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ABSTRACT

The new trade theory emphasizes the role of market-share reallocations across firms (“stealing”) in driving productivity growth, while the older literature focused on average productivity improvements (“learning”). We use comprehensive, firm-level data from India’s organized manufacturing sector to show that market-share reallocations did play an important role in aggregate productivity gains immediately following the start of India’s trade reforms in 1991. However, aggregate productivity gains during the overall 20-year period from 1985 to 2004 were driven largely by improvements in average productivity. By exploiting the variation in reforms across industries, we document that the average productivity increases can be attributed to India’s trade liberalization and FDI reforms. Finally, we construct a panel dataset that allows us to track firms during this time period; our results suggest that while within-firm productivity improvements were important, much of the increase in average productivity also occured because of firm entry and exit.

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1 Introduction

The new trade theory stresses the importance of market-share reallocations in increasing aggregate productivity following a trade liberalization (Bernard, Eaton, Jensen and Kortum 2003, Melitz 2003). In contrast, the earlier literature emphasized the idea that trade could improve average productivity among existing firms (Corden 1974, Grossman and Helpman 1991, Helpman and Krugman 1985, for example). Yet there are few empirical studies that quantify the relative importance of average productivity gains versus gains from market-share reallocations in the wake of a major trade liberalization.

In this paper, we use a comprehensive, firm-level dataset that allows us to examine the role played by market-share reallocations in aggregate productivity growth in India's organized manufacturing sector from 1985 to 2004.[1] In 1991, India embarked on a series of reforms, including a major trade liberalization. We confirm that market-share reallocations were an important source of productivity growth in the years immediately following the start of the 1991 reforms, but not during other periods.

We document three distinct phases in India's manufacturing productivity during the period from 1985 to 2004. During this time, aggregate productivity (defined as output-weighted, mean firm productivity) grew by nearly 20%. From 1985 to 1990, the growth in aggregate productivity was driven by "learning" - that is, an increase in unweighted, average firm productivity. This measure of learning captures the change in productivity for the average firm, and therefore includes not only changes in productivity among surviving firms, but also changes in average productivity that can be attributed to firm entry and exit. In the period immediately following the start of the reforms (1991-1994), the "stealing" of market share - that is, the reallocation of market share from less productive to more productive firms - became more important than learning in driving aggregate productivity growth. In the longer run (1998-2004), learning once again became the more important factor in aggregate productivity growth, with stealing (reallocation) contributing little. During the 20-year

[1] The organized (formal) manufacturing sector in India consists of firms that are registered under Sections 2m(i) and 2m(ii) of the Factories Act; all firms with 20 or more employees (10 if power is used) are required to register. The organized sector accounts for approximately 80% of manufacturing sector output, though only 20% of employment.

period from 1985 to 2004 as a whole, we find that most of the increase in aggregate productivity can be explained by improvements in average productivity.

We then examine the extent to which individual policy reforms were associated with these productivity gains. In particular, we exploit variations in tariff cuts, foreign direct investment (FDI) liberalization, and industrial licensing reforms across industries to examine the contribution of each reform to overall growth. We find that the average decline in final goods tariffs during this time period implies a 3.2% increase in aggregate productivity, while the average decline in input tariffs implies a 21.8% increase. Moreover, the FDI liberalization also accounts for a 2.2% increase in aggregate productivity.

Finally, although firm identifiers are not available for the organized sector data during most of the time period we study, we construct a panel dataset by matching individual firms from one year of the survey to the next. This panel allows us to examine the relative importance of within-firm changes, versus firm entry and exit, in explaining average productivity growth. When we attempt to isolate within-firm changes in average productivity by controlling for firm-level fixed effects, we find that the impacts of the input tariff and FDI liberalizations on average productivity are strongly attenuated, though still economically and statistically significant. Our results suggest that although within-firm productivity growth is important, a substantial fraction of the average productivity increase that is attributable to these policies is also due to firm entry and exit.

Our study was motivated by the emphasis that the new trade theory places on the importance of market-share reallocations in increasing aggregate productivity. Although a number of papers have tested various implications of this literature (see, for example, Arkolakis (forthcoming), Bernard et al. (2003), Bernard, Jensen and Schott (2006), Berthou and Fontagne (2010), Eaton, Kortum and Kramarz (2008), Helpman, Melitz and Yeaple (2004), Manova and Zhang (2010)), few are able to directly test the effect of a trade liberalization episode on market-share reallocations, and existing evidence on the role of reallocation is mixed. For example, Tybout and Westbrook (1995) find that the reallocation of market share to relatively low-cost firms explained little of the overall change in productivity following Mexico's trade liberalization; however, Pavcnik (2002) and Menezes-Filho and Muendler (2007) find that market-share reallocation was an important driver of productivity growth following trade reforms in Chile and Brazil, respectively. Trefler (2004) documents that a fall in Canadian tariffs increased industry-level labor productivity, but not within-plant labor productivity, which he interprets as evidence that reallocation was more important than within-plant improvements. In Colombia, Fernandes (2007) finds that average productivity gains were more important than reallocation, but that reallocation became important in many industries during periods of tariff liberalization. We add to this literature by showing that in the case of India, market-share reallocations were important, but only during the period immediately following the start of the trade reforms.

Our study also contributes to the substantial body of work examining India's 1991 reforms. Topalova and Khandelwal (forthcoming) establish that the reductions in final goods and input tariffs increased productivity among approximately 4,000 large, publicly listed manufacturing firms. Sivadasan (2009) uses a dataset that is similar to ours for the early years of the reforms (1986-1994) and finds that the reduction in final goods tariffs and the FDI liberalization increased productivity. He also documents that the final goods tariff and FDI liberalizations were linked with average productivity increases, but not reallocation, in the early 1990's. Nataraj (2010) compares the reactions of the organized and unorganized manufacturing sectors to trade liberalization, and finds that while the reduction in final goods tariffs increased productivity significantly among unorganized firms, the reduction in input tariffs was more important in increasing organized sector productivity. Aghion, Burgess, Redding and Zilibotti (2008) find that following the removal of licensing requirements, the number of factories and output increased, particularly in states with relatively less restrictive labor regulations.

Our study is distinguished from previous literature on the 1991 reforms in several ways. First, we document that market-share reallocations were important to overall productivity growth immediately following the start of the 1991 reforms, while average productivity gains were more important during the periods from 1985-1990 and 1998-2004. Second, we show that the trade and FDI liberalizations explain a substantial amount of overall productivity growth. Third, our construction of a panel of firms allows us to show that a large share of the increase in average productivity appears to be due to firm entry and exit.

The rest of this paper is organized as follows. Section 2 provides a brief background on the Indian reforms; Section 3 describes the data and outlines the construction of the panel of firms; Section 4 discusses the empirical framework and presents results; and Section 5 concludes.

2 The 1991 Reforms

Prior to 1991, India had a highly restrictive trade regime, with average final goods tariffs on manufactured products of approximately 95%, as well as non-tariff barriers on most goods. FDI was capped at 40% for most industries, and large manufacturing firms were required to obtain operating licenses. During the 1980s, India began to liberalize its licensing policies to some extent, removing licensing requirements from approximately one-third of industries; however, trade and FDI restrictions remained in place. India's fiscal deficit continued to grow during this time, 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 and lower demand from abroad, and an unstable political climate - created a balance of payments crisis (Topalova and Khandelwal forthcoming). A new government requested help from the IMF, which was granted on the condition that India undertake several reforms (Hasan, Mitra and Ramaswamy 2007). In July 1991, the 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 ("delicensing"), the removal of import licensing requirements for capital and intermediate goods, and a reduction and harmonization of tariffs across industries. Many of these policy changes were formalized in India's Eighth Five-Year Plan (1992-97).

