The Impact of Trade Liberalization on Productivity and Firm Size:

Evidence from India's Formal and Informal Manufacturing Sectors

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Abstract

Despite a large literature investigating the impacts of trade on firm productivity, there is almost no evidence on how small firms react to trade liberalization. In this paper, I show that India's unilateral reduction in final goods tariffs increased the average productivity of its manufacturing firms by 15%. Using a unique dataset of firm-level surveys that are representative of the entire Indian manufacturing industry, I document that this result was driven by an increase in productivity among small, informal firms, which account for 80% of Indian manufacturing employment but have been excluded from previous studies. I also examine the effect of the fall in tariffs on the distributions of productivity and firm size, and find evidence consistent with the exit of the smallest, least productive firms from the informal sector.

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1 Introduction

One major potential benefit of trade liberalization is a resulting increase in the productivity of domestic firms. A number of studies (Harrison 1994, Tybout and Westbrook 1995, Pavcnik 2002, Trefler 2004, Amiti and Konings 2007, Fernandes 2007, Topalova 2007, among others) have exploited trade liberalization episodes to examine whether a fall in tariffs has a measurable impact on firm productivity; however, there is almost no empirical evidence on how a fall in tariffs affects the smallest firms. Understanding whether trade liberalization affects firm productivity is important because increases in total factor productivity are linked to growth (see, for example, Bosworth and Collins (2003)). Understanding whether trade liberalization affects small firms in particular is important because these firms account for a large share of employment, especially in developing countries (Tybout 2000), and because recent trade models, most notably Melitz (2003), suggest that entry and exit among these small firms can significantly contribute to aggregate productivity changes.

In this paper, I estimate the impact of India's unilateral trade liberalization on productivity in the entire Indian manufacturing industry, including small, informal firms that account for nearly 80% of Indian manufacturing employment.[1] During the 1990s, India's tariffs were harmonized as part of a reforms package required by the IMF, thus providing rich variation in tariffs across industries and over time while minimizing the potential that certain industries were selected for tariff cuts based on political factors. I have constructed a unique dataset that combines surveys of small, informal firms with surveys of larger, formal firms to provide three cross-sectional snapshots that are representative of the entire manufacturing industry over the course of the trade reforms. I match these firm-level surveys with highly disaggregated data on tariffs for approximately 5,000 product lines. Using a difference-in-differences strategy, I identify the impact of tariff cuts on firm productivity by comparing industries that received relatively high tariff cuts to industries that received relatively low tariff cuts.

My main result confirms that it is important to include small, informal firms when analyzing the impact of a trade reform on productivity. In particular, I find that a 50 percentage point fall in final goods tariffs (the average reduction between 1989 and 1999) increases average productivity by 15%, and that this increase is driven by the informal sector: Average informal sector productivity increases by 15.5%, while average formal sector productivity falls by 5%. However, the fall in final goods tariffs for one industry generates a concurrent fall in tariffs on intermediate inputs for other industries. I find that a 50 percentage point fall in input tariffs increases average formal sector productivity by 30%, which more than offsets the 5% reduction in productivity due to the fall in final goods tariffs. The fall in input tariffs is also associated with higher informal sector productivity, though the result is not statistically significant. The net effect of India's trade liberalization is therefore to increase average productivity in both the formal and informal sectors; however, the increases occur through different channels.

I then investigate two potential mechanisms through which the fall in final goods tariffs may have

[1] Informal firms are not illegal; rather, they are small firms that are not required to register with state governments under India's 1948 Factories Act.

increased average productivity. I focus on two mechanisms that have been extensively incorporated into the recent theoretical trade literature: entry and exit among the smallest, least productive firms, and the reallocation of market share between firms of different productivity levels. It is important to understand whether these two mechanisms make significant contributions to the aggregate changes in productivity because they shed light on which firms gain and which firms lose from a trade liberalization.

Looking for direct evidence of entry and exit among the smallest firms, or even for evidence of reallocation of market share among mid-sized firms, is an empirically daunting task because panel data that track small and medium enterprises over time are often unavailable, particularly in developing countries. This produces a trade-off between following a panel of firms, and including small firms. In this paper, I suggest a way to look for the entry/exit and reallocation mechanisms using pooled, cross-sectional data that includes the smallest firms. In particular, I draw on two recent trade models (Demidova and Rodriguez-Clare (2009), which is based on the seminal work of Melitz (2003), hereafter DR-M, and Melitz and Ottaviano (2008), hereafter MO); these models offer predictions on how a unilateral fall in final goods tariffs will affect firms of different productivity levels and sizes via the entry/exit and reallocation mechanisms. I then look for evidence of changes in the productivity and firm size (output) distributions that are consistent with these predictions.

To measure changes in the productivity and firm size distributions empirically, I employ a quantile regression technique that allows me to simulate and compare the distributions of productivity and firm size that prevailed prior to the reforms, to those that would have prevailed if final goods tariffs had been distributed as they were after the reforms, all else equal. I find that the increase in average informal sector productivity is caused by increases across most quantiles of the distribution, and that firm size increases across most quantiles as well. The increase in productivity is particularly pronounced in the left tail of the distribution, which is consistent with DR-M's prediction that the least productive firms (most of which are found in the informal sector) will exit. In the formal sector, I find that the decrease in average productivity is driven by a decrease among the lowest quantiles of the distribution. Furthermore, average firm size falls among the lower quantiles of the distribution, but this effect is attenuated among the upper quantiles. This result is consistent with the reallocation mechanism suggested by DR-M. DR-M predict that all surviving firms will decrease their domestic output, but that existing exporters (which tend to be the largest firms) will concurrently increase their export output. Therefore, large firms will contract relatively little compared to mid-sized firms. Given the limitations of my dataset, I cannot confirm this mechanism explicitly. However, my findings are consistent with the reallocation of market share away from mid-sized, domestic firms towards large, export-oriented firms. While neither the formal nor the informal sector, considered independently, conforms to the predictions of either the DR-M or MO models, the combination of changes in the productivity and firm size distributions in the two sectors supports the exit and reallocation mechanisms predicted by DR-M.

Although we expect small and large firms to react differently to trade, the stark contrast between the reactions of the informal and formal sectors to the fall in final goods tariffs deserves further examination.

I investigate several potential reasons for this contrast, as well as for the drop in productivity in the formal sector. I find that the fall in final goods tariffs is associated with net entry of formal firms into India's comparative advantage industries, but net exit of informal firms from those industries. I also document that new entrants tend to be less productive than incumbent firms, and that the drop in formal sector productivity is greater in comparative advantage industries. These findings suggest that the entry of new, formal firms into comparative advantage industries may explain part of the decline in formal sector productivity.

Finally, I extend my analysis to explore whether India's trade reforms affect not only the output size distribution, but the employment size distribution as well. India's employment, like that of many developing countries, is concentrated among tiny firms and very large firms, with little employment in mid-sized firms; this phenomenon is known as the "missing middle" (see, for example, Mazumdar (1998)). Although a number of politicians and commentators have expressed concern that India's trade reforms shifted more employment into small, informal firms, there is almost no quantitative evidence linking trade and the employment size distribution. Using the quantile regression based simulation technique discussed above, I find that the fall in final goods tariffs does not affect employment size in the informal sector, but shifts some employment away from mid-sized formal firms, with 10-50 employees, to small formal firms, with fewer than 10 employees. India's trade liberalization does appear to exacerbate the missing middle, albeit slightly. The difference between the output and employment size results also suggests that the reallocation of market share among firms is not accompanied by a simultaneous reallocation of labor.

This paper contributes to the empirical literature on trade and firm productivity. Theory suggests that trade liberalization may either increase or decrease productivity.[2] Empirically, a number of studies have exploited tariff liberalization episodes to measure the impact of trade on productivity (Tybout, de Melo and Corbo (1991) and Pavcnik (2002) for Chile, Harrison (1994) for Cote d'Ivoire, Tybout and Westbrook (1995) for Mexico, Trefler (2004) for Canada, and Amiti and Konings (2007) for Indonesia, among others). The evidence, though somewhat mixed, generally supports the view that trade liberalization is associated with increased firm productivity. However, nearly all of these studies exclude small firms. A notable exception is the work by Tybout et al. (1991), which uses manufacturing census data to test whether Chile's trade reforms increase productivity between 1967 and 1979. The authors find little evidence of an overall productivity improvement after the reforms; however, they do find some evidence that industries that face relatively high tariff cuts exhibit relatively large increases in productivity.

Within India, nearly all of the previous work on trade and productivity has focused on large, for-

[2]For example, individual firms may improve their productivity following a trade reform due to increased managerial effort (Corden 1974), exploitation of economies of scale (Helpman and Krugman 1985), or better access to imported intermediate inputs (Grossman and Helpman 1991). In contrast, Rodrik (1991) argues that trade liberalization may reduce firms' incentives to innovate, while Young (1991) and Stokey (1991) show that trade can slow growth or reduce investment in human capital among developing countries. More recent literature shows that even without changes in individual firm productivity, trade can increase or decrease aggregate industrial productivity by changing entry and exit patterns and by reallocating market share between firms of different productivity levels (see Section 2 for a description of how two such models - DR-M and MO - yield contrasting predictions).

mal firms. Early studies reach conflicting conclusions: Krishna and Mitra (1998) find that productivity growth accelerates after the beginning of the trade reforms in 1991, while Balakrishnan, Pushpangadan and Babu (2000) do not, even though both use data on large firms in a similar set of industries. More recently, Sivadasan (forthcoming) uses data on formal firms with more than five employees, and finds that average productivity increases among industries that experience a large drop in final goods tariffs (more than 33%) between 1990 and 1992, relative to those that do not. The paper most closely related to my own work is a study by Topalova (2007), who finds that tariff cuts increase productivity among large firms.[3] My difference-in-differences strategy is similar to hers, and I employ tariff data at a similar level of disaggregation. The key difference is that her study focuses on approximately 4,000 large firms, and she finds that within-firm productivity improvements are largely responsible for the increase in productivity among those firms. In contrast, my firm-level data are representative of the entire manufacturing industry, which consists of nearly 100,000 formal firms as well as millions of informal firms, and I find evidence consistent with exit among the least productive firms.

This paper is also related to work that examines whether the entry/exit and reallocation mechanisms suggested by recent trade models are important components of aggregate productivity changes. The empirical evidence, particularly in developing countries, is mixed. With respect to the exit mechanism, Pavcnik (2002) notes that trade liberalization has little effect on the productivity of exiting firms in Chile, and Fernandes (2007) finds that the productivity differential between entering and exiting firms plays little role in the increase in aggregate productivity following Colombia's trade reforms; however, Eslava, Haltiwanger, Kugler and Kugler (2009) also study the Colombian trade liberalization and find that exit of the least productive firms is an important factor in aggregate productivity gains. Muendler (2004) documents both within-firm productivity gains and gains from the exit of relatively unproductive firms following Brazil's trade liberalization, but finds that the latter occur more slowly.

With respect to the reallocation mechanism, Tybout and Westbrook (1995) do not find that this mechanism contributes significantly to the change in productivity following Mexico's trade reforms, while Pavcnik (2002) finds that such reallocation accounts for two-thirds of the productivity gains in the years following Chile's trade reforms. In Colombia, Fernandes (2007) finds that within-firm productivity gains are more important than reallocation, but that reallocation becomes important in many industries during periods of tariff liberalization. Like most other studies of trade liberalization episodes, all of these papers exclude small firms. I add to this body of work by using a novel method to look for evidence of entry/exit and reallocation using pooled, cross-sectional data that includes the smallest firms.

The rest of this paper is organized as follows. Section 2 shows how predictions from the models discussed above (DR-M and MO) can be used to look for evidence of the entry/exit and reallocation mechanisms in the wake of a trade reform. Section 3 presents an overview of India's trade liberalization and discusses the tariff data that I use, while Section 4 provides an overview of the combined formal and informal firm dataset. Section 5 presents the empirical strategy and results, and Section 6 concludes.

[3] In related work, Goldberg, Khandelwal, Pavcnik and Topalova (2008) show that the concurrent decrease in input tariffs leads to an increase in the variety of products made by large Indian firms.

2 Theoretical Motivation

In this section, I provide a brief overview of the DR-M and MO models. In particular, I focus on how a unilateral trade liberalization leads to entry and exit among small firms, as well as a reallocation of output among larger firms, in each model. I then discuss how these two mechanisms provide testable implications for the distributions of productivity and firm size (output) following a trade liberalization.

2.1 Free Entry Equilibrium with Costly Trade

Productivity

In both models, there are two countries - Home and Foreign. I will focus on Home, and on the case in which Home lowers its final goods tariffs unilaterally. To facilitate comparison between the two models, I have modified the notation of each slightly.[4]

In order to enter, firms must pay a fixed entry cost f_e. Upon entry, each firm receives a productivity draw ϕ from a known distribution. Both DR-M and MO assume that productivity draws ϕ follow a Pareto distribution with lower bound b and shape parameter β:

$$DR\,and\,MO: G(\phi) = 1 - [b/\phi]^{\beta}, \phi > b \tag{1}$$

Demand and Production

In DR-M, Home consumers have constant elasticity of substitution (CES) preferences over domestic and foreign varieties indexed by ν and ν', which lead to the following demands:

$$DR: q(\nu) = RP^{\sigma-1}[p(\nu)]^{-\sigma}, q_m(\nu') = RP^{\sigma-1}[\tau_H p_m(\nu')]^{-\sigma} \tag{2}$$

where R is aggregate expenditure at Home, P is the aggregate price level at Home, p and p_m are the prices of domestic and imported varieties, respectively, σ is the elasticity of substitution between varieties, and τ_H is the Home tariff on imports.

In contrast, MO employ a linear demand structure, which yields the following demand for variety ν:

$$MO: q(\nu) = \frac{\alpha - p(\nu) - \eta Q}{\gamma} \tag{3}$$

where γ represents the elasticity of substitution between the differentiated varieties, α and η govern the substitution between the differentiated products and an outside good, and Q is total consumption of the differentiated varieties.

[4]In MO, productivity draws are given by $1/c$ where c is the firm's marginal cost of production. All of MO's key results are presented in terms of cost draws, rather than productivity draws. For easier comparison with DR-M, I have rewritten all relevant expressions in terms of productivity draws $\phi \equiv 1/c$. In addition, to simplify the analysis, I remove the consumption and export subsidies that play a role in the DR-M model.

The demand functions highlight two key differences between DR-M and MO. The first is the structure of demand. In DR-M, the CES preference structure means that each firm's price is a constant markup over its marginal cost. In MO, the linear demand structure means that markups depend on the productivity of the marginal firm; a more competitive environment, indicated by a more productive marginal firm, leads to lower markups. The second key difference is the use of an outside, numeraire good in MO. In DR-M, consumers only substitute between differentiated varieties of the same good. In MO, consumers substitute between differentiated varieties as well as an outside good, which is produced in a competitive market under constant returns to scale with unit cost. This sets wages, so changes in Home tariffs do not affect the differentiated goods industry through the factor market. Rather, a fall in tariffs changes the minimum productivity required for survival, which therefore affects the prices and quantities charged by all other firms because of the linear demand structure.

In both models, firms produce their output using only labor. They behave as monopolistic competitors, and choose domestic and export output separately. In DR-M, Home is a "small" country; Home firms cannot affect aggregate price or expenditure levels in Foreign. Furthermore, exporters face a fixed exporting cost wf_{exp} (where w is the wage) in DR-M, while exporters face a per-unit exporting cost τ_F in MO.

