Journal of Economics*, 114(1):83–116, 1999.

A. E. Harrison, L. A. Martin, and S. Nataraj. Learning versus Stealing: How Important Are Market-Share Reallocations to India's Productivity Growth? *The World Bank Economic Review*, 27(2):202–228, 2013.

T. J. Holmes and J. A. Schmitz. Competition and Productivity: A Review of Evidence. *Annual Review of Economics*, 2(1):619–642, 2010.

T. J. Holmes, W.-T. Hsu, and S. Lee. Allocative Efficiency, Mark-ups, and the Welfare Gains from Trade. *Journal of International Economics*, 94(2):195–206, 2014.

H. A. Hopenhayn. Entry, Exit, and Firm Dynamics in Long Run Equilibrium. *Econometrica*, 60(5): 1127–1150, 1992.

C.-T. Hsieh and P. Klenow. Misallocation and Manufacturing TFP in China and India. *Quarterly Journal of Economics*, 124(4):1403–1448, 2009.

S. Jagadeesh. Barriers to Competition and Productivity: Evidence from India. *The B.E. Journal of Economic Analysis Policy*, 9(1):1–66, 2009.

C. I. Jones. *The Facts of Economic Growth*, volume 2. Handbook of Macroeconomics, 2016.

V. Joshi and I. M. D. Little. *India's Economic Reforms, 1991-2001*. Oxford University Press, 1996.

S. Kabiraj. Analyzing the Sources of Misallocation in Indian Manufacturing: A Gross-Output Approach. *Asian Development Review*, 37(2):134–166, 2020.

V. Kathuria and R. Raj S.N. What Explains Exit in Indian Manufacturing Industries? *Indian Growth and Development Review*, 2024.

P. J. Klenow and A. Rodriguez-Clare. The Neoclassical Revival in Growth Economics: Has It Gone Too Far? *NBER Macroeconomics Annual 1997*, 12:73–114, 1997.

J. D. Loecker and F. Warzynskia. Markups and Firm-Level Export Status. *American Economic Review*, 102(6):2437–71, 2012.

J. D. Loecker, P. K. Goldberg, A. K. Khandelwal, and N. Pavcnik. Prices, Markups, and Trade Reform. *Econometrica*, 84(2):445–510, 2016.

G. MacKenzie. Trade and Market Power in Product and Labor Markets. *Bank of Canada Staff Working Paper No. 2021-17*, 2021.

S. K. Majumdar. Assessing Comparative Efficiency of the State-Owned Mixed and Private Sectors in Indian Industry. *Public Choice*, 96(1/2):1–24, 1998.

M. J. Melitz. The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity. *Econometrica*, 71(6):1695–1725, 2003.

M. J. Melitz and S. J. Redding. Chapter 1 - Heterogeneous Firms and Trade. *Handbook of International Economics*, 4:1–54, 2014.

M. Nishida, A. Petrin, M. Rotemberg, and T. White. Are We Undercounting Reallocation's Contribution to Growth? *US Census Bureau Center for Economic Studies*, Paper No. CES-WP-13-55R, 2017.

A. Panagariya. India's Trade Reform. *India Policy Forum, National Council of Applied Economic Research*, 1(1):1–68, 2005.

N. Pavcnik. Trade Liberalisation, Exit and Productivity Improvements: Evidence from Chilean Plants. *The Review of Economic Studies*, 69(1):245–276, 2002.

E. C. Prescott. Needed: A Theory of Total Factor Productivity. *International Economic Review*, 39 (3):525–551, 1998.

D. Restuccia and R. Rogerson. Policy Distortions and Aggregate Productivity with Heterogeneous Establishments. *Review of Economic Dynamics*, 11(4):707–720, 2008.

D. Restuccia and R. Rogerson. The Causes and Costs of Misallocation. *Journal of Economic Perspectives*, American Economic Association, 31(3):151–174, 2017.

M. Shirley and P. Walsh. Public vs. Private Ownership: The Current State of the Debate. *Policy Research Working Paper Series, World Bank*, (2420), 2000.

J. Sivadasan. Barriers to Competition and Productivity: Evidence from India. *The B.E. Journal of Economic Analysis Policy*, 9(1):1–66, 2009.

A. Sönmez. Firm Entry, Survival, and Exit. *Academic Journal of Interdisciplinary Studies*, 2(9): 160–167, 2013.

P. Topalova. Trade Liberalization, Poverty and Inequality: Evidence from Indian Districts. *Globalization and Poverty, ed. Ann Harrison, University of Chicago Press*, page 291–336, 2007.

P. Topalova and A. Khandelwal. Trade Liberalization and Firm Productivity: The Case of India. *The Review of Economics and Statistics*, MIT Press, Vol. 93(3):995–1009, 2011.

A. Varshney. Mass Politics or Elite Politics? India's Economic Reforms in Comparative Perspective. *India in the Era of Economic Reforms, Oxford University Press*, pages 222–260, 1999.

E. Xie, M. Xu, and M. Yu. Trade Liberalization, Labor Market Power, and Misallocation across Firms: Evidence from China's WTO Accession. *Journal of Development Economics*, 171 (103353), 2024.

List of Abbreviations

ASI	Annual Survey of Industries
CSO	Central Statistical Office
CST	Central Sales Tax
EOU	Export-Oriented Units
FDI	Foreign Direct Investment
FTP	Foreign Trade Policy
GDP	Gross Domestic Product
HBP	Handbook of Procedures
HS	Harmonized System
ISIC	International Standard of Industrial Classification
MRP	Marginal Revenue Product
NIC	National Industrial Classification
RBI	Reserve Bank of India
SEZ	Special Economic Zones
SSI	Small Scale Industries
TFP	Total Factor Productivity
TFPQ	Total Factor Physical Productivity
TFPR	Total Factor Revenue Productivity