Between 1991 and 1997, the average final goods tariff rate on manufactured products fell from 95% to 35% (Panel (a) of Figure 1). Not only did average tariffs fall, but tariffs were also harmonized across industries; therefore, the industries with the highest pre-reform tariffs faced the highest tariff cuts. Panel (b) of Figure 1 shows a negative, linear relationship between an industry's pre-reform tariff level and the change in tariffs through 1997.[2] After the Eighth Five-Year Plan (post-1997), India continued to lower its tariffs, though the reductions were no longer as uniform. Panel (a) of Figure 1 shows that tariffs for some industries were even increased during this time. Panel (c) of the same figure indicates that if we compare tariff changes through 2004 with pre-reform tariffs, the negative relationship exhibited through 1997 still holds, although there are a few more outliers.

In addition to final goods tariffs, we also consider the impact of input tariffs on productivity. We calculate input tariffs using India's Input-Output Transactions Table, 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. In our baseline measure of input tariffs, we use both traded and non-traded inputs, assigning tariff rates of zero to non-traded inputs.[3]

One potential concern with including input tariffs in our empirical analysis is that final goods and input tariffs may be highly correlated, thus leading to multicollinearity problems in estimation. Panel (d) 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 coefficient between final goods and input tariffs (across years and industries) is 0.7. Within years, the correlation coefficient is even lower (less than 0.5 in all years), which suggests that multicollinearity is not likely to be a significant problem.

We also consider two other policy changes that occurred during this period: the removal of in-

[2]Section 4.6 shows that excluding the two industries that do not fit this pattern does not affect the results.

[3]In Section 4.6, we present results from an alternative measure of input tariffs that considers only manufacturing sector inputs.

dustrial licensing requirements and the allowance of 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. 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 et al. 2008). The restrictions on foreign investment were also liberalized during the 1990's. 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 2009).

By the end of 1991, nearly 85% of industries had been delicensed. The licensing requirement was removed from several additional industries in subsequent years, and by the end of the 1990's, over 90% of industries had been delicensed. In contrast, the FDI liberalization occurred somewhat more slowly: only one-third of industries were FDI liberalized in 1991. A few additional industries were liberalized by 1997, but it was not until 2000 that the government indicated that all industries would be eligible for automatic FDI approval, except those requiring an industrial license or meeting several other conditions. Table 1 shows the evolution of the reforms over time.

The fact that most of these policy changes occurred as part of an externally-required reforms package lowers the chance that industries were selected into the reforms based on political factors. In addition, to the extent that industries with certain characteristics may have been more likely to be liberalized, we use a fixed-effects estimation strategy that should address any time-invariant characteristics that could have affected selection. However, if the reforms are correlated with pre-reform trends in industry characteristics, then our results may be biased. To evaluate the potential extent of this bias, we examine the correlations between changes in reforms (1990-2004) and pre-reform trends in industry characteristics (1985-1989). We follow Topalova and Khandelwal (forthcoming) and consider a number of industry characteristics including wage, share of production workers, capital-labor ratio, total employment and output, and firm size (average employment).

We also consider pre-reform trends in total factor productivity (TFP). Table A.1 indicates that there are no statistically significant correlations between pre-reform trends in industry characteristics and future reforms. Moreover, in Section 4.6 we show that our results are robust to limiting our analysis to the period through 1997; since these initial reforms were largely carried out as outlined in the Eighth Five-Year Plan, which was developed in the wake of the 1991 crisis, they are even less likely to be subject to potential selection issues than reforms in later years.

3 Data

3.1 Annual Survey of Industries (ASI) Data

The primary dataset we use is firm-level surveys from the Annual Survey of Industries (ASI). The period of coverage for each ASI survey is the accounting year that ended on any day during the fiscal year: the 1985-86 survey (which we refer to as the 1985 survey) refers to the factory's accounting year that ended on any day between April 1, 1985 and March 31, 1986. We obtained firm-level data for all available years between 1985 and 2004. Data were not available for 1995. In addition, the way in which input data were collected and made available for the years 1996 and 1997 did not make it possible to construct certain key variables for those two years that were consistent with the other years. Therefore, we restrict our analysis to the firm-level data for the remaining 17 years between 1985 and 2004 (1985 through 1994 and 1998 through 2004).

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 and service providers. We include only manufacturing firms in our analysis. All firms that have 20 or more employees (10 or more employees if a power source is used) are required to register.[4] The sampling frame is derived from the registry list of each state's Chief

[4]Although firms with fewer than 10 employees are not required to register under this act, and therefore should not appear in the sampling universe, between 15% and 20% of the ASI firms in each year report fewer than 10 employees. These firms may be registered for various reasons, including the possibility that they used to have more than 10 employees but shrank; that they plan to grow in the future; and that registering may be a signal to creditors or other business partners.

Inspector of Factories, and all but four small states are covered.

The ASI divides firms into two sectors - the "census" sector, in which firms are surveyed every year, and the "sample" sector, in which firms are sampled every few years. Between 1985 and 2004, the inclusion of firms in the census and sample sectors, as well as the sampling strategy, changed several times. To ensure that our analysis is consistent over time and is representative of the population of firms, we apply the sampling multiplier weights that are provided for each firm.

Each unit surveyed is generally a factory; however, if an owner has two factories in the same state, sector (census versus sample) and industry, a joint return can be furnished. In the population of firms, fewer than 2% of the observations report more than one factory, and we will use the term "firm" to mean one observation in our dataset.[5]

The key variables we construct from the ASI data are output, material input, labor, and capital.[6] We drop closed firms from the dataset, and we include only firms with positive values of the key variables. To address a few extreme outliers, we also trim the top 0.5% of output and material input values.

We deflate output using industry-specific wholesale price indices (WPI) from the Government of India's Handbook of Industrial Statistics. Similarly, our material input measures are deflated by constructing deflators using the WPI along with India's 1993-94 Input-Output Transactions Table. Labor is measured as the total number of people employed by the firm. For the baseline analysis, we deflate the book value of capital by the WPI for machinery. In Section 4.6, we show that our results are robust to measuring capital using the perpetual inventory method described in Harrison (1994), as modified by Sivadasan (2009).

Summary statistics for the population are presented in Table 2. Only open firms that have positive values of our key variables are included. Sampling weights are applied to the summary statistics in the first column, so the results are representative of the overall organized sector. The second column shows results for the firms that were sampled, without applying sampling weights.

[5]We tested the robustness of our results to including only observations that report one factory. Results are not presented here as they are virtually identical to baseline results.

[6]Output includes the ex-factory value of products, the increase in the stock of semi-finished goods, and the value of own construction; material input includes material and fuel.

Since larger firms are surveyed more often than smaller firms, the mean and median values of output, capital, material inputs, and labor are much larger in the sampled population rather than the estimated population.

3.2 Creating a Panel

The ASI data provide unique firm identifiers beginning in 1998. However, it has not previously been possible to track firms prior to 1998, and thus to follow them during the most significant period of reforms. As discussed in Harrison (2009), we overcome this challenge by matching individual firms from one year of the survey to the next between 1985 and 1998. We then combine this constructed panel with the pre-formed panel provided by the ASI from 1998-2004.

We construct our panel in three steps. First we pair firms that appear in consecutive years. We search for exact duplicates in Open and Close values between one year and the next (e.g. we look for a match between the Close value in 1985 and the Open value in 1986) in one of the following six variables: stock of raw materials, fuels, and stores; stock of semi-finished goods; stock of finished goods; inventory; loans; and fixed capital. We only consider matches with more than four non-zero digits. In the case of multiple potential matches, we take the pair that matches the largest number of digits over the six variables, with a minimum match of six digits, implying an exact match in least two matching variables.

We apply this technique from 1985-1994 and from 1996-1998. After 1998 we use the pre-formed panel. However, the detailed data for 1995 have not been released. To link firms over this gap year, we consider matches within state, 2-digit industry code, and permanent serial number. Though the ASI provides a permanent serial number for each firm, this number is not unique; however, we find that the numbers are consistent across previously matched firms from 1990 onwards. We therefore use the permanent serial number along with state and industry codes to bridge the gap in 1995. We validate matches by checking the year of initial production and growth in labor, fixed capital and fuels. For labor forces of less than 1,000 employees, we use observed growth rates in labor among known matches to develop a nonlinear relationship between labor force observed one year and labor force observed the following year. We then require potential pairs in non-adjacent years to fall within the 10th and 90th percentiles of this observed labor force growth. For fixed capital and fuels we allow for one standard deviation of positive or negative growth. Based on our analysis of the pre-formed panel, for the year of initial production we allow for variation of up to two years, as well as switched tens and ones digits (e.g. 1984 is allowed to replace 1948).