Equilibrium

In each model, firms enter until the expected profit from entering equals the entry cost. This free entry condition defines the domestic productivity cutoff ϕ^*; firms with productivity draws below ϕ^* exit without producing. Similarly, in each model, an exporting condition defines the exporting productivity cutoff ϕ_x^*; firms with productivity draws between ϕ^* and ϕ_x^* sell to the domestic market ("domestic" firms), while those with draws above ϕ_x^* export and sell domestically ("exporters"). Each firm's domestic output q_D and export output q_X can be written as functions of these cutoff productivities:

$$DR : q_D = \frac{f[\sigma-1]}{[\phi^*]^{\sigma-1}}\phi^\sigma \qquad\qquad q_X = \frac{f_{exp}[\sigma-1]}{[\phi_x^*]^{\sigma-1}}\phi^\sigma \tag{4}$$

$$MO : q_D = \frac{L_H}{2\gamma}[\frac{1}{\phi^*} - \frac{1}{\phi}] \qquad\qquad q_X = \frac{L_F}{2\gamma}\tau_F[\frac{1}{\phi_x^*} - \frac{1}{\phi}] \tag{5}$$

In Equation 4, f is the fixed cost of production, while in Equation 5, L_H and L_F are the sizes of the Home and Foreign markets. Note that Equations 4 and 5 imply a positive and monotonic relationship between output and productivity $(\partial q_D/\partial\phi > 0, \partial q_X/\partial\phi > 0)$ in both models.

I now turn to average productivity and firm size. Let average productivity be a simple, unweighted function of the productivity of surviving firms; then the average productivity in both models is:[5]

$$DR\,and\,MO : \overline{\phi} = \frac{\int_{\phi^*}^{\infty} \phi dG(\phi)}{1 - G(\phi^*)} = \frac{\beta\phi^*}{\beta - 1} \tag{6}$$

Average productivity rises with an increase in the domestic productivity cutoff ϕ^*. Similarly, we can derive expressions for average domestic and export output as functions of the domestic and exporting productivity cutoffs:

$$DR : \overline{q_D} = \frac{f[\sigma - 1]\beta}{\beta - \sigma}\phi^* \qquad \overline{q_X} = \frac{f_{exp}[\sigma - 1]\beta}{\beta - \sigma}\phi_x^* \tag{7}$$

$$MO : \overline{q_D} = \frac{L^H}{2\gamma}\frac{1}{[\beta + 1]}\frac{1}{\phi^*} \qquad \overline{q_X} = \frac{L^F}{2\gamma}\frac{1}{[\beta + 1]}\tau^F\frac{1}{\phi_x^*} \tag{8}$$

In DR-M, average domestic output increases with a rise in the domestic productivity cutoff ϕ^*, whereas the opposite occurs in MO. Equations 4 and 5 imply that in both models, an individual firm's domestic output falls when ϕ^* rises. However, when ϕ^* rises, the least productive (smallest) firms can no longer survive. The latter effect outweighs the former in DR-M, but not in MO, resulting in the differing predictions. Similarly, in DR-M, average export output increases with a rise in the exporting productivity cutoff ϕ_x^*; in MO, the opposite occurs.

2.2 Effects of a Unilateral Fall in Final Goods Tariffs

Both DR-M and MO explicitly consider the effects of a fall in final goods tariffs at Home on the domestic and exporting productivity cutoffs at Home. In DR-M, the fall in Home final goods tariffs causes the domestic productivity cutoff ϕ^* to rise and the exporting productivity cutoff ϕ_x^* to fall. This occurs because consumers shift spending away from domestic varieties and towards imports. The reduction in spending on domestic varieties forces the least productive domestic firms to exit, raising ϕ^*. At the same time, ϕ_x^* falls, which allows more Home firms to begin exporting. In contrast, MO show that the fall in final goods tariffs causes ϕ^* to fall and ϕ_x^* to rise. This occurs because fewer firms choose to enter at Home when there is less protection. Less entry yields less competition at Home, which allows less productive firms to survive. Conversely, there is more entry in Foreign, so ϕ_x^* rises.

I use these predicted changes in the domestic and exporting productivity cutoffs to derive testable predictions for average productivity and firm size, as well as for the firm size and productivity distributions. Examining the effects of a fall in tariffs at various points of the productivity and size distributions

[5] Each model defines average productivity in a slightly different way. To facilitate comparison, I follow MO's method of calculating average productivity.

can shed light on whether the entry/exit and reallocation mechanisms suggested by the two models are important in the Indian case. I test the following predictions for the effects of a unilateral fall in tariffs:

Average productivity. DR-M predict that ϕ^* rises, while MO predict that ϕ^* falls. Therefore, from Equation 6, average productivity rises in DR-M and falls in MO.

Left tail of the productivity distribution. In DR-M, since the least productive firms exit, the left tail of the productivity distribution should shift to the right. We should therefore see a sharp increase in productivity among the lowest percentiles of the distribution of surviving firms, with the increase tapering off among higher percentiles. In MO, since less productive firms can survive, the left tail of the productivity distribution should shift to the left. We should therefore see a sharp decrease in productivity among the lowest percentiles of the distribution, with the decrease tapering off among higher percentiles.

Right tail of the productivity distribution. In both models, the productivity of the largest firms remains unchanged. Therefore, we would expect to see little or no change among the upper percentiles of the productivity distribution.

Average firm size (output). In DR-M, ϕ^* rises and ϕ_x^* falls; meanwhile, in MO, ϕ^* falls and ϕ_x^* rises. Therefore, from Equations 7 and 8, average domestic output increases, while average export output decreases, in both models. The impact of a fall in tariffs on average firm size is therefore ambiguous.

Left tail of the firm size (output) distribution. There is a positive, monotonic relationship between firm size (output) and productivity in both models. The smallest firm in DR-M has productivity level ϕ^* and size:

$$DR : q_D(\phi = \phi^*) = f[\sigma - 1]\phi^* \tag{9}$$

A fall in final goods tariffs raises ϕ^*, which increases the size of the smallest firm and moves the left tail of the size distribution to the right. In MO, the smallest firm, which has productivity ϕ^*, always has zero output (see Equation 5). Therefore, the left tail of the size distribution does not shift.

Right tail of the firm size (output) distribution. In DR-M, Equation 4 shows that when ϕ^* rises and ϕ_x^* falls, the domestic output of existing firms falls, while the export output of existing exporters rises. In MO, Equation 5 shows that when ϕ^* falls and ϕ_x^* rises, the domestic output of existing firms rises, while the export output of existing exporters falls. Since the largest firms are exporters, the right tail of the firm size distribution may therefore either shift left or right in both models.[6]

Change in size of large firms relative to mid-sized firms. In both models, the largest firms are exporters, and are therefore relatively less exposed to the domestic market than are mid-sized and small firms. Therefore, the effect of a fall in tariffs on firm size will be attenuated for large, export-oriented firms relative to mid-sized, domestic firms. In DR-M, the change in firm size will be less negative among the upper percentiles of the distribution, relative to the middle percentiles; in MO, the change

[6]In the original Melitz (2003) framework, Home and Foreign as symmetric, so the increase in export sales necessarily outweighs the decrease in domestic sales for the largest firms, and the size of the largest firms increases. However, this need not be the case in the DR-M framework, since Home and Foreign are asymmetric.

in firm size will be less positive among the upper percentiles of the distribution, relative to the middle percentiles.

Table 1 summarizes these predictions. In the following sections, I describe how I will look for evidence of these effects in the Indian case.

3 A Brief Overview of the Indian Trade Reforms

Prior to 1991, import substitution was the cornerstone of India's trade regime. Just before the 1991 reforms, the average final goods tariff on manufactured products was approximately 95%. Aksoy (1992) notes that tariffs constituted over a third of tax revenues in 1987, and that "[h]istorically, to contain balance of payments crises, tariff rates were increased instead of adjusting the exchange rate. However, these rates were not reduced when the exchange rate was eventually adjusted. Thus with every foreign exchange crisis, the average tariff collection rate has ratcheted upward to a higher plateau." India also had restrictive non-tariff barriers, which required firms to apply for licenses in order to import most items, and banned many imports altogether.

Throughout the 1980's, India's budget deficit continued to grow, as did its balance of payments deficit. In 1991, a combination of economic and political shocks - namely, a rise in oil prices, a decrease in remittances from Indians living abroad, and an unstable political climate - forced additional change by creating a balance of payments crisis. The IMF granted India a Stand-By Agreement on the condition that it undertake several reforms (Topalova 2007). In July 1991, India's government announced a series of major policy changes, including FDI liberalization, exchange rate liberalization, the removal of the requirement for operating licenses in most industries, the removal of import licensing requirements for capital and intermediate goods, and a reduction and harmonization of tariffs across industries.

Between 1989 and 1999, the average final goods tariff rate on manufactured products fell from 95% to 35%. I calculate final goods tariff rates for each industry based on the Government of India's Customs Tariff Working Schedules, in which rates are given for approximately 5,000 product lines. Using the concordance of Debroy and Santhanam (1993), I match the product lines with 3-digit National Industrial Classification (NIC-87) codes, and calculate average final goods tariff rates within each of approximately 170 industries. Table 2 shows average final goods tariffs for broad manufacturing industry groups in 1989, 1994, and 1999. Panel (a) of Figure 1 illustrates that final goods tariffs varied significantly across industries in 1989, and were both lowered and harmonized during the 1990s.

India's trade liberalization provides an excellent case study because of the manner in which the reforms took place. Tariffs were lowered and harmonized across all industries; therefore, the industries with the highest pre-reform tariffs faced the highest tariff cuts (Panel (b) of Figure 1). This pattern provides rich variation in tariffs across industries and over time, allowing me to control for macroeconomic shocks that affected all industries in the same way, as well as for time-invariant, industry-specific characteristics. It also lowers the chance that industries were selected into tariff cuts based on political factors.

It is still possible, though, that pre-reform tariff levels are correlated with industry characteristics. I explore this possibility by looking at the correlations between changes in final goods tariffs (1989-1999) and pre-reform industry characteristics in 1989. I consider the two main outcomes of interest (total factor productivity, or TFP, measured as discussed in Section 4.1, and firm size, measured in terms of output) as well as other characteristics that might influence political decisions about tariff protection: the capital-employee ratio, wages, export orientation (the share of exports in output, based on data from the World Bank's Trade and Production Database), industry size (the number of firms), and industry concentration (for which I use the formal sector's four-firm concentration ratio as a proxy).

Panels A and B of Table 3 present correlations between tariff changes from 1989-1999 and the levels of each of these pre-reform characteristics in 1989, for the informal and formal sectors, respectively. None of the informal sector characteristics are related to tariff changes, but there is some evidence that industries with higher average firm sizes and capital-employee ratios in the formal sector may have received larger tariff cuts. However, Panel C of Table 3 shows that pre-reform trends in formal sector characteristics (measured as the change from 1986-1989) are not correlated with subsequent tariff changes. These findings suggest that the use of industry fixed effects should account for the potential selection of industries with relatively large, capital-intensive firms into the tariff cuts. In all of the analyses that follow, I include both year and industry fixed effects, thus comparing changes in industries that received relatively large tariff cuts to those that received relatively small tariff cuts.[7]

Recent work by Amiti and Konings (2007) suggests that failing to control for input tariffs may lead to biased estimates of the impact of final goods tariffs on firm productivity. To address this possibility, I calculate input tariffs using India's input-output transactions table (IOTT), following the method suggested by Amiti and Konings (2007). For example, if the footwear industry derives 80% of its inputs from the leather industry and 20% from the textile industry, then the input tariff for the footwear industry is 0.8 times the final goods tariff for the leather industry plus 0.2 times the final goods tariff for the textile industry. This measure of input tariffs is not perfect; the IOTT provides data at a relatively aggregated level (it has 66 manufacturing industries, compared to 171 manufacturing industries for final goods tariffs). In addition, I cannot identify which individual firms import raw materials, and are therefore most likely to be affected by the fall in input tariffs.

One potential concern is that final goods and input tariffs may be highly correlated, thus leading to multicollinearity problems in estimation. Panel (c) of Figure 1 shows the relationship between the change in final goods tariffs and the change in input tariffs for a given industry. Though the two measures are related, there are a number of industries that received relatively large reductions in final goods tariffs but relatively small reductions in input tariffs, and vice versa. Moreover, the overall correlation

[7]The lack of a relationship between tariffs and pre-reform industry characteristics is somewhat surprising. However, Topalova (2007) finds similar results; she suggests that the lack of a relationship may be explained by Gang and Pandey's (1996) argument that India's tariff policy was largely set during the 1950s by its Second Five-Year Plan, and that industrial protection patterns have not significantly changed since then.

coefficient between tariffs and input tariffs (across years and industries) is 0.65. Within years, the correlation coefficient is even lower (0.48, 0.38, and 0.55 in 1989, 1994, and 1999 respectively), which suggests that multicollinearity is not likely to be a significant problem.

4 Combined Informal and Formal Firm-Level Data

A key contribution of this work is the creation of a unique dataset that links both formal and informal Indian firms, thus providing three snapshots of the entire manufacturing industry during the period of the trade reforms. All manufacturing firms with more than 10 workers that use electrical power, or 20 workers that do not use electrical power, are required to register under the Factories Act; these firms are considered organized, or formal. Firms below these employment thresholds are not required to register under the Factories Act, and unregistered firms are considered unorganized, or informal. India's formal manufacturing sector has approximately 100,000 firms and employs eight million people, while the informal manufacturing sector includes 15 million firms that employ nearly 30 million people. I combine informal sector data from 1989-90, 1994-95, and 2000-01 with formal sector data from 1989-90, 1994-95, and 1999-2000.[8]

The formal sector is surveyed by the Central Statistical Organisation (CSO) every year through the Annual Survey of Industries (ASI). The sampling universe for the ASI is all firms that are registered under Sections 2m(i) and 2m(ii) of the Factories Act, as well as firms registered under the Bidi & Cigar Workers Act, and a number of utility providers.[9] Large firms (those with 100 or more employees from 1987-1996, and with 200 or more employees or a certain output value between 1997 and 2002) are surveyed every year, while approximately one-third of the smaller firms are surveyed. In states designated as "industrially-backwards," all firms are surveyed, regardless of size. The ASI provides multipliers for each firm, indicating the inverse sampling probability. Since I am interested in estimating the effects of trade on the population of firms, I use the multipliers to re-weight firm-level observations in all of my analyses.

The informal sector is surveyed by the National Sample Survey Organisation (NSSO), with a sampling universe of all manufacturing firms that are not registered under the Factories Act (in other words, the informal sector).[10] The NSSO surveyed informal enterprises in 1989-90 as a follow-up round to the all-India Economic Census of 1980; in 1994-95 as a follow-up round to the 1990 Economic Census; and in 2000-01 as a follow-up to the 1998 Economic Census. Given the long period of time between the Economic Census and the follow-up surveys, it is possible that there is a large amount of entry and exit

[8]In 1989, informal firms with six or more employees (known as Directory Manufacturing Enterprises, or DME) were excluded from the survey I use; however, in the 1994 and 1999 surveys these firms represent fewer than 5% of the population of informal firms. The effect of this omission that does not vary across industries will be addressed by the inclusion of year dummies in the empirical work. Furthermore, I re-estimated the baseline equation while excluding DMEs from the 1994 and 1999 surveys, and the results are similar. I thank Kalina Manova for suggesting this robustness check.