We then extend the technique used to bridge the gap across 1995 to other years, in order to match broken series to each other and to unmatched observations. We consider matching any series with an exact match in terms of state, 2-digit industry code, and permanent serial number.[7] We apply the same labor, fixed capital, and fuels checks that we performed when bridging the gap in 1995, only allowing a successful match to fail one of these checks.

From 1985 to 1994, and in particular from 1985 to 1989 when permanent serial numbers are rarely consistent across more than two years for known matches, we iterate a similar procedure using exact district code matches. The mapping of district codes to geographical regions changes frequently over the period of our survey, so we generate a concordance of district codes over time, using existing concordances as well as the changing codes observed in our known panel matches.[8]

Since we observe each firm's year of initial production, we are confident that we can correctly identify survivors and entrants in our panel. However, given the substantial fraction of firms that are not surveyed every year, we are more reserved about our ability to identify exiting firms. The rates of exit that we observe in our panel are significantly higher than the rates that we extrapolate from the observed distribution of year of initial production. Therefore, in estimating productivity, we avoid methods that rely on accurately identifying firm exits, and instead employ an index number method that is robust to potentially spurious exit. In Section 4.4, we exploit the fact that we can confidently identify surviving firms to examine the extent to which average productivity improvements are driven by within-firm learning.

Summary statistics for the panel are presented in the final column of Table 2. Larger firms

[7]Given the number of firms that switch between manufacturing different types of textiles, we combine textile codes (NIC-87 codes 23, 24, and 25) for this exercise.

[8]We thank Pauline Grosjean and Ben Crost for providing us with their district code concordance, which formed a basis for ours.

(those that are in the "census" sector and are surveyed every year) make up more than 60% of the firm-year observations in the panel, 45% of firm-year observations in the full sample of firms, and only 20% of firm-year observations in the estimated population. The panel should not be seen as representative of a random selection of firms in the population, but rather a selection of relatively large firms. Nonetheless, the bottom rows in Table 2 show that 71% of firm-year observations that appeared in the sample, representing 94% of total deflated output over the entire period and 92% of the labor force, are captured for at least two years in the panel.

3.3 Policy Variables

The four policies we consider - final goods tariffs, input tariffs, delicensing, and FDI reform - were discussed in Section 2. Our tariff data are based on the Government of India's Customs Tariff Working Schedules and the Trade Analysis and Information System (TRAINS) database. Both sources provide rates for approximately 5,000 harmonized system (HS) product codes. Using the concordance of Debroy and Santhanam (1993), we match the product lines with 3-digit NIC-87 codes, and calculate average final goods tariff rates within each of approximately 140 industries.[9] We calculate input tariffs as described in Section 2

To capture the effects of the delicensing reforms, we use data from Aghion et al. (2008) from 1985 to 1997, supplemented by information from Press Notes from the Ministry of Commerce & Industry from 1998 to 2004. The delicensing variable is a dummy that takes on a value of one if any products in a three-digit industry have been delicensed, zero otherwise. Our measure of FDI liberalization is also based on Press Notes from the Ministry of Commerce & Industry, and takes on a value of one if any products in a three-digit industry have been liberalized, zero otherwise. Table 1 shows the evolution of the trade, licensing, and FDI reforms between 1985 and 2004.

[9]Prior to 1986, tariff data were reported in Brussels Tariff Nomenclature (BTN) rather than HS codes. For these years, we first map BTN codes to HS codes using a concordance table from the TRAINS database.

4 Empirical Framework and Results

4.1 Measuring Total Factor Productivity

For the full sample of data, we measure TFP using a chain-linked, index number method suggested by Aw, Chen and Roberts (2001):

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

where
q_{ijt}=log of output for firm i, industry j, time t
ζ_{ijt}^{z}=revenue share of input z
z_{ijt}=log of input z

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. Inputs include labor, capital, and material input; inputs and output are measured and deflated as discussed in Section 3.1. Bars over variables indicate average values within a particular industry and year. Revenue shares for labor and material input are calculated as the share of each input in total revenue; capital's revenue share is assumed to be one minus the sum of the other two shares.

4.2 Overall TFP Growth

We begin by looking at productivity changes for the entire manufacturing industry from 1985 to 2004. To do so, we first calculate aggregate TFP in year t, Φ_t^{AGG}, by taking the sum of each firm's productivity ϕ_{it}, weighted by its market share ψ_{it}. Olley and Pakes (1996) show that this measure of aggregate TFP can be decomposed into two components:

$$
\begin{aligned}
\Phi_t^{AGG} &\equiv \sum_i \psi_{it}\phi_{it} \\
&= \overline{\phi_t} + \sum_i [\psi_{it} - \overline{\psi_t}][\phi_{it} - \overline{\phi_t}] \\
&\equiv \Phi_t^U + R_t
\end{aligned}
$$

where $\overline{\phi_t}$ and $\overline{\psi_t}$ are unweighted average productivity and market share, respectively. The first component, Φ_t^U, is unweighted average productivity. The second component, R_t, measures the covariance between firm productivity and market share; changes in this measure represent a reallocation of market share between firms of different productivity levels. The new trade theory suggests that trade liberalization should cause the reallocation component to rise, as output is reallocated from less productive to more productive firms. In addition, it is important to note that using this decomposition, the average productivity component can change not only due to changes in productivity among existing firms, but also due to firm entry or exit. Therefore, the new trade theory suggests that the average productivity component is also likely to increase as the least productive firms exit in response to competition from trade.

We begin by constructing these measures at the all-India level. To make the results representative of the population of firms, and consistent over time, we pre-multiply each observation by the sampling weight provided in the ASI. Furthermore, to make the results more comparable with our later regression results, we consider only firms in state-industry groups that exist over the entire period.[10]

Figure 2 and Table 3 present results. Following Pavcnik (2002), we normalize productivity values to be zero in 1985, so that changes in productivity levels can be interpreted as growth since 1985. Between 1985 and 2004, aggregate productivity grew by 19%. This increase in productivity implies an annual increase of slightly less than 1% per year, which is within the range of previous

[10] We have confirmed that including all firms makes little difference to the overall results.

studies.[11]

When we consider the time period as a whole, nearly all of this increase (17.1%) can be attributed to growth in average productivity, rather than reallocation. However, Figure 2 and Table 3 suggest that there are three distinct phases between 1985 and 2004. First, from 1985 to 1990, average productivity rose by over 8%, while the reallocation component actually fell by more than 6%, indicating that more productive firms lost market share to less productive firms. Starting in 1991, this trend was reversed: average productivity fell, while reallocation productivity rose sharply. By 1998, however, average productivity improvements were once again the more important driver of aggregate productivity growth. Reallocation productivity remained at approximately the level it achieved between 1992 and 1993, but rose no further.

Our results suggest that market-share reallocations did play an important role in aggregate productivity growth, but only during the few years immediately following the start of the 1991 reforms. Over the longer time horizon, average productivity improvements remained more important in explaining the increase in aggregate TFP.

4.3 TFP Changes and Policy Reforms

To what extent can the increase in productivity be attributed to the trade and other policy reforms that occurred during the 1990's? To answer this question, we exploit the variation in those policies across industries to examine whether changes in the individual components of productivity were systematically related to specific reforms.

In order to use the policy variation across industries, we re-create our aggregate, average, and reallocation TFP measures at the state-industry level. We use the state-industry level because this level of disaggregation allows us to consider variations in policies and other characteristics across both industries and states, and because the ASI survey is designed to be representative at this level.

[11] There has been an extensive debate about TFP growth in the organized Indian manufacturing sector, particularly during the 1980's; Goldar (December 7, 2002) provides a summary of a number of TFP growth estimates, and discusses many of the measurement issues involved. It is important to note that our TFP estimates are based on a gross output, rather than value-added, production function; value-added TFP growth rates tend to be much higher than gross output growth rates.

We construct these measures for each state-industry group, and Figure 3 and Table 4 present the average results across all groups, weighting each group by the total number of firms that appear in that group across all years. Doing so ensures that the results are more comparable to the all-India results, since larger state-industry groups are given more weight.

Note that this weighting scheme ensures that average productivity is nearly the same at the state-industry and all-India levels. However, the reallocation component is lower across most years at the state-industry level. The reason is that at this level, we can only measure reallocation *within* state-industry groups. For example, suppose that the steel industry is more productive than the chemical industry, and that all firms in the steel industry increase output by 10%, while all firms in the chemical industry reduce output by 10%. The all-India reallocation measure will increase, but the state-industry reallocation measure will not. While it would be ideal to capture between-industry as well as within-industry market-share reallocations, our identification strategy (described below) does not allow us to use an all-India measure of productivity. Nonetheless, despite some differences, the reallocation component at the state-industry level follows the same basic pattern as the all-India measure.

We exploit the fact that the trade, licensing, and FDI reforms occurred differentially across industries to isolate the impacts of each policy on each productivity measure. Consider the relationship between our outcomes of interest and the reforms:

$$\widehat{Y_{jst}} = \beta_1 \tau_{j,t-1} + \beta_2 \tau^I_{j,t-1} + \beta_3 Delic_{j,t-1} + \beta_4 FDI_{j,t-1} + \alpha_{js} + \alpha_t + \varepsilon_{jst} \qquad (2)$$

where $\widehat{Y_{jst}}$ is estimated aggregate TFP ($\widehat{\Phi^{AGG}_{jst}}$), average TFP ($\widehat{\Phi^{U}_{jst}}$), or reallocation ($\widehat{R_{jst}}$) for industry j and state s at time t, $\tau_{j,t-1}$ and $\tau^I_{j,t-1}$ are final goods tariffs and input tariffs, $Delic_{j,t-1}$ is a dummy variable equal to one if any products in an industry are delicensed, zero otherwise, $FDI_{j,t-1}$ is a dummy variable equal to one if any products in an industry are FDI-liberalized, zero otherwise; and α_{js} and α_t are state-industry and year dummy variables, respectively. Since our firm data are annual, and policy changes occurred throughout the year, we lag all policy variables by one year. We employ a fixed-effects estimator to estimate Equation 2, and cluster all standard errors at the state-industry level. We use the balanced panel of state-industries in order to avoid confounding within-group effects with the entry and exit of certain industries in particular states, and we weight all observations using the total number of firms in each state-industry group over all years. This ensures that industries (and states) with large firm populations will receive higher weight in the analysis, and will make the results more representative of the all-India level.[12]

Table 5 presents baseline results for the entire period from 1986 to 2004.[13] Column (1) indicates that the trade liberalization is strongly correlated with aggregate productivity increases. The coefficient on final goods tariffs (-0.055) indicates that a 10 percentage point reduction in final goods tariffs yields an 0.55% increase in aggregate productivity. The impact of input tariffs is an order of magnitude larger, with a 10 percentage point reduction in input tariffs yielding a 5.6% increase in aggregate productivity. Moreover, FDI liberalization increases aggregate productivity by 2.4%.

Columns (2) and (3) present results for the average and reallocation components of productivity, respectively. Column (2) indicates that 10 percentage point declines in final goods and input tariffs raise average productivity by 0.44% and 5.5%, respectively, though the coefficient on final goods tariffs is no longer statistically significant at the 10% level. FDI liberalization increases average productivity by 4.9%. However, Column (3) shows that the variation in individual polices cannot explain the increase in reallocation. The only statistically significant result, for FDI reform, indicates that liberalization would lower rather than raise reallocation productivity.

In Table 6, we show the extent to which the policy changes that occurred during the 1990's can explain overall productivity growth. In particular, we multiply the coefficients from the baseline results by the average policy change, to estimate the productivity growth implied by each reform. The results suggest that trade liberalization, in particular the decline in input tariffs, is largely responsible for aggregate and average productivity growth. The decline of 60 percentage points in final goods tariffs implies an aggregate productivity increase of 3.2%, and an average productivity

[12]The results are robust to not including these weights; see Section 4.6.

[13]We exclude 1985 because we do not have lagged policy variables for this year.

increase of 2.6% (though the related regression coefficient is not statistically significant). Meanwhile, the decline of 40 percentage points in input tariffs implies aggregate and average productivity increases of nearly 22%. The FDI liberalization also plays a role, implying a 4.6% increase in average productivity.[14] As discussed above, the variation in policies across industries cannot explain the gains in reallocation productivity that were observed in the initial years following the reforms. However, the policies do explain the gains in average productivity, which was the more important driver of aggregate productivity growth during this period.

4.4 Panel Results

We now use the panel we have constructed to examine the results on average productivity in more detail. As discussed above, the average productivity measure we use can increase either because existing firms increase their productivity, or because less productive firms exit, or more productive firms enter.

The panel allows us to explore this issue by isolating within-firm productivity improvements. We estimate the following equation at the firm level:

$$\widehat{\phi_{ijst}} = \beta_1 \tau_{j,t-1} + \beta_2 \tau^I_{j,t-1} + \beta_3 Delic_{j,t-1} + \beta_4 FDI_{j,t-1} + \alpha_i + \alpha_t + \varepsilon_{ijst} \quad (3)$$

We use a fixed-effects estimator, which allows us to identify within-firm changes in productivity. We then compare our results to the results for the population. To make our population and panel results more comparable, we remove the sampling multipliers from the population data.

Table 7 presents results. In Column (1), we include all firms that were used in the state-industry level analysis. This specification includes industry and year dummy variables. The coefficients on the policy variables are similar to the average productivity results at the state-industry level.

Column (2) also presents results for the population, but includes only the firms that appear in the panel for at least two years. We call these "population" results because we include only industry

[14] In fact, the average policy changes can explain somewhat more than the total increase in productivity during this time period. In the regression framework, the coefficients on several year dummies are negative, implying that in the absence of the policy reforms, productivity would have fallen.

and year dummy variables, rather than firm fixed effects. Therefore, changes in productivity can be attributed not only to within-firm productivity changes, but also to firm entry and exit. The results for this sample of firms are similar to the results for the full sample.

In Column (3), we present results for the panel. The panel specification includes firm fixed effects, thus isolating within-firm changes in productivity. The panel results are qualitatively similar to the population results, but the impacts are different in magnitude. The coefficient on final goods tariffs is somewhat larger (-0.041 instead of -0.035). In contrast, in the population, a 10 percentage point decline in input tariffs raises average productivity by 5.4%; in the panel, the same decline raises average productivity by only 1.7%. Similarly, the effect of FDI liberalization on average productivity is reduced from 5.6% to 3.1% in the panel.

These results suggest that a large fraction of the impact of the trade and FDI reforms on average productivity occurs not through productivity improvements among existing firms, but through firm entry and exit. This finding presents an interesting contrast to earlier work by Topalova and Khandelwal (forthcoming), who find that nearly all of the productivity gains among 4,100 large Indian firms occurred because of within-firm improvements. Our contrasting findings are likely due to the fact that we consider a broader set of firms, including small firms that are more likely to exit.

4.5 State and Industry Characteristics

We also explore the extent to which the effects of the reforms varied across states or industries with different pre-reform characteristics. First, we consider the role of labor regulations. Although India reformed a number of its industrial policies in the 1990's, labor regulations remained stringent. Besley and Burgess (2004) show that Indian states with stricter labor regulations had lower output than states with less stringent labor regulations. Building on their work, Aghion et al. (2008) demonstrate that the effects of delicensing on output growth were lower in states with stricter labor regulations. We explore the extent to which state-level labor regulations may have affected each of component of productivity growth. One important aspect of the labor regulations is that large firms must obtain government permission to shut down or to lay off workers; this requirement may have affected productivity by making it difficult to achieve the optimal input mix or to shut down.