[9]I exclude all non-manufacturing firms from my analyses.

[10]The NSSO surveys include non-manufacturing firms in some years; these firms are excluded from my analyses.

between the two, particularly among small firms. However, this concern is mitigated by the NSSO's sampling procedure. Information from the Economic and Population Censuses is used to select first-stage sampling units (FSUs); however, once an NSSO investigator arrives at an FSU, s/he creates an updated list of households and enterprises to be used in second- and third-stage sampling. Each sample consists of approximately 1% of informal firms. Large firms are oversampled to ensure that enough of them are included; as with the ASI data, I use sampling weights provided by the NSSO to re-weight firm-level observations.

Although firms with fewer than 10 employees are not required to register under the Factories Act, and therefore should not appear in the ASI data, between 15% and 20% of the ASI firms in each year have fewer than 10 employees. Bedi and Banerjee (2007) argue that the process of "deregistration" is difficult for firms that have cut employment, and that many closed firms still appear in the list of registered (formal) firms. For my analyses, I exclude firms that are reported to be closed, but I retain firms in the ASI dataset that have fewer than 10 employees. As Bedi and Banerjee (2007) point out, some firms may appear too small to be formal because they have temporarily reduced employment. It is also possible that small firms may choose to register in the expectation that they may grow in the future, or as a signal to creditors.

Similarly, a few firms in the NSSO survey (approximately 0.5% in each year) report having more than 20 employees. These firms appear to be larger than other informal firms, and it is unclear whether they are illegally operating in the informal sector, whether they experienced an increase in employment after being classified as informal, or whether their employment figures simply represent data entry mistakes. In the analyses below, I exclude these firms; however, I have confirmed that including them does not change the informal sector results.

A further refinement I make is in defining manufacturing firms as those that produce physical products. A number of firms in both sectors (though predominantly in the informal sector) report producing no physical products; the source of their revenue is uncertain, but likely comes from services. I restrict my analysis to firms that use raw materials to produce physical products in order to improve the comparability of the formal and informal datasets and to focus on manufacturing firms.[11]

Table 4 provides summary statistics for key variables in the sample. Labor is measured as the number of employees. Capital stock values are deflated using the perpetual inventory method of Harrison (1994), as modified by Sivadasan (forthcoming).[12] Output is the total value of manufactured products, deflated using industry-level price deflators.[13] To deflate raw material inputs, I use India's IOTT to calculate the average deflator for each industry, using the technique described for input tariffs (Section 3).

[11] I have performed the baseline analysis using all firms, and the results are similar in sign, significance, and magnitude; results are not shown here, but are available upon request.

[12] I start with the initial value of capital stock in 1989, and assume a 10% depreciation rate. The value of real capital stock in industry j and year t is $K_{jt} = 0.9K_{jt-1} + I_{jt}$ where K_{jt-1} is real capital stock in the previous year and I_{jt} is nominal investment in year t. Data on nominal investment and capital stocks are calculated based on industry-level formal sector data only, since informal sector data are not available every year. Each firm's nominal capital stock is deflated by $K_{jt}/K_{j,1989}$.

[13] As a robustness check, in Section 5.5 I use the method suggested by Hsieh and Klenow (forthcoming) to account for differential firm pricing by assuming particular values for the elasticity of substitution between goods.

To match the formal and informal firm surveys across the three years, I first make the industrial codes comparable over time. The 1989-90 and 1994-95 surveys classify firms using India's NIC-87 industrial code; however, the 1999-2001 data use a different (NIC-98) industrial code. The official concordance table, which matches 3-digit NIC-87 codes with 4-digit NIC-98 codes, contains many instances in which multiple NIC-98 codes map to multiple NIC-87 codes, thus confounding matching over these years. However, the firm-level data provide more detailed (5-digit) NIC-98 codes, which enables me to map each firm in the 1999-2001 data to a unique 3-digit NIC-87 code. I then combine the firm-level data with tariff data (discussed in Section 3) at the 3-digit NIC-87 industry level using the concordance table developed by Debroy and Santhanam (1993). At this level, there are approximately 140 unique industries in my dataset.

4.1 Measuring Total Factor Productivity

I use firm-level data on output, employment, capital, and materials to construct a measure of total factor productivity (TFP) using a chain-linked, index number method suggested by Aw, Chen and Roberts (2001). These authors show that the log of TFP (hereafter simply referred to as TFP) for firm i in industry j in year t can be calculated as follows:

$$\begin{aligned} TFP_{ijt} = & \underbrace{(q_{ijt} - \overline{q_{jt}})}_{deviation\, from\, avg.\, q} + \underbrace{\sum_{r=2}^{t}(\overline{q_{jr}} - \overline{q_{jr-1}})}_{yearly\, change\, in\, q} \\ & - [\underbrace{\sum_{k=1}^{K}\frac{1}{2}(S^k_{ijt} + \overline{S^k_{jt}})(k_{ijt} - \overline{k_{jt}})}_{deviation\, from\, avg.\, k} + \underbrace{\sum_{r=2}^{t}\sum_{k=1}^{K}\frac{1}{2}(\overline{S^k_{jr}} + \overline{S^k_{jr-1}})(\overline{k_{jr}} - \overline{k_{jr-1}})}_{yearly\, change\, in\, k}] \end{aligned} \quad (10)$$

where
q_{ijt}=log of output
S^k_{ijt}=cost share of input k
k_{ijt}=log of input k

A firm's TFP is the deviation of its output from average output in that year, along with how average output in that year differs from the base year, minus the deviation of the firm's inputs from average inputs in that year, along with how average inputs in that year differ from the base year. I allow average output, cost shares, and inputs to differ across industries. Bars over variables indicate average values within a particular industry and year. VanBiesebroeck (2007) has shown that the index number method provides a robust measurement of productivity levels when firms use different technologies, which is likely to be the case given that my data include both informal and formal firms.

Output, material, and capital are deflated as discussed above. Cost shares are based on material costs, labor costs (the wage bill, deflated using the consumer price index), and capital costs (the real capital stock multiplied by the estimated rental rate of capital).[14]

Panels (a)-(d) of Figure 2 illustrate some features of the formal and informal sectors by showing kernel density plots of employment, capital, output, and TFP in 1989. The densities are weighted using the sampling multipliers, so the distributions are representative of the population of firms. The modal value of employment is two in the informal sector and slightly over 10 in the formal sector. There does not appear to be any lumpiness around the 10- or 20-employee mark in the informal sector (even when the data are plotted using smaller bandwidths or histograms), suggesting that the 10- or 20-employee constraint is not binding for most informal firms. There is little overlap between the capital and output distributions of the formal and informal sectors. In contrast, I find considerable overlap between the two sectors' TFP distributions, though the bulk of the least productive firms are informal.

5 Empirical Strategy and Results

5.1 Effect of a Fall in Tariffs on Average Productivity and Firm Size

I begin by estimating the effects of the trade reforms on average productivity and firm size (measured in terms of output). I employ a difference-in-differences approach that exploits the variation in tariffs across industries and over time. I model the outcomes of interest (TFP and firm size) for firm i in industry j at time t as:

$$y_{ijt} = \beta_1 \tau_{jt} + \beta_2 \tau^I_{jt} + \alpha_j + \alpha_t + \varepsilon_{ijt} \tag{11}$$

where
y_{ijt}=log of TFP or firm size (output)
τ_{jt}=final goods tariff, as a negative fraction (e.g., a 100% ad valorem tariff corresponds to -1)
τ^I_{jt}=input tariff, as a negative fraction
α_j=industry fixed effects
α_t=year fixed effects

I control for macroeconomic changes that affected all industries at the same time and in the same manner by including year fixed effects, and for time-invariant industry characteristics by including industry fixed effects. For ease of interpretation, I include final goods and input tariff values as negative numbers, so the coefficients on these two variables can be interpreted as the effect of a *fall* in tariffs on the outcome of interest.

Table 5 presents results. All specifications include year and industry fixed effects, and standard errors are clustered at the state-industry level.[15] Column (1) of Panel A includes only final goods tariffs (not

[14]For the wage bill in own-account enterprises in the informal sector (those that do not hire non-family labor), I impute per-employee cost based on the average cost per employee among informal firms that do hire labor. For capital rental rates, I use data from the informal sector surveys, which provide information on the value of rented capital and rental payments. I calculate the average rental rate, based on firms that rent capital, in each industry and year, and I apply the average rental rate to all firms in that industry/year.

[15]The standard errors are similar, and significance levels do not change, when I use the multi-way clustering method

input tariffs) and shows a highly significant, positive relationship between the fall in final goods tariffs and average productivity. Since final goods tariffs and input tariffs are included as negative fractions (e.g., a 100% ad valorem tariff is equivalent to $\tau_{jt} = -1$), the average fall in final goods tariffs between 1989 and 1999 of 50 percentage points corresponds to a change of 0.5 in τ_{jt}. The magnitude of the coefficient (0.39) suggests that this fall in final goods tariffs is associated with a nearly 20% increase in average productivity. In Column (2), I control for input tariffs as well, and find that the effect of final goods tariffs is attenuated (to 0.30, or 15% given the average fall in final goods tariffs) but remains significant at the 1% level. Input tariffs also increase average productivity, though the effect is not statistically significant.

Columns (3) through (6) of Panel A show that the positive relationship between the fall in final goods tariffs and productivity is driven by the informal sector. Once input tariffs are taken into account, a 50 percentage point fall in final goods tariffs decreases average formal sector productivity by 5%, but increases average informal sector productivity by 15.5%. Panel B shows similar results for firm size. When controlling for input tariffs, a 50 percentage point fall in final goods tariffs increases average firm size by approximately 23%. Average formal firm size decreases by 15%, while average informal firm size increases by 23.5%. These initial results lend support to the DR-M framework, which predicts that a fall in final goods tariffs will increase both average firm size and productivity.

Although firm size and productivity in the formal sector fall when final goods tariffs are reduced, both effects are offset by a concurrent fall in input tariffs. The coefficients on input tariffs suggest that a 50 percentage point fall in input tariffs increases productivity by 30% and firm size by 49% in the formal sector. The fall in input tariffs is also positively correlated with informal sector productivity, but the results are not statistically significant. The net effect of the trade liberalization, therefore, is to increase productivity in both the formal and informal sectors, though the increases occur through different channels in the two sectors.

5.2 Effect of a Fall in Tariffs on the Distributions of Productivity and Firm Size

I now explore whether changes in the productivity and firm size distributions are consistent with the entry/exit and reallocation mechanisms suggested by the DR-M and MO models. In this section, I focus on final goods tariffs rather than input tariffs for two reasons. First, as discussed above, my measure of input tariffs is available at a more aggregate level than my measure of final goods tariffs, and is based on input-output tables for relatively broad manufacturing industries. Second, the two trade models that guide the empirical work on productivity and firm size distributions focus on final goods tariffs. Of course, the results in Section 5.1 indicate that it is important to control for input tariffs when estimating the effects of final goods tariffs on firm size and productivity. Therefore, in the analyses below, I control for input tariffs as well as final goods tariffs, but input tariff results are not presented.

developed by Cameron, Gelbach and Miller (2006) to account for within-industry clustering across states, as well as within-state clustering across industries.

I use a quantile regression (QR) framework to estimate the effects of final goods tariffs on various percentiles of the firm size and productivity distributions. Let $z'_{ijt} = (\tau_{jt}, \tau^I_{jt}, \alpha'_j, \alpha'_t)'$, and Equation 11 can be modified to allow the effects of the covariates to vary across percentiles:

$$y_{ijt} = z'_{ijt}\beta_\theta + \varepsilon_{\theta_{ijt}} \tag{12}$$

Let $F_{ijt}(y_{ijt}|z_{ijt})$ be the distribution of y_{ijt} conditional on z_{ijt}. Then the θth conditional quantile of y_{ijt} (the location of the θth percentile of y_{ijt}, conditional on the covariate vector z_{ijt}) is:

$$Q_\theta(y_{ijt}|z_{ijt}) \equiv \inf\{y|F_{ijt}(y|z) \geq \theta\} = z'_{ijt}\beta(\theta) \tag{13}$$

where we assume that $Q_\theta(\varepsilon_{\theta_{ijt}}|z_{ijt}) = 0$. As shown by Koenker and Bassett (1978), the estimator for $\beta(\theta)$ is found by minimizing:

$$n^{-1}\sum_{i=1}^{n}\rho_\theta(y_{ijt} - z'_{ijt}\beta_\theta), \quad \rho_\theta(u) = \begin{cases} \theta u & u > 0 \\ (\theta - 1)u & u \leq 0 \end{cases} \tag{14}$$

The estimated effect of a marginal change in the kth covariate z^k_{ijt} on the θth percentile of the outcome of interest is given by:

$$\frac{\partial Q_\theta(y_{ijt}|z_{ijt})}{\partial z^k_{ijt}} = \widehat{\beta^k_\theta} \tag{15}$$

I conduct quantile regressions for TFP and firm size in the formal and informal sectors individually, at every 5th percentile of the distributions.[16] Figures 3 and 4 show the QR results for final goods tariffs graphically. The solid line plots the QR coefficient β_θ for final goods tariffs at every 5th percentile, while the two dotted lines show the 90% confidence intervals from a block bootstrap estimate of the standard errors.[17] As before, the coefficients on final goods and input tariffs are negative fractions, so coefficients can be interpreted as the effect of a *fall* in tariffs.

Panel (a) of Figure 3 shows that the fall in final goods tariffs increases productivity across most quantiles in the informal sector, with a particularly large increase at the 5th percentile. This finding is consistent with the exit of the least productive firms, which are found in the informal sector (see Panel (d) of Figure 2). I would not have found this result if I had only considered formal firms; Panel (b) of Figure 3 shows that the fall in final goods tariffs actually decreases the bottom quantiles of productivity in the formal sector, while having no effect on productivity among the top quantiles.

[16] I also conducted quantile regressions for the overall manufacturing industry, including both formal and informal firms. Results are not shown because given the overwhelming size of the informal sector relative to the formal sector, the overall results are largely the same as the informal sector results.

[17] I re-sample over state-industry clusters in order to correct for possible serial correlation. In order to reduce computational time, I follow Abrevaya (2001) and sample (with replacement) m out of n clusters, where $m = 0.1n$. Standard errors are based on 100 bootstrap estimates, and are corrected by $\sqrt{m/n}$.

Figure 4 indicates that firm size increases across all quantiles in the informal sector. In the formal sector, firm size falls in the lower quantiles, but the fall is attenuated among the higher quantiles. This finding is consistent with the reallocation mechanism suggested by DR-M. DR-M predict that firms will decrease their domestic output, but that existing exporters (which tend to be the largest firms) will concurrently increase their export output. Therefore, large firms contract relatively little compared to mid-sized firms. Given the limitations of my dataset, I cannot confirm this mechanism explicitly; however, the decrease in firm size among formal firms, which is attenuated among the upper quantiles of the distribution, is consistent with this reallocation of market share away from mid-sized, domestic firms towards large, export-oriented firms.

How do the changes in the formal and informal sectors affect the overall productivity and firm size distributions? To address this issue, I use a simulation technique that allows me to compare the densities of productivity and firm size in 1989, to the densities that would have prevailed in 1989 had final goods tariffs been distributed as in 1999, with all other covariates distributed as in 1989. Machado and Mata (2005) show that it is possible to simulate such counterfactual densities using regression quantiles. I implement a slightly modified version of their approach as follows.[18] First, I take m=1,000 draws of θ from a uniform distribution $U \sim [0,1]$, and estimate $\widehat{\beta_\theta}$ for each draw. I then draw a representative sample of 1,000 observations of the covariates z_{ijt} from the 1989 data (with probability proportional to each observation's sampling multiplier). Then $\{\widehat{y_{ijt}} = z'_{ijt}\widehat{\beta(\theta)}\}_{l=1}^{m}$ is a sample of 1,000 observations from the estimated marginal density of the outcome y_{ijt}, if all of the covariates were distributed as in 1989. Next, I draw 1,000 observations of τ_{jt} from the 1999 data and 1,000 observations of all covariates expect τ_{jt} from the 1989 data. I use this counterfactual sample of covariates z^c_{ijt} to obtain a sample of 1,000 observations from the estimated counterfactual density of outcome y_{ijt}, $\{\widehat{y^c_{ijt}} = (z^c_{ijt})'\widehat{\beta(\theta)}\}_{l=1}^{m}$ if all covariates except final goods tariffs were distributed as in 1989, and final goods tariffs were distributed as in 1999.

Panel (a) of Figure 5 shows the simulated productivity distributions. When final goods tariff fall, the TFP distribution in the informal sector shifts right, while the distribution in the formal sector shifts left. Kolmogorov-Smirnov tests for the equality of distributions strongly reject that the 1989 and counterfactual 1999 distributions are the same, for both the informal and formal sectors. Since there is considerable overlap between the productivity distributions in the two sectors, and since the informal sector is very large relative to the formal sector, the right shift in the informal sector productivity distribution offsets the left shift in the formal sector productivity distribution to a great extent. Panel (b) illustrates this offsetting effect more clearly by showing the changes in density (1999 density minus 1989 density) for each sector.

Panels (a) and (b) of Figure 6 show the counterfactual firm size distributions and the changes in distributions (1999 minus 1989). In this case, there is little overlap between the two sectors' firm size distributions, so the rightward shift of the informal sector complements the leftward shift of the formal

[18] I am indebted to José Machado for his advice on using this technique.

sector. The overall effect is to increase the mass of mid-sized firms, at the expense of relatively small and large firms. At the top end of the formal sector distribution, there is virtually no effect, which is consistent with the results shown in Figure 4.

Table 6 summarizes the results for the formal and informal sectors, and compares them to the predictions of the DR-M and MO models. When considered individually, neither the informal nor the formal sector fits the predictions of either model. However, when we consider the overall effects of the two sectors, the results are consistent with DR-M. As discussed earlier, average firm size and productivity both increase. Informal firms constitute the bulk of the least productive firms (see Panel (d) of Figure 2); therefore, the relatively large increase in productivity at the left tail of the informal sector productivity distribution, which tapers off towards the right, is consistent with the mechanism of exit by the least productive firms. At the right tail of the productivity distribution (the most productive formal firms), there is no change. The left tail of the firm size distribution (represented by the smallest informal firms) shifts right, while the right tail (represented by largest formal firms) shifts left. Finally, within the formal sector, the decrease in size is less pronounced at the right tail of the size distribution, which is what we would expect if the largest formal firms are relatively more export-oriented.

5.3 Effect of a Fall in Tariffs on Survival and Net Entry

Why are the results for the formal and informal sectors so different? On the one hand, we would expect exit to be more prevalent in the informal rather than the formal sector, since informal firms are generally less productive; thus we would expect to see increases in productivity and firm size in this sector. In the formal sector, which is at the right tail of the size distribution, it is reasonable that the contraction in output among existing firms would outweigh any exit effects, thus resulting in a fall in size among formal firms. On the other hand, it is surprising that there is such a stark contrast between the two sectors, even when we compare the upper quantiles of the informal sector distribution with the lower quantiles of the formal sector distribution. In addition, the fall in productivity among the lowest quantiles of the formal sector distribution is puzzling.

To explore this puzzle, I first investigate whether the productivity changes in the two sectors are caused by changes in productivity among incumbents, or by the productivity of new entrants. Given the pooled, cross-sectional nature of my dataset, I cannot explicitly separate within-firm productivity changes from changes that occur because of firm exit. However, I can use information about firm age to shed light on whether productivity changes are caused by firm entry or by either within-firm productivity changes or exit. The formal sector survey includes the firm's year of initial production, and the informal sector survey includes the firm's age in the 1989 and 1994 rounds, and a variable indicating whether the firm is more than three years old in the 1999 round. I classify firms that are less than three years old as new firms, and those that are more than three years old as incumbents.

In Table 7, I re-estimate Equation 11, allowing the effect of the fall in tariffs to differ for new firms and incumbents. I perform this exercise for all three periods (1989, 1994 and 1999) as well as for 1989-

1994 alone; using the latter time period allows me to compare the productivity of firms that entered just prior to the reforms (1986-1989) to that of firms that entered just after the reforms (1991-1994).

Columns (1) and (2) indicate that in the formal sector, the fall in final goods tariffs decreases average productivity among (surviving) incumbent firms, but not among entrants, by 1994. By 1999, Columns (3) and (4) show that the fall in final goods tariffs decreases productivity among both incumbents and entrants (though to a lesser extent among entrants). In the informal sector (Columns (5)-(8)), the fall in final goods tariffs increases productivity among both incumbents and new entrants, though the effect is attenuated for new entrants. In both sectors, new firms tend to be less productive than incumbent firms.[19]

It appears that both a decrease in productivity among surviving, incumbent firms and the entry of less productive firms contribute to the overall decline in average formal sector productivity. I address the former possibility by considering whether formal firms face barriers to exit, as suggested by Pursell (1990); some of the least productive formal firms, which should exit, might remain in operation with low levels of productivity. India's labor regulations are often cited for creating barriers to exit and size adjustment for formal firms. Besley and Burgess (2004) classify state amendments to India's Industrial Disputes Act (IDA) as "pro-worker" or "pro-employer"; they find that "pro-worker" states have lower formal sector output, and higher informal sector output, relative to "pro-employer" states. Ahsan and Pages (2007) extend Besley and Burgess' (2004) work by dividing state amendments into those that affect workers' ability to sustain an industrial dispute and those that affect the ability of large firms to adjust their employment size. They find that both types of regulations decrease formal output and increase informal output, with the amendments regulating disputes generally affecting output to a greater extent.[20] If labor regulations are responsible for creating barriers to exit for formal firms, then I would expect to see less exit (more survival) in states with stricter labor laws.

I classify firms that existed in 1989 as "survivors" based on their reported age or year of initial production. I then estimate the total number of surviving firms in each state-by-industry cluster every year, in the formal and informal sectors, and explore the relationship between survival and tariffs using the following specification:

$$s_{jst} = \beta_1 \tau_{jt} + \beta_2 \tau^I_{jt} + \alpha_j + \alpha_s + \alpha_t + \varepsilon_{jst} \tag{16}$$

where s_{jst} is the log of the number of survivors in each state-by-industry cluster at time t, and α_j, α_s, and α_t are industry, state, and time fixed effects, respectively. I also interact the fall in tariffs with three pre-reform measures of labor regulations (the original Besley and Burgess (2004) measure, as well as

[19]Bartelsman, Haltiwanger and Scarpetta (2005) document that entrants are less productive than incumbent firms in certain countries and more productive in others; they postulate that learning-by-doing may account for lower productivity among entrants.

[20]In related work, Hasan, Mitra and Ramaswamy (2007) find that the elasticity of labor demand increases in the formal sector following the trade reforms, and that the increases are more pronounced in states with more flexible labor laws, while Gupta, Hasan and Kumar (2009) find that formal employment grows more quickly in states with flexible labor regulations after India's industrial reforms.

the two measures from Ahsan and Pages (2007)). Since I cannot identify which informal firms existed in 1989 from the 1999 data, I perform the analysis for the informal sector from 1989-1994, and for the formal sector from both 1989-94 and 1989-99.

Table 8 presents results. Columns (1)-(4) present results for the formal sector between 1989 and 1994, Columns (5)-(8) present results for the formal sector from 1989-1999, and Columns (9)-(12) present results for the informal sector from 1989-1994. Comparing Columns (1), (5), and (9) suggests that the fall in tariffs may have decreased survival in the informal sector to a greater extent than in the formal sector; however, the coefficients are not statistically significant. The results also indicate that stricter labor regulations have little impact on survival among formal firms, though they do appear to increase the survival rates of informal firms. While these findings are consistent with previous work on India's labor laws, they do not provide strong evidence that onerous labor regulations are responsible for blocking exit among formal firms.

A second potential source of the decrease in formal sector productivity is the entry of less productive firms. To investigate this possibility, I re-estimate Equation 16 with the (log of the) total number of firms as the dependent variable. I perform this exercise using all three rounds of data (1989, 1994 and 1999) in both sectors. Columns (1) and (6) of Table 9 indicate that the fall in final goods tariffs is associated with net exit from the formal sector, but net entry into the informal sector, by 1999. If the reduction in final goods tariffs causes firms to leave the formal sector and enter the informal sector, that could partially explain the increase in productivity among the top quantiles of the informal sector, since formal firms are generally more productive than informal firms. However, if (as we would expect) the formal firms that exit are the least productive, then productivity should increase, rather than decrease, among the bottom quantiles of the formal sector.

It may also be the case that firms are not moving between sectors within an industry, but across industries. In particular, we might expect trade liberalization to increase exporting opportunities to a greater extent in India's comparative advantage industries, thus attracting firms into those industries. To explore this issue, I construct a measure of each industry's revealed comparative advantage (RCA) based on Balassa (1965):[21]

$$RCA = \frac{X_j^{India} / \sum_j X_j^{India}}{X_j^{World} / \sum_j X_j^{World}} \tag{17}$$

where X_j is the value of exports in industry j and $\sum_j X_j$ is total manufacturing exports. I estimate each industry's RCA using pre-reform (1989) data from the World Bank's Trade and Production database. I construct a dummy variable that equals one for industries with RCA greater than one and zero for industries with RCA less than one. This variable is then interacted with the fall in final goods tariffs.

Columns (2) and (7) of Table 9 present results. I find that the fall in final goods tariffs is associated with net entry of formal firms into RCA industries, and net exit of informal firms out of RCA industries. This suggests that at least part of the drop in productivity in the formal sector may be due to the entry

[21] I thank Kala Krishna for suggesting this measure.

of less productive firms into RCA industries. To explore this finding in more detail, I perform a quantile regression analysis that estimates the effects of the fall in final goods tariffs on various percentiles of formal sector productivity, allowing the effects to vary across RCA and non-RCA industries. Figure 7 shows the estimated effects for the RCA and non-RCA industries separately. The fall in final goods tariffs decreases the lowest percentiles of productivity by more in RCA industries, which is consistent with the entry of less productive firms into RCA industries. However, the 5th percentile of productivity still falls in non-RCA industries, in which there is net exit, indicating that entry does not completely explain the decrease in formal sector productivity.

Finally, I consider whether India's labor regulations may impede the movement of firms across industries. Columns (3)-(5) and (8)-(10) of Table 9 show that the net entry of formal firms into RCA industries is lower in states with more onerous labor regulations, and that labor regulations governing dispute resolutions are largely responsible for this effect. Interestingly, while the coefficients on the triple interactions are never significant in the informal sector, two out of three are similar in sign and magnitude to the formal sector, suggesting that the movement of both formal and informal firms into RCA industries may be reduced in states with onerous labor regulations. Although the labor regulations I consider do not directly affect informal firms, they may reflect the overall business climate of the state, or there may be spillovers from formal to informal firms.

Overall, I find that the fall in final goods tariffs decreases productivity among both surviving incumbents and entrants in the formal sector, while increasing productivity among both surviving incumbents and entrants in the informal sector. I also find that there is net entry into the formal sector in comparative advantage industries, which may occur if trade liberalization encourages firms to enter the formal sector in order to take advantage of exporting opportunities in these industries. I document that the drop in formal sector productivity is greater in comparative advantage industries, and that new entrants tend to be less productive than incumbent firms. The combination of these findings indicates that the entry of new, formal firms into comparative advantage industries may explain part of the decline in formal sector productivity. However, the decline in productivity among surviving incumbents in the formal sector remains somewhat puzzling; there appears to be less exit in the formal sector than in the informal sector, but it is unclear whether formal firms face barriers that prevent the least productive firms from exiting.

5.4 Effect of a Fall in Tariffs on the "Missing Middle"

So far, I have measured firm size in terms of output, and most trade theory focuses on output size. Yet the size distribution of employment in India is also a subject of interest among researchers. India, like many other developing countries, exhibits a "missing middle": a concentration of employment among small and large firms, with little employment in mid-sized firms, compared to the US or to many other large Asian economies (Mazumdar 1998, Tybout 2000, among others). A number of reasons for the missing middle have been proposed, including labor regulations that become more onerous as employment rises, and credit constraints that prevent small firms from growing. However, there is little empirical evidence on what causes the employment size distribution in developing countries to differ from that of developed countries. A notable exception is VanBiesebroeck (2005), who documents the slow growth of small firms relative to large firms in South Africa, and shows that the allocation of workers and credit to high-productivity firms is an important factor.

In India, a number of commentators and politicians (Hensman 2001, Jhabvala and Sinha 2002, Vajpayee 2003, among others) have argued that globalization has pushed more employment into small, informal firms, but there is little quantitative evidence to substantiate these claims. Empirical evidence from other countries is mixed: Goldberg and Pavcnik (2003) find no link between Brazil's trade liberalization and informal employment, while Menezes-Filho and Muendler (2007) study the same liberalization episode and find that trade liberalization is associated with lower formal sector employment and higher informal sector employment. Goldberg and Pavcnik (2003) and Attanasio, Goldberg and Pavcnik (2004) do find a link between trade and informal employment in Colombia, but only before Colombia's labor market is liberalized as well.

I employ the same quantile regression methods used in the previous section to test the effects of the fall in final goods tariffs on employment size. I perform the exercise for the informal and formal sectors separately, as well as for the combined employment distribution. Results for the informal sector, and for overall employment, are not shown here because the coefficients on final goods and input tariffs are indistinguishable from zero (both statistically and economically speaking) across all quantiles.

Figure 8 presents the formal sector results. Panel (a) shows that the fall in final goods tariffs decreases employment to some extent across all quantiles, though the effect is only statistically significant among the lower quantiles. Panels (b) and (c) show that the fall in final goods tariffs shifts the employment distribution slightly to the left, creating more firms with fewer than 10 employees at the expense of firms with 10-50 employees. However, a Kolmogorov-Smirnov test of the equality of distributions fails to reject that the 1989 and counterfactual 1999 distributions are the same. It appears that India's trade reform did exacerbate the missing middle slightly; however, since it had no impact on employment size in the informal sector, which accounts for 80% of manufacturing employment, its overall contribution to the missing middle is small.

It is also interesting to compare the employment size results with the output size results. Both the output and employment size distributions shift to the left in the formal sector; however, the shift in employment is much less pronounced. One possibility is that formal firms adjust the number of hours worked by employees, rather than laying them off; unfortunately, since I only observe the total number of employees in my dataset, I cannot test this hypothesis. Another possibility is that labor is not reallocated across firms in the wake of the trade liberalization; in Brazil, Menezes-Filho and Muendler (2007) find that output, but not employment, is reallocated to more productive firms when tariffs fall.