We use two measures of labor regulations. First, we use the measure developed by Besley and Burgess (2004), who classify state amendments to India's Industrial Disputes Act (IDA) as "pro-worker" or "pro-employer". This measure of labor regulations exhibits very few changes during the time period we consider, and only one state moves from one category to another. Therefore, we classify states as neutral, pro-worker, or pro-employer based on their cumulative score in 1985, and interact all policy variables in Equation 2 with an indicator for whether the state was pro-worker or pro-employer in 1985. The inclusion of state-industry fixed effects controls for time-invariant, state-level characteristics. In addition to this *de jure* measure of labor regulations, we have developed a *de facto* measure of how easy it is for firms to adjust their size or shut down based on court outcomes. We gathered data from various publications of the Ministry of Labor that provided the number of times a firm requested permission to close down or to lay off workers between 1988 and 1992, as well as the number of cases in which permission was granted or denied. We calculated the fraction of cases in which permission was granted, and constructed a dummy variable equal to one for states in which the fraction granted was above the median.

Tables 8 and 9 present results for the two measures of labor regulations.[15] Both tables indicate that the effects of all of the policy reforms were largely similar across states, regardless of labor regulations. In Table 8, the coefficients on the interaction terms between final goods tariffs and pro-employer states are negative and statistically significant for aggregate and reallocation productivity, but are an order of magnitude smaller than the coefficients on final goods tariffs. Similarly, the interaction term between input tariffs and pro-employer states is positive and statistically significant for reallocation productivity, but is much smaller than the coefficient on input tariffs alone. In Table 9, the only statistically significant interaction term indicates that the impact of FDI reform on average productivity was smaller in states in which it was relatively easy to lay off workers.

Another factor that may have influenced the impact of liberalization on firm productivity is

[15]The samples we use are restricted to states for which we have data on labor regulations, and are therefore smaller than the baseline sample.

exposure to trade. We use three measures as proxies for trade exposure. First, firms located close to ports may have been more affected by trade liberalization, particularly in the short run. We create a dummy variable that is equal to one if a state-industry group is located in a state with a port, zero otherwise. We also develop measures of the extent to which particular industries might have been more or less exposed to competition from imports, or to export opportunities. To so do, we use data from the COMTRADE database to estimate total exports and total imports for each industry in 1990. We then calculate the shares of imports and exports in output for each industry. Our importing (exporting) variable is a dummy equal to one if the industry has an import (export) share in output that is above the median, zero otherwise.

The advantage of using the 1990 measure is that it captures pre-reform industry characteristics. However, this means that we lose variation across time, so we interact our measures of trade exposure with the reforms. In addition, if certain industries became relatively more exposed to trade as a result of the reforms, and were thus further impacted by trade, then we will not capture this effect.

Table 10 shows the results of interacting each of these measures with our policy change variables. The interaction terms between tariff reforms and trade exposure, although statistically significant in some cases, are economically insignificant compared to the coefficients on the tariff reforms themselves. Interestingly, delicensing is now associated with increased average productivity, but decreased reallocation productivity, in states that do not have a port. In addition, delicensing is correlated with increased aggregate and average productivity among non-importing industries. Furthermore, the impacts of FDI reform on average productivity appear to be concentrated in non-exporting industries.

4.6 Robustness of the Baseline Results

In Tables B.1 through B.8, we present results from several robustness tests. We begin by examining our measure of productivity, which is calculated using an index number method. First, we winsorize the top and bottom 1% of the firm-level TFP values to ensure that the results are not being driven by extreme outliers. Table B.1 confirms that the results are nearly unchanged. Second, we re-calculate our measure of TFP using cost shares instead of revenue shares. The challenge in using cost shares is that the rental rate of capital must be estimated. If we assume that firms must borrow money in order to purchase capital, then we can use the interest rate as a proxy for the cost of capital. Table B.2 indicates that using cost shares yields similar results as using revenue shares. Third, we use OLS rather than an index number method to calculate TFP. Table B.3 indicates that the effects of final goods and input tariffs on aggregate and average productivity are similar to the baseline results, though the effect of FDI reforms becomes statistically insignificant.

Measuring capital also presents a challenge to estimating TFP. In our baseline specification, we deflated the book value of capital by the WPI for machinery. However, book values of capital may have little to do with the actual productive value of capital. Therefore, we also measure capital using the perpetual inventory method suggested by Harrison (1994) and adapted by Sivadasan (2009) for the cross-sectional setting.[16] Table B.4 confirms that using this alternate measure of capital makes little difference to the coefficient estimates.

As discussed in Section 2, our analysis of the relationship between pre-reform trends in industry characteristics and reforms indicates that selection bias is unlikely to be a major factor in our results. However, we can also focus on the reforms during India's Eighth Five-Year Plan (1992-1997), which were largely formulated during the 1991 crisis, thus reducing the likelihood for political selection even further. In Table B.5, we present results for 1986 to 1998 only; since we are using lagged policy variables, this allows us to capture policy changes through 1997. The coefficients on final goods tariffs, input tariffs and FDI reform are somewhat smaller in magnitude than the results for the overall time period, but are qualitatively similar.

In Table B.6, we re-compute input tariffs using only manufacturing industries, which allows us to avoid assigning tariff rates of zero to non-traded goods, but requires us to assume that only manufacturing inputs are used in production. The results for input tariffs are substantially larger in

[16]We start with the total 1985 book value of capital in industry j. We construct the real capital stock in each subsequent year as $K_{jt} = K_{j,t-1}[1-\delta] + I_{jt}$ where I_{jt} is real investment (nominal investment deflated by the WPI for machinery in year t) and we assume a depreciation rate (δ) of 10%. The capital price deflator is then given by dividing nominal capital by real capital.

magnitude, but qualitatively similar, to the baseline results.

Next, we remove the two industries (the blending of spirits and the production of wine) for which the tariff reforms did not fit the pattern shown in Figure 1. In Table B.7, we show that the results are robust to excluding these two industries. Finally, as discussed in Section 4, we weight our baseline results by the total number of firms in a state-industry group over all years. Table B.8 shows that the results are similar when we place an equal weight on each state-industry.

5 Conclusion

Our results confirm that the market-share reallocations predicted by the new trade theory were important in increasing India's productivity growth during the years immediately following the start of the major trade reforms. We document three distinct periods during the years from 1985 to 2004. First, from 1985 to 1990, increases in aggregate (output-weighted) productivity were nearly exclusively due to increases in average (unweighted) productivity, while reallocation productivity actually fell. Between 1991 and 1994, reallocation productivity rose sharply while average productivity initially fell, then rose more slowly. Finally, from 1998 onwards, reallocation productivity stagnated, while average productivity improvements once again became more important.

We also document that the increases in aggregate productivity are linked to the trade and FDI liberalization that took place during the 1990's. Our main specification indicates that the average declines in final goods and input tariffs were associated with aggregate productivity increases of 3.2% and 21.8%, respectively. Meanwhile, the FDI reforms implied an aggregate productivity increase of 2.2%.

We then construct a panel of firms from 1985 to 2004 to examine the extent to which the increase in average productivity was driven by within-firm productivity improvements. We find much smaller productivity effects, particularly for the input tariff and FDI reforms, when controlling for firm fixed effects. This finding suggests that while within-firm productivity improvements did play a role in average productivity growth, the impacts of input tariffs and FDI reform on firm entry and exit were also important.

Our results lend support to the importance of market-share reallocations in increasing productivity. In the case of India, however, we show that such reallocations were only important at the beginning of the major trade liberalization period, and that over the 20-year period from 1985 to 2004, average productivity improvements played a larger role in determining aggregate productivity growth.