5.5 Robustness Checks

In this section (as well as in Appendices A and B), I test the robustness of the main results in a variety of ways. First, I test whether the productivity results are sensitive to the way in which productivity is measured. I begin by calculating TFP using two index number methods. I then develop two additional estimates of TFP based on one-stage and two-stage OLS methods. To address the simultaneous selection of output and inputs, I also use the approaches developed by Olley and Pakes (1996) and Levinsohn and Petrin (2003), modified as suggested by Blalock and Gertler (2008). Next, I attempt to account for differential pricing within an industry by using a method suggested by Hsieh and Klenow (forthcoming). Finally, to avoid the difficulties involved in measuring capital, I also test the robustness of the results to using labor productivity rather than TFP. Appendix A discusses each of these productivity measures in detail, and Table A.1 presents results. Despite some variation in magnitude across specifications, I find that the main results are robust to a variety of productivity measures. A fall in final goods tariffs decreases average formal sector productivity and increases average informal sector productivity; meanwhile, a concurrent fall in input tariffs increases formal sector productivity and may also increase informal sector productivity.

Second, I test whether my main results are robust to controlling for a number of other policy changes that occurred at the same time as the trade reforms. As discussed in Section 3, tariffs were harmonized beginning in 1991. However, India's pre-reform trade regime also included high non-tariff barriers (NTB), which required that firms obtain licenses in order to import most goods (Aksoy 1992). Following the 1991 reforms, licensing requirements were sharply reduced for non-consumer goods but remained in place for most consumer goods (Epifani 2003). Disaggregated measures of NTBs are unfortunately not available during the period of the reforms. However, if NTBs are important in explaining productivity changes, then I would expect the impact of the fall in tariffs on productivity to be larger in industries that also faced declines in NTB protection. As shown in Table B.1, I find some evidence that NTB liberalization magnifies the effect of the fall in tariffs on firm productivity in both sectors, but the additional impacts are not statistically significant.

I also investigate potential confounding effects of two other industrial policy changes that occurred during the 1990s: the dismantling of the "license raj" and the allowance of foreign direct investment (FDI) into most industries without case-by-case approval. Appendix B discusses these reforms in more detail, and confirms that the effects of tariff cuts are robust to controlling for the delicensing and FDI reforms.

Third, as discussed in Section 3, I find no relationship between pre-reform levels or trends in TFP and final goods tariff changes. Topalova (2007) performs a similar exercise and finds no relationship between TFP levels among large firms and subsequent tariff changes until 1997; however, she finds a negative and statistically significant relationship between these two variables after 1997. She notes that final goods tariffs were uniformly changed until 1997 (during India's Eighth Five-Year Plan), but that they may have diverged somewhat after 1997, indicating that political factors may have influenced tariff cuts after this point. To address the potentially endogenous selection of industries into tariff cuts after 1997, I re-run the analysis using 1997 tariffs in place of 1999 tariffs. Results are not presented here, as they are almost exactly the same as the baseline results.

Finally, Table 2 shows that by 1999, tariff levels were harmonized across all industries except the beverage and tobacco industry. Since tariffs in this industry likely remained high due to political factors, I re-run the baseline analysis while excluding this industry. The results (not shown) are nearly identical to the baseline findings.

6 Conclusion

This paper is the first to consider the effects of India's tariff liberalization on the entire manufacturing industry, including large, formal firms, as well as small, informal firms. I construct a unique dataset that combines firm-level data on formal and informal firms from 1989, 1994, and 1999, a period of time that spans the major trade reforms. During this period, tariffs were harmonized across industries as part of a reforms package required by the IMF, thus minimizing the potential that certain industries were selected for tariff cuts based on political factors. I use a differences-in-differences approach, which compares industries that received relatively high tariff cuts with those that received relatively low tariff cuts, to identify the impacts of final goods and input tariffs on productivity and firm size (measured in terms of output).

I find that a 50 percentage point fall in final goods tariffs (the average fall between 1989 and 1999) increases average firm productivity by 15%. An important contribution of this paper is to show that the increase in average productivity is driven by the informal sector: the fall in final goods tariffs raises productivity by 15.5% in the informal sector while lowering productivity by 5% in the formal sector. However, I also find that the concurrent fall in input tariffs increases average productivity by 30% among formal firms. Therefore, the overall effect of the trade reforms is to increase productivity in both sectors.

I then employ quantile regression techniques to examine whether changes in the distributions of productivity and firm size are consistent with entry and exit among the smallest, least productive firms, as well as a reallocation of market share among surviving firms, as suggested by two recent trade models (Demidova and Rodriguez-Clare (2009), based on Melitz (2003), and Melitz and Ottaviano (2008)). When the informal and formal sectors are considered together, the empirical results support the predictions of the Demidova and Rodriguez-Clare (2009) - Melitz (2003) model. The increase in informal sector productivity is most pronounced in the left tail of the distribution, which is consistent with the exit of the least productive firms. In the formal sector, both productivity and firm size fall among the lower quantiles of the distributions, but these effects are attenuated among the upper quantiles. This finding is consistent with Demidova and Rodriguez-Clare's (2009) prediction that a fall in final goods tariffs will force all firms to reduce their domestic output, but will allow existing exporters to increase their export output. Since exporters tend to be large firms, my empirical findings are consistent with this prediction.

These results confirm the importance of including small firms when analyzing the impacts of a trade liberalization on firm productivity. Both the increase in average productivity due to the fall in final goods tariffs, as well as the evidence consistent with exit among the smallest, least productive firms, were identified by including small firms from India's informal sector. In addition, since the informal sector employs nearly 80% of India's manufacturing workers, understanding how trade reforms affect this sector is a key component in understanding India's post-reform growth.

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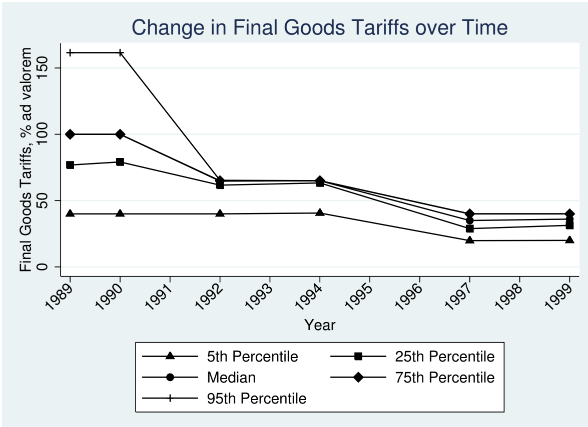
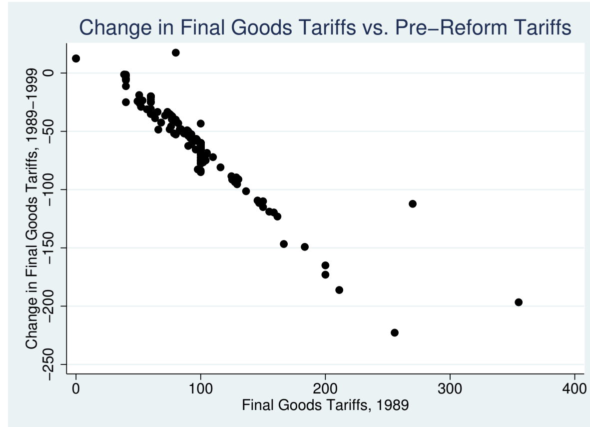
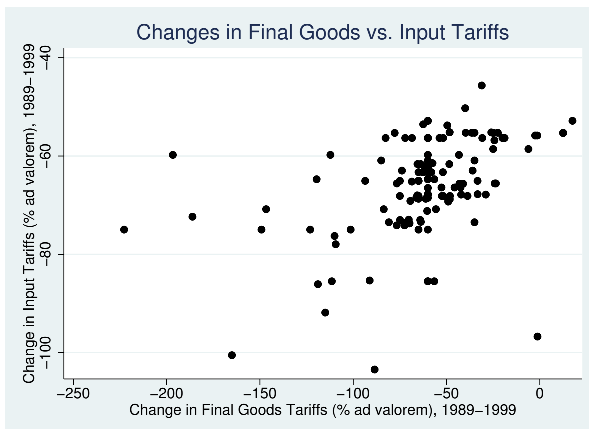
Figure 1: Tariff Reforms



(a) Change in Final Goods Tariffs



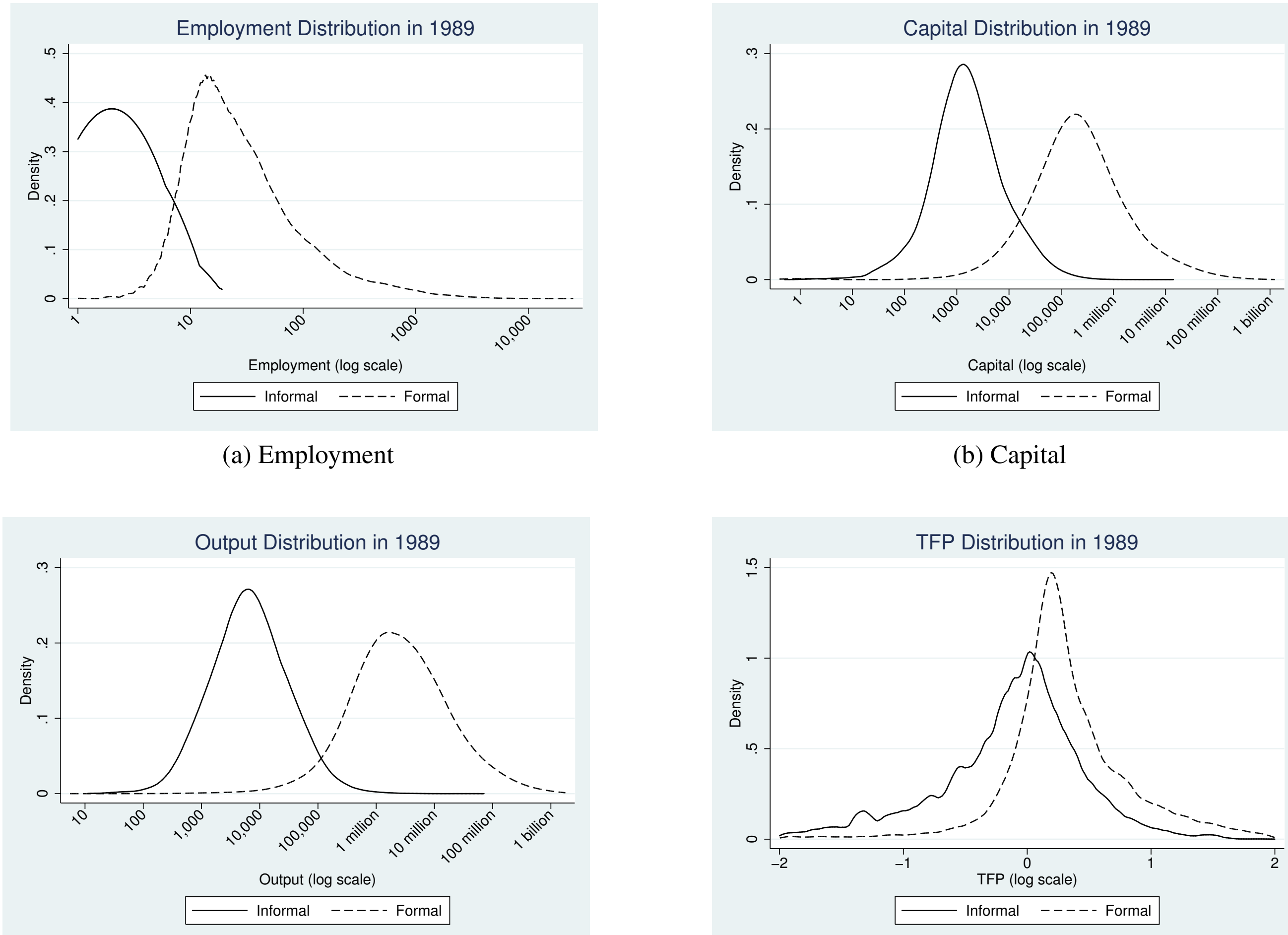
(b) Change in Tariffs vs. Pre-Reform Tariffs



(c) Changes in Final Goods vs. Input Tariffs

Panel (a) shows the 5th, 25th, 50th, 75th, and 95th percentiles of final goods tariffs by 3-digit National Industrial Classification (NIC) code in each year. Panel (b) shows the correlation between the change in final goods tariffs from 1989-1999 and 1989 final goods tariffs. Panel (c) shows the relationship between the changes in final goods and input tariffs between 1989 and 1999. Source: Author's calculations based on various publications of the Government of India.

Figure 2: Distributions of Key Variables in the Formal and Informal Sectors



(a) Employment

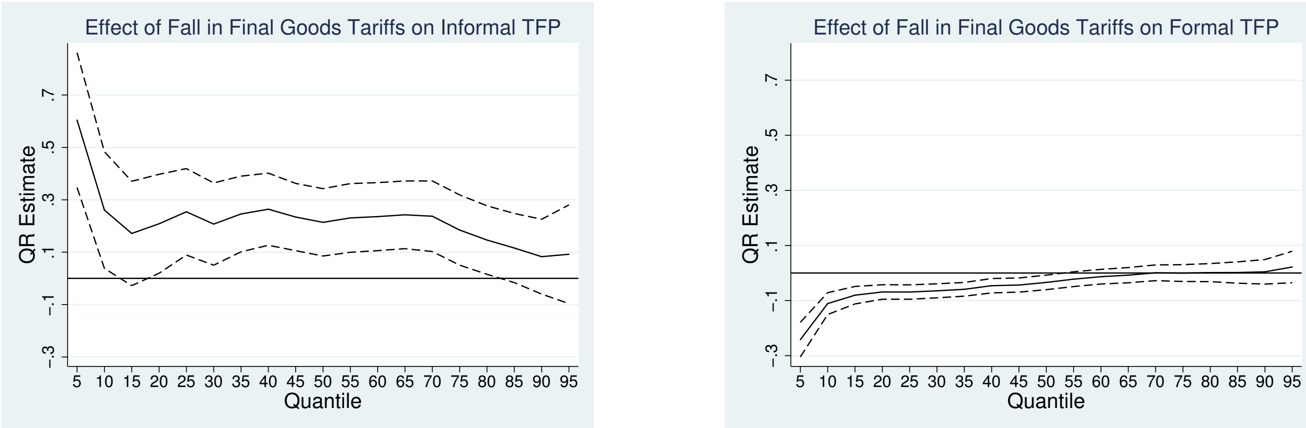
(b) Capital

(c) Output

(d) Total Factor Productivity

Kernel density plots of employment, capital, output, and total factor productivity (TFP) in the formal and informal sectors in 1989 (pre-reform). Employment indicates the number of employees, while output and capital are measured in 1989 Rupees. TFP is calculated using a chain-linked index number method based on Aw et al. (2001). All observations are weighted using inverse sampling probabilities, so distributions are representative of the population of firms. All plots use Epanechnikov kernels and Silverman's optimal bandwidth, except for the plot of the employment distribution in the informal sector, which uses a bandwidth of 0.8. Source: Author's calculations based on ASI and NSSO data.