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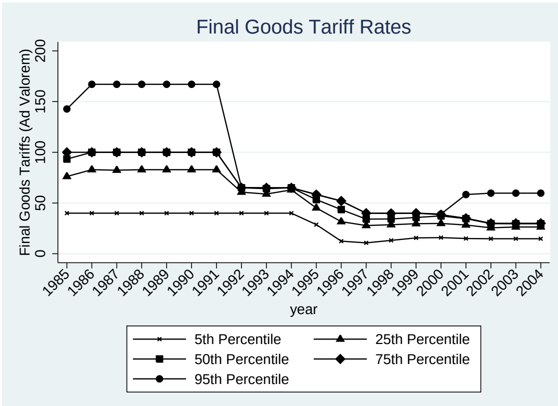
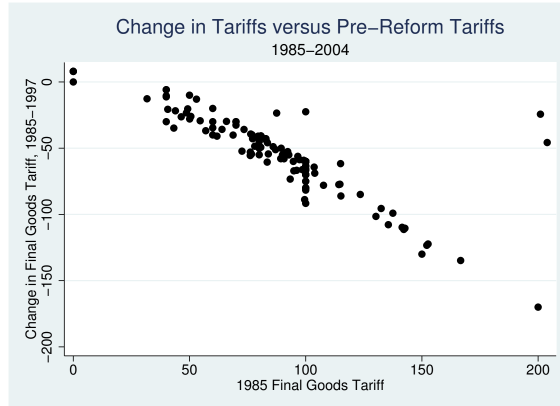
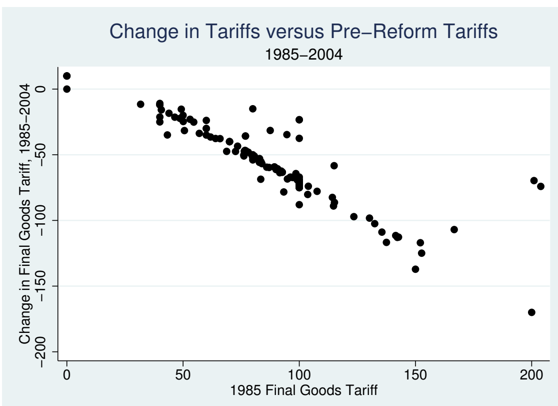
Figure 1: Trade Reforms



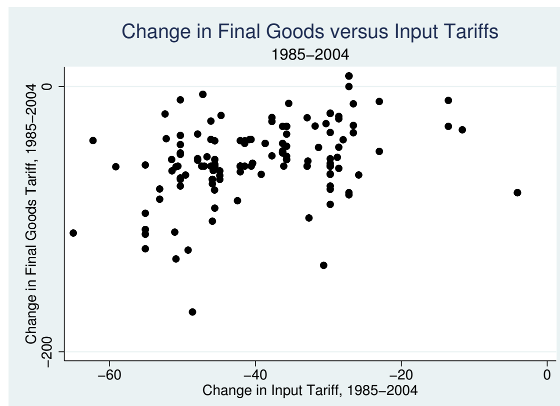
(a) Final Goods Tariffs



(b) Change in Tariffs vs. Pre-Reform Tariffs, 1985-1997



(c) Change in Tariffs vs. Pre-Reform Tariffs, 1985-2004



(d) Changes in Final Goods versus Input Tariffs, 1985-2004

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. Panels (b) and (c) show the relationship between 1985 final goods tariffs and the changes in final goods tariffs through 1997 and 2004, respectively. Panel (d) shows the relationship between the changes in final goods and input tariffs between 1985 and 2004. Source: Authors' calculations based on TRAINS and various publications of the Government of India.

Table 1: Trade, FDI, and Licensing Reforms

Year	Final Goods Tariffs	Input Tariffs	FDI Reform	Delicensing
1985	0.89	0.58	0.00	0.34
1986	0.96	0.61	0.00	0.35
1987	0.95	0.59	0.00	0.35
1988	0.95	0.60	0.00	0.35
1989	0.96	0.60	0.00	0.36
1990	0.96	0.60	0.00	0.36
1991	0.96	0.60	0.36	0.84
1992	0.64	0.40	0.36	0.84
1993	0.64	0.39	0.36	0.85
1994	0.64	0.37	0.36	0.85
1995	0.53	0.30	0.36	0.85
1996	0.42	0.23	0.36	0.85
1997	0.34	0.18	0.43	0.89
1998	0.35	0.19	0.43	0.93
1999	0.36	0.20	0.43	0.93
2000	0.35	0.21	0.93	0.93
2001	0.34	0.21	0.93	0.93
2002	0.31	0.19	0.93	0.93
2003	0.31	0.19	0.93	0.93
2004	0.31	0.19	0.93	0.93

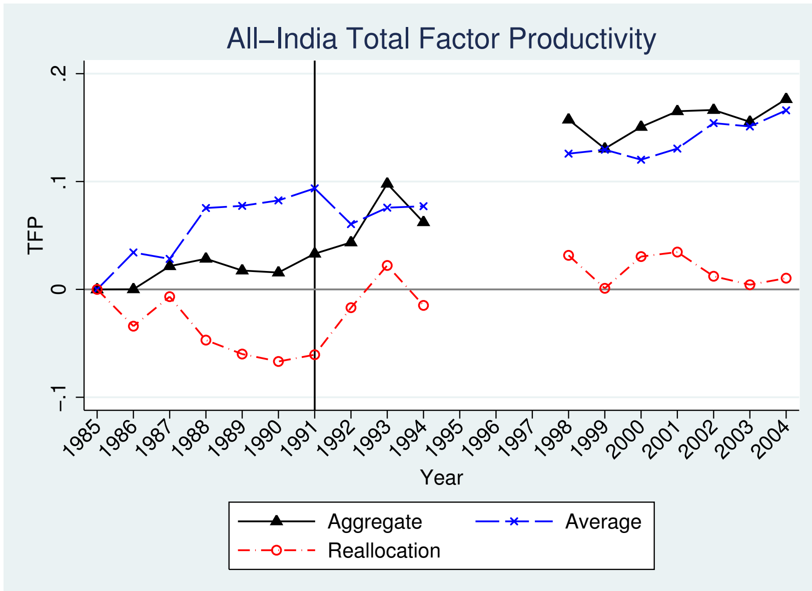
Mean values of policy variables from 1985 to 2004. Final goods and input tariffs variables are fractions, with 1 representing an ad valorem tariff of 100%; FDI Reform is a dummy variable equal to 1 if any products within the industry are liberalized, 0 if not; and Delicensing is a dummy variable equal to 1 if any products within the industry are delicensed, 0 if not. Source: Authors' calculations based on various publications of the Government of India, as well as the TRAINS database.

Table 2: Summary Statistics for the Firm-Level Data

	Estimated population	Sampled firms	Panel
Firm-years	1,422,398	587,303	415,701
Firms per year, mean	83,670	34,547	24,453
Census firm-years	275,552	275,552	250,186
Census firms per year, mean	16,209	16,209	14,717
Unique firm series			138,278
Output, mean (million Rs.)	25.6	48.1	64.2
Output, median (million Rs.)	2.6	3.5	5.3
Capital, mean (million Rs.)	7.0	13.1	17.5
Capital, median (million Rs.)	0.4	0.5	0.8
Material Inputs, mean (million Rs.)	16.6	30.9	41.1
Material Inputs, median (million Rs.)	1.9	2.6	3.8
Labor, mean (no. employees)	77	140	181
Labor, median (no. employees)	21	31	44
In panel, as fraction of total in sampled population:			
Output			0.94
Capital			0.95
Labor			0.92
Firm-years >100 employees			0.94
Firm-years >200 employees			0.96
Firm-years			0.71
Census firm-years			0.91

Summary statistics for the estimated population (using sampling weights), for the sampled population (not using sampling weights), and for firms that appear for two or more years in the panel. Only open firms with positive values of key variables are included. “Firm-years” indicates the total number of observations, while “Census firm-years” indicates the number of observations in the census sector. Mean and median values are averages across all years used in the analysis (1985-1994 and 1998-2004). Output, material inputs and capital have been deflated to 1985 values and are expressed in millions of rupees. Fractions of output, capital, etc. that appear in panel are given in relation to the sampled (rather than the estimated) population.

Figure 2: All-India Total Factor Productivity



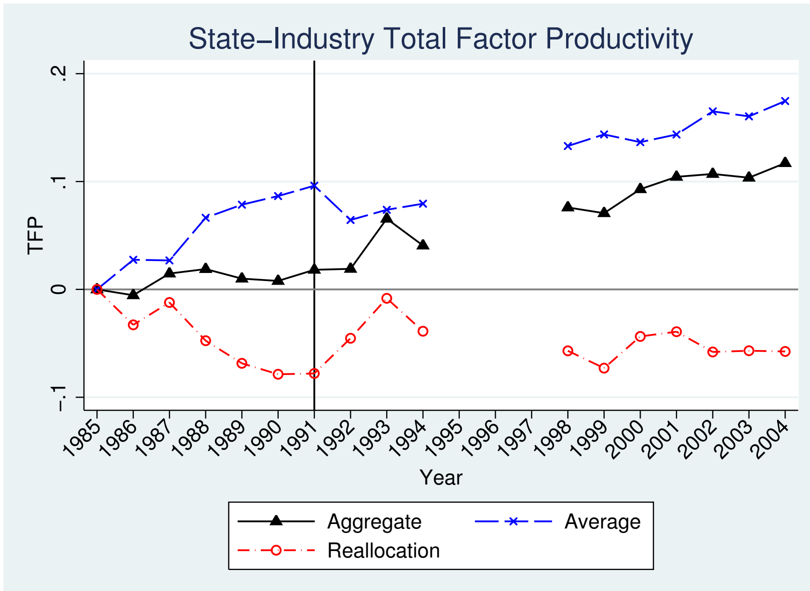
Total factor productivity (TFP) decompositions for the population of firms, conducted at the all-India level. "Aggregate" indicates market-share weighted mean productivity, "Average" indicates unweighted mean productivity, and "Reallocation" indicates the covariance between market share and productivity.

Table 3: Aggregate Total Factor Productivity

	Aggregate	Average	Reallocation
1985	0.000	0.000	0.000
1986	0.001	0.026	-0.025
1987	0.023	0.027	-0.004
1988	0.030	0.074	-0.044
1989	0.017	0.075	-0.058
1990	0.014	0.081	-0.066
1991	0.033	0.094	-0.061
1992	0.042	0.057	-0.015
1993	0.094	0.070	0.024
1994	0.061	0.074	-0.013
1998	0.161	0.124	0.036
1999	0.137	0.131	0.007
2000	0.160	0.127	0.033
2001	0.176	0.137	0.039
2002	0.176	0.158	0.018
2003	0.167	0.155	0.012
2004	0.190	0.171	0.019

Total factor productivity (TFP) decompositions for the population of firms, conducted at the all-India level. "Aggregate" indicates market-share weighted mean productivity, "Average" indicates unweighted mean productivity, and "Reallocation" indicates the covariance between market share and productivity.

Figure 3: State-Industry Total Factor Productivity



Total factor productivity (TFP) decompositions for the population of firms, conducted at the state-industry level. "Aggregate" indicates market-share weighted mean productivity, "Average" indicates unweighted mean productivity, and "Reallocation" indicates the covariance between market share and productivity.

Table 4: State-Industry Total Factor Productivity

	Aggregate	Average	Reallocation
1985	0.000	0.000	0.000
1986	-0.005	0.027	-0.033
1987	0.015	0.027	-0.012
1988	0.019	0.066	-0.048
1989	0.010	0.079	-0.069
1990	0.008	0.087	-0.079
1991	0.018	0.096	-0.078
1992	0.019	0.064	-0.045
1993	0.065	0.074	-0.008
1994	0.041	0.079	-0.039
1998	0.076	0.133	-0.057
1999	0.071	0.144	-0.073
2000	0.093	0.136	-0.044
2001	0.104	0.144	-0.039
2002	0.107	0.165	-0.058
2003	0.104	0.160	-0.057
2004	0.117	0.175	-0.058

Total factor productivity (TFP) decompositions for the population of firms, conducted at the state-industry level. "Aggregate" indicates market-share weighted mean productivity, "Average" indicates unweighted mean productivity, and "Reallocation" indicates the covariance between market share and productivity.

Table 5: Productivity Decompositions and Policy Changes

	Aggregate	Average	Reallocation
	(1)	(2)	(3)
Final Goods Tariff	-.055	-.044	-.011
	(.026)**	(.030)	(.015)
Input Tariff	-.560	-.556	-.005
	(.104)***	(.115)***	(.061)
FDI Reform	.024	.049	-.025
	(.013)*	(.014)***	(.010)***
Delicensed	-.007	.004	-.011
	(.017)	(.017)	(.011)
Obs.	17074	17074	17074
R^2	.086	.083	.014

Each observation is a state-industry. Dependent variable names are given at the top of each column. "Aggregate" indicates market-share-weighted mean productivity, "Average" indicates unweighted mean productivity, and "Reallocation" indicates the covariance between market share and productivity. All specifications are fixed-effects analyses at the state-industry level, and include year dummies. Each observation is weighted by the total number of firms in the state-industry across all years, and standard errors are clustered at the state-industry level.

Table 6: Productivity Increases Implied by Policy Changes

	Final Goods Tariffs	Input Tariffs	FDI Liberalization	Delicensing
Aggregate	**3.2%**	**21.8%**	**2.2%**	-0.4%
Within	2.6%	**21.7%**	**4.6%**	0.2%
Between	0.6%	0.2%	**-2.3%**	-0.6%

Implied increases in aggregate, average, and reallocation productivity. Results are based on regression coefficients and average policy changes. Bold font indicates that the underlying regression results are statistically significant at the 10% level.

Table 7: Firm-Level Productivity

	Population	Population	Panel
	(1)	(2)	(3)
Final Goods Tariff	-.034	-.035	-.041
	(.020)*	(.019)*	(.008)***
Input Tariff	-.563	-.538	-.169
	(.088)***	(.086)***	(.035)***
FDI Reform	.053	.056	.031
	(.013)***	(.011)***	(.004)***
Delicensed	-.006	-.005	-.002
	(.013)	(.013)	(.005)
Obs.	528127	385666	385666
R^2	.054	.058	.002

Each observation is a firm. Dependent variable is total factory productivity (TFP). Column (1) includes all firms that were part of the state-industry level analysis; Columns (2) and (3) include only firms that appear in the panel for at least two years. Columns (1) and (2) include industry and time dummies, and standard errors are clustered at the state-industry level. Column (3) includes year dummies and firm fixed effects, and standard errors are clustered at the firm level.

Table 8: Productivity Decompositions and Policy Changes: Pro-Worker versus Pro-Employer States

	Aggregate	Aggregate	Average	Average	Reallocation	Reallocation
	(1)	(2)	(3)	(4)	(5)	(6)
Final Goods Tariff	-.078	-.035	-.065	-.049	-.013	.013
	(.029)***	(.031)	(.039)*	(.034)	(.022)	(.016)
Input Tariff	-.500	-.570	-.550	-.526	.050	-.044
	(.108)***	(.112)***	(.122)***	(.121)***	(.065)	(.065)
FDI Reform	.035	.019	.054	.045	-.019	-.026
	(.014)**	(.015)	(.015)***	(.017)***	(.011)*	(.011)**
Delicensed	-.0008	-.010	.010	.002	-.011	-.012
	(.019)	(.020)	(.019)	(.020)	(.013)	(.012)
Pro-Worker X Final Goods Tariff	.0004		.0003		.0001	
	(.0005)		(.0006)		(.0003)	
Pro-Worker X Input Tariff	-.0006		.0003		-.001	
	(.001)		(.001)		(.0007)	
Pro-Worker X FDI Reform	-.028		-.012		-.016	
	(.018)		(.019)		(.015)	
Pro-Worker X Delicensed	-.015		-.019		.004	
	(.034)		(.032)		(.022)	
Pro-Employer X Final Goods Tariff		-.001		-.00009		-.0009
		(.0005)*		(.0007)		(.0004)**
Pro-Employer X Input Tariff		.002		-.0008		.002
		(.001)		(.001)		(.0008)***
Pro-Employer X FDI Reform		.020		.014		.006
		(.019)		(.020)		(.017)
Pro-Employer X Delicensed		.012		.003		.008
		(.033)		(.032)		(.022)
Obs.	14962	14962	14962	14962	14962	14962
R^2	.079	.079	.082	.081	.016	.018

Each observation is a state-industry. Dependent variable names are given at the top of each column. “Aggregate” indicates market-share-weighted mean productivity, “Average” indicates unweighted mean productivity, and “Reallocation” indicates the covariance between market share and productivity. All specifications are fixed-effects analyses at the state-industry level, and include year dummies. Each observation is weighted by the total number of firms in the state-industry across all years, and standard errors are clustered at the state-industry level. “Pro-employer” and “pro-worker” are dummies based on Besley and Burgess (2004).