Figure 3: Effect of a Fall in Final Goods Tariffs on Various Quantiles of the Productivity Distributions

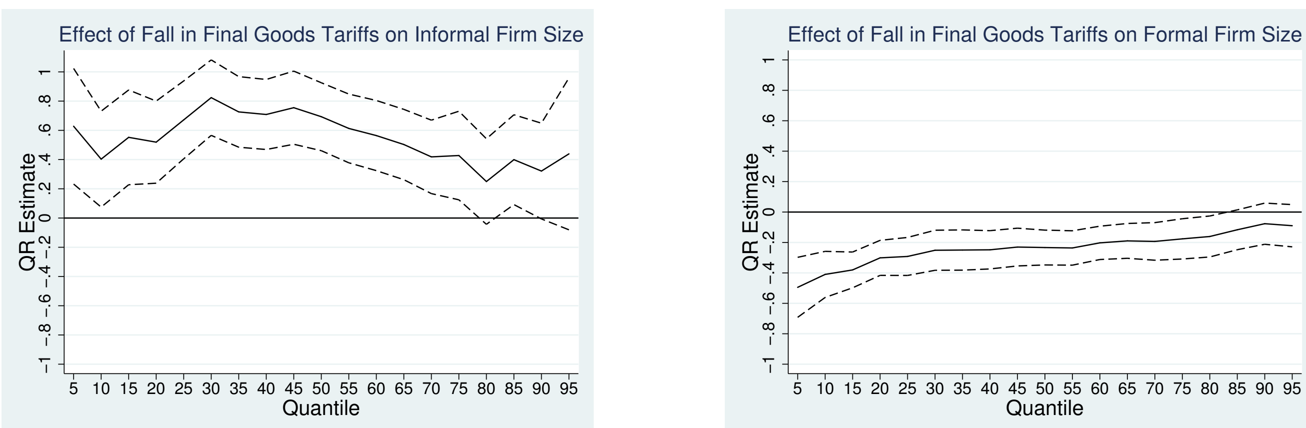


(a) Informal Sector

(b) Formal Sector

Effect of a fall in final goods tariffs on various quantiles of the total factor productivity (TFP) distributions in the formal and informal sectors. Dependent variable is log of TFP. Solid lines show quantile regression (QR) coefficients at each of 19 quantiles (5th, 10th,...,95th) of the TFP distribution. Dashed lines indicate 90% confidence intervals, based on a block bootstrap.

Figure 4: Effect of a Fall in Final Goods Tariffs on Various Quantiles of the Firm Size Distributions

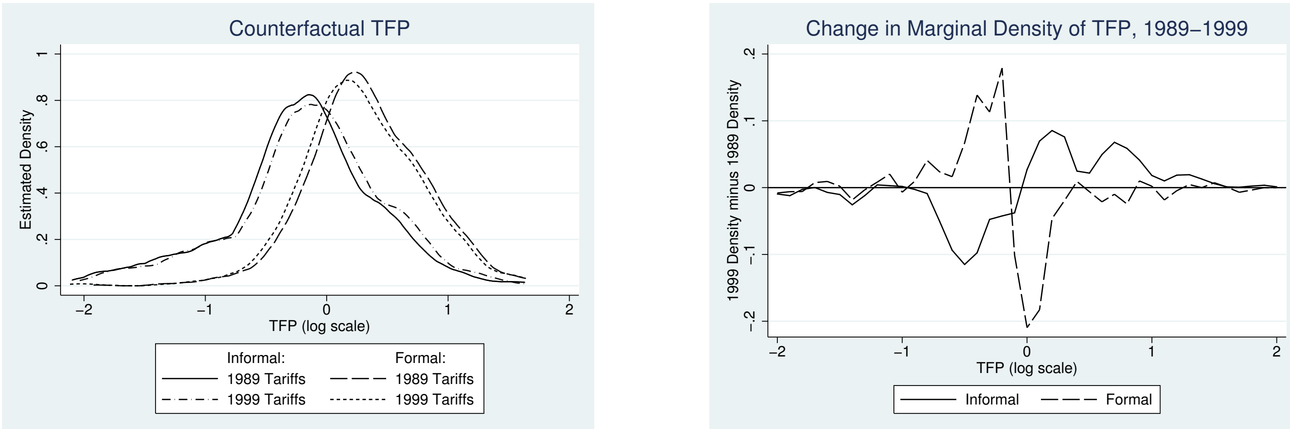


(a) Informal Sector

(b) Formal Sector

Effect of a fall in final goods tariffs on various quantiles of the firm size (output) distributions in the formal and informal sectors. Dependent variable is log of firm size. Solid lines show quantile regression (QR) coefficients at each of 19 quantiles (5th, 10th,...,95th) of the firm size distribution. Dashed lines indicate 90% confidence intervals, based on a block bootstrap.

Figure 5: Simulated Pre-Reform and Post-Reform Productivity Distributions

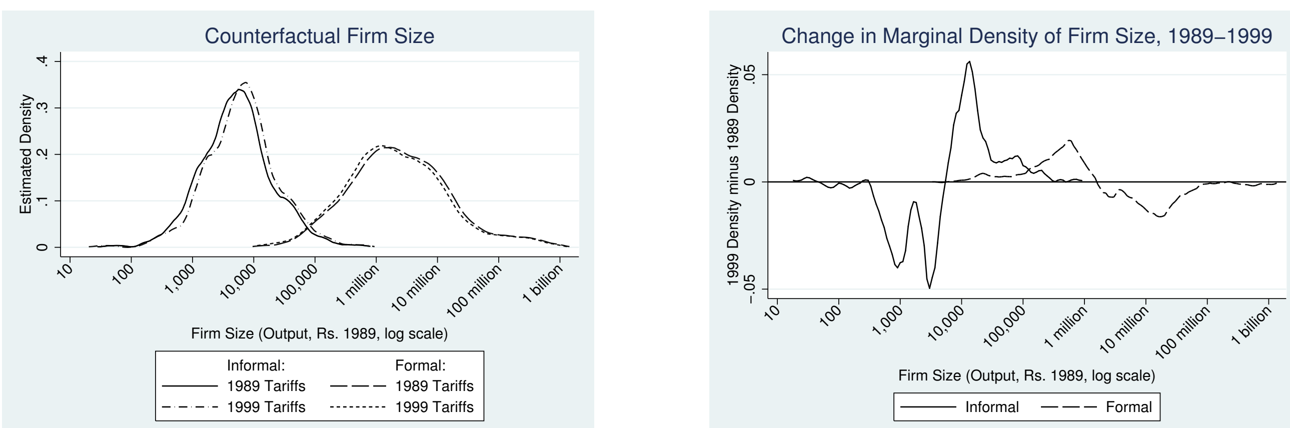


(a) Simulated Productivity Distributions

(b) Changes in Productivity Distributions

Panel (a) shows simulated densities of total factor productivity (TFP) in 1989, and densities that would have prevailed had tariffs been distributed as in 1999, with all other covariates distributed as in 1989. Densities are simulated using a modified version of the procedure developed by Machado and Mata (2005). All plots use Epanechnikov kernels and Silverman's optimal bandwidth. Panel (b) shows the changes in densities (1999 densities minus 1989 densities). Change in density is calculated by estimating the 1989 and 1999 densities at the same points and subtracting the 1989 value from the 1999 value.

Figure 6: Simulated Pre-Reform and Post-Reform Firm Size Distributions

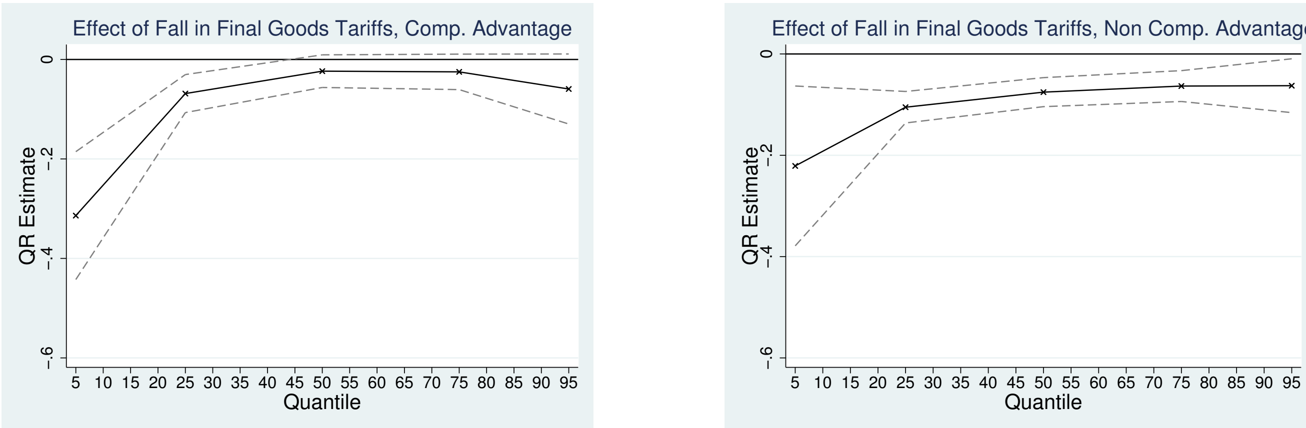


(a) Simulated Firm Size Distributions

(b) Changes in Firm Size Distributions

Panel (a) shows simulated densities of firm size (output) in 1989, and densities that would have prevailed had tariffs been distributed as in 1999, with all other covariates distributed as in 1989. Densities are simulated using a modified version of the procedure developed by Machado and Mata (2005). All plots use Epanechnikov kernels and Silverman's optimal bandwidth. Panel (b) shows the changes in densities (1999 densities minus 1989 densities). Change in density is calculated by estimating the 1989 and 1999 densities at the same points and subtracting the 1989 value from the 1999 value.

Figure 7: Effect of a Fall in Final Goods Tariffs on Various Quantiles of the Formal Sector Productivity Distribution by Comparative Advantage

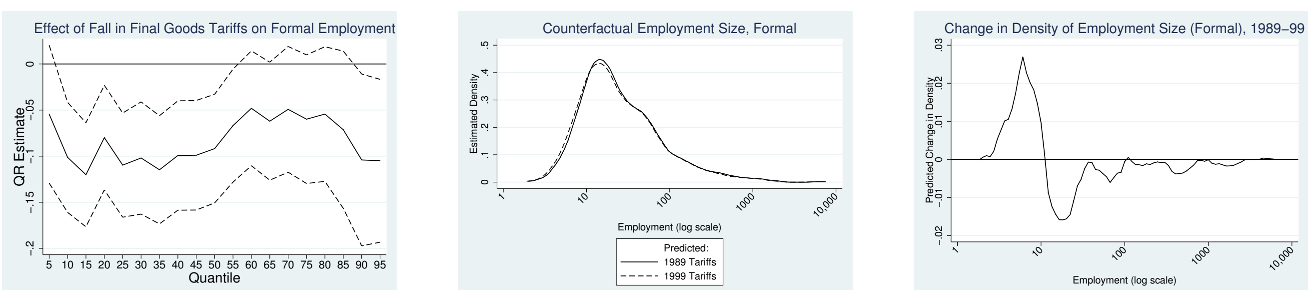


(a) Comparative Advantage Industries, Formal Sector

(b) Non-Comparative Advantage Industries, Formal Sector

Effect of a fall in final goods tariffs on various quantiles (5th, 25th, 50th, 75th, 95th) of the productivity distribution in the formal sector, for comparative advantage industries versus non-comparative advantage industries. Solid lines show quantile regression (QR) coefficients, while dashed lines indicate 90% confidence intervals, based on a block bootstrap.

Figure 8: Effect of a Fall in Final Goods Tariffs on Formal Sector Employment Size Distribution



(a) Quantile Regression Coefficients

(b) Simulated Employment Distributions

(c) Change in Employment Distribution

Panel (a) shows the effect of a fall in final goods tariffs on various quantiles of the employment size distribution in the formal sector. Solid line shows quantile regression (QR) coefficients, while dashed lines indicate 90% confidence intervals. Panel (b) shows the simulated density of employment in 1989, and the density that would have prevailed had tariffs been distributed as in 1999, based on a modified version of the procedure developed by Machado and Mata (2005). Both plots use Epanechnikov kernels and Silverman's optimal bandwidth. Panel (c) shows the change in density (1999 minus 1989), which is calculated by estimating the 1989 and 1999 densities at the same points and subtracting the 1989 value from the 1999 value.

Table 1: Summary of Predictions for a Unilateral Reduction in Final Goods Tariffs

	Predicted Changes	
	DR-M	MO
Average productivity	+	-
Left tail of productivity distribution	+	-
Right tail of productivity distribution	0	0
Average firm size	-/+	-/+
Left tail of firm size distribution	+	0
Right tail of firm size distribution	-/+	-/+
Change in size of largest firms relative to mid-sized firms	Less negative	Less positive

Summary of predicted changes in the productivity and firm size distributions from Demidova and Rodriguez-Clare (2009)-Melitz (2003), DR-M and Melitz and Ottaviano (2008), MO. For average values, "+" indicates an increase and "-" indicates a decrease. For the left and right tails of the distributions, "+" indicates a rightward shift while "-" indicates a leftward shift.

Table 2: Average Final Goods Tariffs by 2-Digit Manufacturing Industry

	1989	1994	1999
Food Products	105.38	52.57	32.76
Beverages and Tobacco	157.86	133.44	78.78
Cotton Textiles	87.38	65.00	37.65
Wool, Silk, and Synthetic Fibers	94.55	64.26	36.70
Jute and Vegetable Fibers	61.43	65.00	39.00
Textile Products	102.85	65.00	39.74
Wood	71.71	65.00	35.47
Paper	58.25	54.14	23.65
Leather	94.29	65.00	33.57
Basic Chemicals	114.00	64.09	34.43
Rubber, Plastic, Petroleum, and Coal	89.82	54.25	33.15
Non-Metallic Mineral Products	96.86	65.00	37.06
Basic Metals, Alloys	102.32	49.26	32.35
Metal Products and Parts	156.52	54.99	35.22
Machinery and Equipment	84.93	64.87	27.32
Electrical Machinery	102.27	64.98	31.57
Transport Equipment	70.27	64.36	37.32
Other	92.25	63.64	34.03

Average final goods tariffs by 2-digit manufacturing industry in 1989, 1994, and 1999. Source: Author's calculations, based on Customs Tariff Working Schedules published by the Government of India.

Table 3: Tariff Changes and Pre-Reform Industrial Characteristics

Dependent Variable: Change in Final Goods Tariffs (1989-1999)

Panel A: Informal Sector, Pre-Reform Levels

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
log(Average TFP)	0.071						0.090
	(0.14)						(0.21)
log(Average Firm Size)		0.017					0.027
		(0.026)					(0.041)
log(Average Capital-Employee Ratio)			0.0087				-0.013
			(0.028)				(0.059)
log(Average Wage)				-0.0013			-0.045
				(0.071)			(0.068)
Export Share in Output					0.0041		0.0047
					(0.028)		(0.012)
log(No. Firms)						-0.0065	-0.0089
						(0.013)	(0.018)
Observations	134	134	134	134	134	134	134
R^2	0.002	0.003	0.001	0.000	0.000	0.002	0.009

Panel B: Formal Sector, Pre-Reform Levels

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
log(Average TFP)	-0.0069							0.014
	(0.070)							(0.073)
log(Average Firm Size)		0.054**						0.034
		(0.026)						(0.033)
log(Average Capital-Employee Ratio)			0.098**					0.091**
			(0.039)					(0.040)
log(Average Wage)				0.14				-0.031
				(0.090)				(0.12)
Export Share in Output					0.0031			0.020
					(0.027)			(0.015)
log(No. Firms)						0.033		0.033
						(0.022)		(0.036)
C4 Ratio							-0.21	-0.11
							(0.15)	(0.23)
Observations	137	137	137	137	137	137	137	137
R^2	0.000	0.031	0.043	0.018	0.000	0.017	0.014	0.081

Panel C: Formal Sector, Pre-Reform Trends

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
log(Average TFP)	0.022							0.022
	(0.035)							(0.041)
log(Average Firm Size)		0.0071						0.0072
		(0.059)						(0.058)
log(Average Capital-Employee Ratio)			0.0074					-0.018
			(0.082)					(0.065)
log(Average Wage)				0.14				0.12
				(0.18)				(0.20)
Export Share in Output					0.11			0.100
					(0.32)			(0.14)
log(No. Firms)						-0.0090		-0.025
						(0.056)		(0.081)
C4 Ratio							-0.092	-0.23
							(0.23)	(0.33)
Observations	119	119	119	119	119	119	119	119
R^2	0.003	0.000	0.000	0.005	0.001	0.000	0.001	0.012

Panel A shows the correlation between pre-reform, informal sector characteristics in 1989 and tariff changes from 1989-1999. Panel B shows the correlation between pre-reform, formal sector characteristics in 1989 and tariff changes from 1989-1999. Panel C shows the correlation between *changes* in pre-reform, formal sector characteristics from 1986-1989 and tariff changes from 1989-1999. "C4 Ratio" is the sum of the market shares of the four largest firms in the formal sector. Standard errors are in parentheses. *, **, and *** represent significance at the 10%, 5% and 1% levels, respectively.

Table 4: Summary Statistics for Firm-Level Data

	Mean	St. Dev.	Minimum	Maximum
Formal Sector				
Labor (number of Employees)	130.92	454.41	1	36,988
Capital (thousands of Rs. 1989)	8,705	48,400	0.00	1,950,000
Material (thousands of Rs. 1989)	21,300	66,300	0.01	1,520,000
Output (thousands of Rs. 1989)	32,800	107,000	0.00	5,160,000
No. Observations	93,768			
Informal Sector				
Labor (number of Employees)	3.09	2.46	1	20
Capital (thousands of Rs. 1989)	44.75	181.85	0.00	13,800
Material (thousands of Rs. 1989)	85.23	543.40	0.00	53,100
Output (thousands of Rs. 1989)	121.64	649.67	0.01	69,700
No. Observations	178,210			

Summary statistics for formal and informal firm-level data. Data from 1989, 1994 and 1999 are pooled. Capital, material and output are deflated as discussed in Section 4. Source: Author's calculations, based on ASI and NSSO data.

Table 5: Effect of a Fall in Tariffs on Average Productivity and Firm Size

Panel A: Dependent Variable - Total Factor Productivity

	(1) All	(2) All	(3) Formal	(4) Formal	(5) Informal	(6) Informal
Fall in Final Goods Tariffs	0.39***	0.30***	0.0051	-0.10***	0.40***	0.31***
	(0.077)	(0.093)	(0.021)	(0.025)	(0.079)	(0.096)
Fall in Input Tariffs		0.59		0.61***		0.61
		(0.57)		(0.097)		(0.61)
Observations	270676	270676	93586	93586	177090	177090
R^2	0.078	0.078	0.271	0.272	0.079	0.080

Panel B: Dependent Variable - Firm Size

	(1) All	(2) All	(3) Formal	(4) Formal	(5) Informal	(6) Informal
Fall in Final Goods Tariffs	0.62***	0.46**	-0.13**	-0.30***	0.65***	0.47**
	(0.15)	(0.19)	(0.051)	(0.061)	(0.15)	(0.19)
Fall in Input Tariffs		1.06		0.98***		1.20
		(0.99)		(0.21)		(1.05)
Observations	271978	271978	93768	93768	178210	178210
R^2	0.407	0.407	0.193	0.194	0.399	0.400

Final goods tariffs and input tariffs are measured as negative fractions (e.g., a 100% ad valorem tariff is represented by -1), so coefficients may be interpreted as the effects of a *fall* in final goods or input tariffs. All specifications include year and industry dummy variables. Standard errors are in parentheses, and are clustered at the state-industry level. *, **, and *** represent significance at the 10%, 5% and 1% levels, respectively.

Table 6: Summary of Results for a Unilateral Reduction in Final Goods Tariffs

	Predicted		Actual		
	DR-M	MO	Informal	Formal	Overall
Average productivity	+	-	+	-	+
Left tail of productivity distribution	+	-	+	-	+
Right tail of productivity distribution	0	0	+	0	0
Average firm size	-/+	-/+	+	-	+
Left tail of firm size distribution	+	0	+	-	+
Right tail of firm size distribution	-/+	-/+	+	-	-
Change in size of largest firms relative to mid-sized firms	Less negative	Less positive	Same	Less negative	Less negative

Summary of predicted changes in the productivity and firm size distributions from Demidova and Rodriguez-Clare (2009)-Melitz (2003), DR-M and Melitz and Ottaviano (2008), MO, as well as actual changes for the formal and informal sectors. For average values, "+" indicates an increase and "-" indicates a decrease. For the left and right tails of the distributions, "+" indicates a rightward shift while "-" indicates a leftward shift.

Table 7: Effect of a Fall in Tariffs on Average Productivity: Survivors vs. New Entrants

Dependent Variable - Total Factor Productivity

	(1) Formal 89-94	(2) Formal 89-94	(3) Formal 89-99	(4) Formal 89-99	(5) Informal 89-94	(6) Informal 89-94	(7) Informal 89-99	(8) Informal 89-99
Fall in FG Tariffs	-0.074***	-0.081***	-0.10***	-0.11***	0.25**	0.26**	0.31***	0.33***
	(0.027)	(0.027)	(0.025)	(0.026)	(0.11)	(0.11)	(0.096)	(0.094)
New Firm		-0.038		-0.080***		-0.13		-0.17***
		(0.027)		(0.026)		(0.089)		(0.062)
Fall in Tariffs x New		0.099***		0.065*		-0.082		-0.14*
		(0.031)		(0.033)		(0.10)		(0.076)
Fall in Input Tariffs	0.52***	0.53***	0.61***	0.61***	0.45	0.44	0.61	0.59
	(0.11)	(0.10)	(0.097)	(0.094)	(0.69)	(0.69)	(0.61)	(0.61)
Observations	74666	74018	93586	92804	103815	103776	177090	177024
R^2	0.274	0.275	0.272	0.274	0.063	0.064	0.080	0.081

Final goods (FG) tariffs and input tariffs are measured as negative fractions (e.g., a 100% ad valorem tariff is represented by -1), so coefficients may be interpreted as the effects of a *fall* in final goods or input tariffs. "New Firm" indicates a firm that is fewer than three years old. All specifications include year and industry dummy variables. Standard errors are in parentheses, and are clustered at the state-industry level. *, **, and *** represent significance at the 10%, 5% and 1% levels, respectively.

Table 8: Effect of a Fall in Tariffs on the Number of Survivors

Dependent Variable - Log of the Number of Survivors

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Formal	Formal	Formal	Formal	Formal	Formal	Formal	Formal	Informal	Informal	Informal	Informal
	89-94	89-94	89-94	89-94	89-99	89-99	89-99	89-99	89-94	89-94	89-94	89-94
Fall in Final Goods Tariffs	-0.027	-0.028	-0.0023	-0.032	-0.066	-0.069	-0.034	-0.069	-0.087	-0.089	-0.29*	-0.10
	(0.047)	(0.047)	(0.053)	(0.047)	(0.054)	(0.054)	(0.056)	(0.056)	(0.15)	(0.15)	(0.17)	(0.15)
Fall in Tariffs x Labor		0.012				0.019				0.11**		
		(0.018)				(0.017)				(0.056)		
Fall in Tariffs x Adjust			-0.052				-0.068				0.49***	
			(0.059)				(0.055)				(0.15)	
Fall in Tariffs x Dispute				0.054				0.029				0.19
				(0.055)				(0.055)				(0.13)
Observations	3846	3846	3846	3846	5138	5138	5138	5138	2666	2666	2666	2666
R^2	0.644	0.644	0.644	0.644	0.580	0.580	0.580	0.580	0.582	0.583	0.584	0.583

Unit of analysis is a state-by-industry cluster. Final goods tariffs are measured as negative fractions (e.g., a 100% ad valorem tariff is represented by -1), so coefficients may be interpreted as the effects of a *fall* in tariffs. "Labor Regs" is a measure of how "pro-worker" each state's labor regulations were in 1989, from Besley and Burgess (2004); more positive values indicate more "pro-worker" regulations. "Adjust" and "Dispute" divide labor regulations into those that make it difficult for firms to adjust their employment and those that make it difficult for firms to resolve industrial disputes, from Ahsan and Pages (2007). All specifications control for input tariffs and include year, state, and industry dummy variables. Standard errors are in parentheses, and are clustered at the state-industry level. *, **, and *** represent significance at the 10%, 5% and 1% levels, respectively.

Table 9: Effect of a Fall in Tariffs on the Total Number of Firms

Dependent Variable - Log of the Total Number of Firms

	(1) Formal	(2) Formal	(3) Formal	(4) Formal	(5) Formal	(6) Informal	(7) Informal	(8) Informal	(9) Informal	(10) Informal
Fall in Final Goods Tariffs	-0.039	-0.088	-0.092	-0.044	-0.095	0.12	0.19	0.18	0.11	0.18
	(0.060)	(0.061)	(0.061)	(0.062)	(0.063)	(0.12)	(0.12)	(0.13)	(0.13)	(0.12)
Fall in Tariffs x RCA		0.30***	0.31***	0.31***	0.32***		-0.30**	-0.29**	-0.31*	-0.28**
		(0.073)	(0.072)	(0.096)	(0.074)		(0.14)	(0.14)	(0.18)	(0.14)
Fall in Tariffs x Labor			0.021					0.084*		
			(0.019)					(0.046)		
Fall in Tariffs x Adjust				-0.093					0.20	
				(0.065)					(0.14)	
Fall in Tariffs x Dispute					0.070					0.087
					(0.066)					(0.11)
Fall in Tariffs x RCA x Labor			-0.11***					-0.074		
			(0.042)					(0.096)		
Fall in Tariffs x RCA x Adjust				-0.019					0.012	
				(0.14)					(0.26)	
Fall in Tariffs x RCA x Dispute					-0.21*					-0.23
					(0.13)					(0.23)
Observations	5319	5319	5319	5319	5319	4374	4374	4374	4374	4374
R^2	0.611	0.612	0.614	0.613	0.612	0.577	0.578	0.578	0.578	0.579

Unit of analysis is a state-by-industry cluster. Final goods tariffs are measured as negative fractions (e.g., a 100% ad valorem tariff is represented by -1), so coefficients may be interpreted as the effects of a *fall* in tariffs. "RCA" is a dummy variable that takes on a value of one if Balassa's (1965) measure of revealed comparative advantage is greater than one, zero otherwise, based on 1989 data from the World Bank's Trade and Production database. "Labor Regs" is a measure of how "pro-worker" each state's labor regulations were in 1989, from Besley and Burgess (2004); more positive values indicate more "pro-worker" regulations. "Adjust" and "Dispute" divide labor regulations into those that make it difficult for firms to adjust their employment and those that make it difficult for firms to resolve industrial disputes, from Ahsan and Pages (2007). All specifications control for input tariffs and include year, state, and industry dummy variables. Columns (3)-(5) and (8)-(10) also include interactions between RCA and labor regulations. Standard errors are in parentheses, and are clustered at the state-industry level. *, **, and *** represent significance at the 10%, 5% and 1% levels, respectively.

Appendix A: Alternate Productivity Measures

As discussed in Section 4.1, the index number method is robust to the variation in technology across firms (VanBiesebroeck 2007). However, this method also has several limitations, including the assumptions of perfect competition and constant returns to scale, as well as the failure to account for measurement error in the variables. I therefore explore whether my findings are robust to alternate TFP measures.

First, given the inherent difficulties in calculating capital rental rates, which are used to construct cost shares in the baseline TFP measurement, I also calculate TFP using revenue shares instead of cost shares.[22] The results of the two index number methods (using cost shares and revenue shares) are shown in Columns (1) and (2) of Table A.1, and are quite similar for both sectors. A 50 percentage point fall in final goods tariffs reduces average TFP in the formal sector by 5-7%, while increasing average TFP in the informal sector by 15-17%. The fall in input tariffs is associated with a large increase in TFP in both sectors, though the effect is only significant in the formal sector.

Next, I turn to parametric and semi-parametric methods to estimate TFP. I begin by estimating a production function using OLS:

$$q_{ijt} = \beta_0 + \beta_l l_{ijt} + \beta_m m_{ijt} + \beta_k k_{ijt} + \mu_{ijt} \tag{18}$$

where q_{ijt} is the log of output for firm i in industry j in year t, and l_{ijt}, m_{ijt}, and k_{ijt} are the logs of labor, material, and capital inputs, respectively. If we assume that μ_{ijt} is uncorrelated with the covariates, then we can estimate the coefficients on the input parameters using OLS. I allow the coefficients on the inputs to vary across industries by estimating the production function separately for each 2-digit industry. TFP is given by:

$$\widehat{tfp_{ijt}} \equiv q_{ijt} - \widehat{\beta}_0 - \widehat{\beta}_l l_{ijt} - \widehat{\beta_m} m_{ijt} - \widehat{\beta}_k k_{ijt} \tag{19}$$

I then estimate the effects of tariffs and input tariffs on TFP, using the baseline specification:

$$\widehat{tfp_{ijt}} = \beta_1 \tau_{jt} + \beta_2 \tau^I_{jt} + \alpha_j + \alpha_t + \varepsilon_{ijt} \tag{20}$$

I also estimate the effects of tariffs and input tariffs on TFP using a one-stage OLS method, which combines the two previous steps.

Columns (3) and (4) of Table A.1 present results for both OLS methods. In the formal sector, the coefficients on both final goods tariffs (-0.07 in both specifications) and input tariffs (0.42 and 0.58) are somewhat attenuated relative to the baseline results, but remain highly significant. In Column (4), the sum of the coefficients on the inputs (1.04) suggests that there are (slight) increasing returns to scale; an F-test strongly rejects the null hypothesis that $\widehat{\beta}_l + \widehat{\beta}_k + \widehat{\beta_m} = 1$. In the informal sector, the coefficients

[22] To do so, I calculate the shares of the wage bill S^l and of materials S^m in output; the share of capital is given by $S^k = 1 - S^l - S^m$.

on final goods tariffs (0.26 and 0.30) are slightly attenuated relative to the baseline results, while the coefficients on input tariffs (0.79 and 0.85) are larger in magnitude than the baseline results, and are now statistically significant. Although the sum of the coefficients on the inputs is slightly greater than one (1.02), I cannot statistically reject the null of constant returns to scale in this sector.

The fact that firms choose inputs and output simultaneously means that the OLS parameter estimates are likely to be biased. Olley and Pakes (1996, OP) propose a three-step method that addresses both the simultaneous choice of inputs and output, as well as the endogenous exit of firms. Implementing their method fully requires panel data, which are unavailable for informal firms, as well as small formal firms, in India. However, following Blalock and Gertler (2008), I conduct only the first stage of the OP method, which identifies the coefficients on the variable inputs (labor and materials), as well as on tariffs. In the first stage, OP show that given certain assumptions, we can use a firm's investment ι_{ijt} as a proxy for its unobserved productivity shock ω_{ijt}. Similar to Blalock and Gertler (2008), I therefore rewrite the production function as:

$$\begin{aligned} q_{ijt} &= \beta_1 \tau_{jt} + \beta_2 \tau^I_{jt} + \alpha_j + \alpha_t + \beta_l l_{ijt} + \beta_m m_{ijt} + \beta_k k_{ijt} + \omega_{ijt} + \eta_{ijt} \\ &= \beta_1 \tau_{jt} + \beta_2 \tau^I_{jt} + \alpha_j + \alpha_t + \beta_l l_{ijt} + \beta_m m_{ijt} + \beta_k k_{ijt} + h_t(\iota_{ijt}, k_{ijt}) + \eta_{ijt} \end{aligned} \quad (21)$$

where I approximate $h_t(\cdot)$ using a third-order polynomial function in capital and investment that is allowed to vary over time. Estimating Equation 21 produces consistent estimates for β_1, β_2, β_l, and β_m.

VanBiesebroeck (2003) also notes that if we are willing to assume constant returns to scale, then we can modify the OP method to estimate only β_l and β_m in the first stage, and $\beta_k \equiv 1 - \beta_l - \beta_m$. TFP is then calculated and related to tariffs as shown in Equations 19 and 20. As in the two-stage OLS procedure, I allow β_l, β_m, and β_k to vary across industries.

Columns (5) and (6) of Panel A show the results for these two procedures (OP-1 and OP-2) for the formal sector. I conducted the OP-1 method using observations with positive investment (about 70% of observations). For the OP-2 method, factor shares were calculated using observations with positive investment, then applied to all firms. The coefficients on final goods tariffs (-0.06 in both cases) are statistically significant at the 1% level and indicate that a 50 percentage point fall in final goods tariffs decreases formal sector productivity by approximately 3% (against 5% in the baseline case). In Column (5), we see that the coefficients on labor and materials are slightly lower than the corresponding OLS coefficients, suggesting that unobserved productivity shocks may bias the coefficients on variable inputs upwards in an OLS estimation (as predicted by OP).

I do not conduct the OP method for the informal sector, as fewer than 20% of observations in the sample have positive investment values. However, I use a similar method, suggested by Levinsohn and Petrin (2003, LP). LP note that in a value-added production function, material inputs can be used to proxy for unobserved productivity shocks. I therefore modify the first stage of the LP procedure in a similar manner as discussed above for the OP procedure. In this case, the dependent variable is the log of value added (output minus material inputs). Column (7) in Panel A, and Column (5) in Panel B, show the modified LP results for the formal and informal sectors, respectively. In both sectors, the LP coefficients on final goods tariffs and input tariffs are similar to the baseline results.

In all of the productivity estimates above, I deflate output using industry-level price deflators. However, heterogeneous firms models generally predict that more productive firms have higher output and revenue, but charge lower prices. If this is the case in my dataset, then deflating firm revenues by industry-level price deflators will systematically underestimate large firms' productivities while overestimating small firms' productivities. Hsieh and Klenow (forthcoming) suggest that we can correct for differential pricing within an industry by raising each firm's nominal output (sales) to the power $\sigma/(\sigma-1)$ where σ is the elasticity of substitution between differentiated goods. The authors note that typical values of σ range from 3 to 10 in the literature; I therefore modify observed output using each of these bounds for σ, and construct the TFP index based on this modified output measure. Columns (8) and (9) in Panel A, and Columns (6) and (7) in Panel B, show the results for the formal and informal sectors respectively. The results for $\sigma = 10$ (high) are similar to the baseline results, while the results for $\sigma = 3$ (low) are larger in magnitude in both sectors. However, the same pattern holds; a fall in final goods tariffs decreases formal sector productivity but increases informal sector productivity.

Finally, I use labor productivity (the log of output per number of employees) as an alternative to TFP. While labor productivity is likely to overstate the productivity of larger, more capital-intensive firms, it avoids having to calculate real capital input values. Column (10) in Panel A, and Column (8) in Panel B, show a similar pattern as the baseline, with a fall in final goods tariffs decreasing formal labor productivity by 9.5% and increasing informal labor productivity by 20%.

Despite some variation in magnitude across specifications, the results are robust to a variety of productivity measures. A fall in final goods tariffs decreases average formal sector productivity and increases average informal sector productivity; meanwhile, a concurrent fall in input tariffs increases formal sector productivity and may also increase informal sector productivity.

Table A.1: Alternate TFP Measures

Panel A: Formal Sector

	(1) IN-1	(2) IN-2	(3) OLS-1	(4) OLS-2	(5) OP-1	(6) OP-2	(7) LP	(8) σ Low	(9) σ High	(10) Labor Prod.
Fall in Final Goods Tariffs	-0.10***	-0.14***	-0.07***	-0.07***	-0.06***	-0.06***	-0.08***	-0.25***	-0.14***	-0.19***
	(0.03)	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.05)	(0.03)	(0.05)
Fall in Input Tariffs	0.61***	0.77***	0.42***	0.58***	0.46***	0.46***	0.54***	1.10***	0.72***	0.66***
	(0.10)	(0.12)	(0.08)	(0.09)	(0.08)	(0.08)	(0.08)	(0.18)	(0.11)	(0.16)
log(Employment)				0.19***	0.15***		0.14***			
				(0.02)	(0.01)		(0.01)			
log(Materials)				0.83***	0.82***					
				(0.01)	(0.01)					
log(Capital)				0.02***						
				(0.00)						
Observations	93586	93586	93768	93768	66993	93768	93768	93586	93586	93768
R^2	0.272	0.259	0.135	0.917	0.915	0.900	0.453	0.424	0.334	0.219

Panel B: Informal Sector

	(1) IN-1	(2) IN-2	(3) OLS-1	(4) OLS-2	(5) LP	(6) σ Low	(7) σ High	(8) Labor Prod.
Fall in Final Goods Tariffs	0.31***	0.33***	0.26***	0.30***	0.29***	0.54***	0.36***	0.40**
	(0.10)	(0.11)	(0.08)	(0.09)	(0.08)	(0.19)	(0.12)	(0.18)
Fall in Input Tariffs	0.61	0.61	0.79***	0.85***	0.71***	1.21	0.74	0.97
	(0.61)	(0.62)	(0.19)	(0.23)	(0.21)	(1.11)	(0.72)	(0.97)
log(Employment)				0.23***	0.18***			
				(0.02)	(0.02)			
log(Materials)				0.72***				
				(0.02)				
log(Capital)				0.07***				
				(0.01)				
Observations	177090	177090	178210	178210	178210	177090	177090	178210
R^2	0.080	0.075	0.069	0.910	0.680	0.105	0.086	0.387

"IN-1" and "IN-2" indicate that the dependent variable is total factor productivity (TFP), which is calculated using an index number method following Aw et al. (2001), using factor cost shares and revenue shares, respectively. "OLS-1" indicates a two-stage OLS estimation procedure; second-stage results are shown, with TFP as the dependent variable. In "OLS-2", a one-stage OLS estimation is performed; the dependent variable is the log of output. "OP-1" and "OP-2" show results from the modified Olley and Pakes (1996) procedure; the dependent variable is the log of output. The OP methods are not used for the informal sector, since fewer than 20% of informal firms in the sample reported positive investment. "LP" shows results from the modified Levinsohn and Petrin (2003) procedure; the dependent variable is the log of value added. "σ Low " and "σ High" indicate that output is corrected assuming low and high values for the elasticities of substitution between goods, as in Hsieh and Klenow (forthcoming). "Labor Prod." indicates that the dependent variable is the log of labor productivity (output per employee). Final goods tariffs and input tariffs are measured as negative fractions (e.g., a 100% ad valorem tariff is represented by -1), so coefficients may be interpreted as the effects of a *fall* in final goods or input tariffs. Standard errors are in parentheses, and are clustered at the state-industry level. *, **, and *** represent significance at the 10%, 5% and 1% levels, respectively.

Appendix B: Other Industrial Policy Changes

As discussed in Section 3, tariffs were harmonized beginning in 1991. However, India's pre-reform trade regime also included high non-tariff barriers (NTB), which required that firms obtain licenses in order to import most goods (Aksoy 1992). Following the 1991 reforms, licensing requirements were sharply reduced for non-consumer goods but remained in place for most consumer goods (Epifani 2003).

Disaggregated measures of NTB barriers are unfortunately not available during the period of the reforms. However, if NTB barriers are important in explaining productivity changes, then I would expect the impact of the fall in tariffs on productivity to be larger in industries that also faced declines in NTB protection. To that end, I create a dummy variable for NTB liberalization that equals one for non-consumer goods industries and zero for consumer goods industries, based on Nouroz's (2001) classification. I then interact this dummy variable with the fall in final goods tariffs in Table B.1. The sample size is somewhat smaller as I restrict the analysis to those industries for which data on a variety of industrial policy changes (including those discussed below) are available. Columns (1) and (6) of Panel A indicate that in this restricted set of industries, the effects of the fall in final goods tariffs on productivity are slightly smaller in magnitude than the baseline effects in both sectors. Columns (2) and (7) suggest that NTB liberalization magnifies the effect of the fall in tariffs on firm productivity in both sectors, but the additional impacts are not statistically significant.

Table B.1 also investigates potential confounding effects of two other industrial policy changes that occurred during the 1990s: the dismantling of the "license raj" and the allowance of foreign direct investment (FDI) into most industries without case-by-case approval. Until the 1980s, India's "license raj" required every firm with more than 50 employees (100 employees without power) and a certain amount of assets to obtain an operating license. The license specified, among other things, the amount of output a firm could produce, the types of goods it could make, and its location (Sharma 2008). In 1985, approximately one-third of industries were "delicensed" (the requirement for a license was dropped); in 1991, most industries were delicensed as part of the broader reforms package (Aghion, Burgess, Redding and Zilibotti 2008). Using aggregate industry-level data from 1980 to 1997, Aghion et al. (2008) find that delicensing increases the number of formal firms (as well as output, to some extent) in the formal sector, and increases formal sector growth among "pro-employer" states relative to "pro-worker" states. A second important policy change that occurred in 1991 was the liberalization of FDI inflows. Prior to 1991, FDI was capped at 40% for most industries; beginning in 1991, FDI inflows of up to 51% were allowed in selected industries with "automatic" approval (Sivadasan forthcoming). Using firm-level ASI data, Sivadasan (forthcoming) finds that FDI liberalization increases productivity by approximately 15% in value added terms, or 4.5% in gross output terms, among formal firms with more than 5 employees.

Table B.1 shows that the impacts of final goods tariffs are robust to controlling for these policies, both separately and together.[23] The coefficients on the fall in final goods tariffs are similar in magnitude

[23]Data on delicensing and FDI reform are from Aghion et al. (2008). Since their data stop in 1997, I use the 1997

to the baseline results in both sectors, and remain significant at the 5% level in all specifications.

I find that delicensing decreases average firm size and productivity in both the formal and informal sectors. The negative coefficient on formal firm size is consistent with the findings of Aghion et al. (2008), who show that delicensing increases the number of formal firms by 6% while increasing output by 3% (which would thus decrease average firm output). Sharma (2009) shows that the informal sector contracts when delicensing takes place, which may account for the decrease in productivity and firm size in this sector: If the most productive, largest informal firms move from the informal sector to the formal sector, then average productivity and firm size would likely fall in both sectors. Finally, I find a positive correlation between FDI liberalization and average formal sector productivity. Though statistically insignificant, the magnitude of the increase (2.7%) is similar to the results presented by Sivadasan (forthcoming), who finds that FDI liberalization increases average productivity by 4.5% (when measured in terms of gross output).

delicensing and FDI reform variables for the 1999-2000 survey round.

Table B.1: Other Industrial Policies

Panel A: Dependent Variable- Total Factor Productivity

	(1) Formal	(2) Formal	(3) Formal	(4) Formal	(5) Formal	(6) Informal	(7) Informal	(8) Informal	(9) Informal	(10) Informal
Fall in Final Goods Tariffs	-0.077**	-0.068**	-0.079***	-0.079***	-0.069**	0.28***	0.28***	0.31***	0.20**	0.28***
	(0.030)	(0.030)	(0.030)	(0.030)	(0.031)	(0.086)	(0.088)	(0.082)	(0.086)	(0.084)
Fall in Final Goods Tariffs x NTB		-0.032			-0.040		0.041			0.13
		(0.034)			(0.033)		(0.15)			(0.13)
Delicensed			-0.046**		-0.043*			-0.15***		-0.13**
			(0.021)		(0.022)			(0.052)		(0.059)
FDI				0.027	0.014				0.38***	0.23**
				(0.023)	(0.023)				(0.089)	(0.10)
Fall in Input Tariffs	0.41***	0.42***	0.45***	0.40***	0.45***	1.12**	1.07**	1.13**	1.04**	0.91*
	(0.15)	(0.15)	(0.14)	(0.15)	(0.14)	(0.49)	(0.53)	(0.47)	(0.46)	(0.48)
Observations	73020	73020	73020	73020	73020	132314	132314	132314	132314	132314
R^2	0.254	0.254	0.254	0.254	0.254	0.078	0.078	0.081	0.081	0.083

Panel B: Dependent Variable- Firm Size

	(1) Formal	(2) Formal	(3) Formal	(4) Formal	(5) Formal	(6) Informal	(7) Informal	(8) Informal	(9) Informal	(10) Informal
Fall in Final Goods Tariffs	-0.23***	-0.24***	-0.23***	-0.24***	-0.24***	0.57***	0.58***	0.61***	0.44**	0.50***
	(0.070)	(0.072)	(0.070)	(0.071)	(0.075)	(0.18)	(0.18)	(0.18)	(0.18)	(0.18)
Fall in Final Goods Tariffs x NTB		0.034			-0.026		0.068			0.087
		(0.079)			(0.077)		(0.25)			(0.26)
Delicensed			-0.16***		-0.11*			-0.17**		-0.10
			(0.049)		(0.058)			(0.078)		(0.090)
FDI				0.21***	0.16**				0.65***	0.53**
				(0.060)	(0.070)				(0.20)	(0.22)
Fall in Input Tariffs	0.62**	0.61**	0.74***	0.51*	0.63**	1.03	0.94	1.04	0.90	0.81
	(0.29)	(0.29)	(0.27)	(0.28)	(0.26)	(0.87)	(0.92)	(0.88)	(0.88)	(0.90)
Observations	73020	73020	73020	73020	73020	132314	132314	132314	132314	132314
R^2	0.214	0.214	0.214	0.214	0.214	0.399	0.399	0.400	0.400	0.400

"NTB" is a dummy variable that takes on a value of one for non-consumer goods industries, zero for consumer goods industries, based on the classification by Nouroz (2001). "Delicensed" is a dummy variable that takes on a value of one if the industry is delicensed, zero otherwise. "FDI" is the fraction of product lines in an industry that allow FDI inflows up to 51% without case-by-case approval. Data on delicensing and FDI reform are from Aghion et al. (2008). Final goods tariffs and input tariffs are measured as negative fractions (e.g., a 100% ad valorem tariff is represented by -1), so coefficients may be interpreted as the effects of a *fall* in final goods or input tariffs. All specifications are restricted to industries for which delicensing and FDI data were available, and include year and industry dummy variables. Standard errors are in parentheses, and are clustered at the state-industry level. *, **, and *** represent significance at the 10%, 5% and 1% levels, respectively.