Table 9: Productivity Decompositions and Policy Changes: Ease of Laying Off Workers and Closing

	Aggregate	Aggregate	Average	Average	Reallocation	Reallocation
	(1)	(2)	(3)	(4)	(5)	(6)
Final Goods Tariff	-.074	-.062	-.087	-.088	.013	.027
	(.038)**	(.037)	(.038)**	(.048)*	(.020)	(.027)
Input Tariff	-.555	-.590	-.482	-.483	-.073	-.108
	(.138)***	(.139)***	(.153)***	(.146)***	(.090)	(.080)
FDI Reform	.043	.032	.070	.046	-.027	-.014
	(.018)**	(.018)*	(.019)***	(.021)**	(.011)**	(.013)
Delicensed	.002	.015	.011	.032	-.009	-.018
	(.022)	(.021)	(.024)	(.022)	(.017)	(.017)
Ease of Layoff X Final Goods Tariff	.0003		.0006		-.0003	
	(.0005)		(.0006)		(.0003)	
Ease of Layoff X Input Tariff	-.0005		-.0009		.0004	
	(.001)		(.001)		(.0007)	
Ease of Layoff X FDI Reform	-.028		-.044		.017	
	(.019)		(.020)**		(.015)	
Ease of Layoff X Delicensed	-.003		-.006		.003	
	(.031)		(.032)		(.022)	
Ease of Closure X Final Goods Tariff		.0001		.0007		-.0006
		(.0005)		(.0007)		(.0004)
Ease of Closure X Input Tariff		.0001		-.0009		.001
		(.001)		(.001)		(.0007)
Ease of Closure X FDI Reform		-.012		-.008		-.004
		(.019)		(.023)		(.016)
Ease of Closure X Delicensed		-.024		-.040		.016
		(.031)		(.031)		(.022)
Obs.	11993	11993	11993	11993	11993	11993
R^2	.087	.087	.087	.086	.015	.015

Each observation is a state-industry. Dependent variable names are given at the top of each column. "Aggregate" indicates market-share-weighted mean productivity, "Average" indicates unweighted mean productivity, and "Reallocation" indicates the covariance between market share and productivity. All specifications are fixed-effects analyses at the state-industry level, and include year dummies. Each observation is weighted by the total number of firms in the state-industry across all years, and standard errors are clustered at the state-industry level. "Ease of Layoff" ("Ease of Closure") is a dummy variable equal to one if the state is above the median in granting requests by large firms to lay off workers (close).

Table 10: Productivity Decompositions and Policy Changes: Trade Exposure

	Aggregate	Aggregate	Aggregate	Avg	Avg	Avg	Reallocation	Reallocation	Reallocation
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Final Goods Tariff	-.043	-.039	-.016	-.068	.004	.004	.025	-.044	-.021
	(.035)	(.019)**	(.025)	(.045)	(.032)	(.028)	(.026)	(.027)	(.022)
Input Tariff	-.583	-.488	-.595	-.506	-.567	-.586	-.078	.079	-.009
	(.113)***	(.108)***	(.094)***	(.121)***	(.111)***	(.106)***	(.068)	(.066)	(.069)
FDI Reform	.030	.028	.048	.051	.050	.075	-.021	-.022	-.027
	(.016)*	(.017)*	(.018)***	(.019)***	(.019)***	(.018)***	(.012)*	(.013)*	(.012)**
Delicensed	.012	.051	-.022	.042	.054	-.002	-.031	-.003	-.020
	(.020)	(.018)***	(.025)	(.021)**	(.020)***	(.024)	(.015)**	(.015)	(.014)
Port in state X Final Goods Tariff	-.0002			.0003			-.0005		
	(.0005)			(.0006)			(.0003)		
Port in state X Input Tariff	.0004			-.0006			.001		
	(.0009)			(.001)			(.0006)*		
Port in state X FDI Reform	-.008			-.003			-.005		
	(.016)			(.020)			(.014)		
Port in state X Delicensed	-.029			-.058			.029		
	(.028)			(.027)**			(.019)		
Importing industry X Final Goods Tariff		-.0002			-.0009			.0007	
		(.0005)			(.0005)			(.0003)**	
Importing industry X Input Tariff		-.001			.00004			-.002	
		(.0009)*			(.001)			(.0006)**	
Importing industry X FDI Reform		-.007			.001			-.008	
		(.017)			(.020)			(.016)	
Importing industry X Delicensed		-.177			-.140			-.037	
		(.044)***			(.040)***			(.025)	
Exporting industry X Final Goods Tariff			-.0009			-.001			.0001
			(.0005)*			(.0006)*			(.0003)
Exporting industry X Input Tariff			.002			.001			.0004
			(.0009)**			(.001)			(.0007)
Exporting industry X FDI Reform			-.038			-.046			.008
			(.016)**			(.017)***			(.014)
Exporting industry X Delicensed			.033			.014			.019
			(.031)			(.030)			(.019)
Obs.	17074	17074	17074	17074	17074	17074	17074	17074	17074
R^2	.087	.098	.091	.084	.09	.086	.015	.015	.015

Each observation is a state-industry. Dependent variable names are given at the top of each column. "Aggregate" indicates market-share-weighted mean productivity, "Average" indicates unweighted mean productivity, and "Reallocation" indicates the covariance between market share and productivity. All specifications are fixed-effects analyses at the state-industry level, and include year dummies. Each observation is weighted by the total number of firms in the state-industry across all years, and standard errors are clustered at the state-industry level. "Port in state" is a dummy variable equal to one if the state-industry group is located in a state with a port, zero otherwise. "Importing" ("Exporting") is a dummy variable equal to one if the industry's share of imports (exports) in total output is greater than the median, zero otherwise.

Table A.1: Changes in Reforms and Pre-Reform Trends in Industry Characteristics

	ΔFinal Goods Tariffs	ΔInput Tariffs	ΔDelicensing	ΔFDI Reform
Δ log(wage)	0.024	-0.046	0.024	-0.017
	(0.19)	(0.051)	(0.13)	(0.26)
Δ Production Share	-0.092	-0.15	0.28	0.89
	(0.92)	(0.25)	(0.63)	(1.27)
Δ log(K/L Ratio)	-0.12	0.0077	0.052	0.051
	(0.080)	(0.022)	(0.055)	(0.11)
Δ log(Employment)	-0.051	-0.025	-0.036	-0.049
	(0.060)	(0.016)	(0.041)	(0.083)
Δ log(Firm Size)	-0.10	-0.033	0.044	-0.0098
	(0.12)	(0.032)	(0.080)	(0.16)
Δ log(Output)	-0.038	-0.0086	0.024	-0.00079
	(0.040)	(0.011)	(0.028)	(0.055)
Δ TFP (Total)	0.038	-0.0066	0.062	0.014
	(0.072)	(0.020)	(0.047)	(0.099)
Observations	137	137	137	137

Results are coefficients from regressions of the change in reforms (final goods tariffs, input tariffs, delicensing, FDI reform) from 1990 to 2004 on changes in industry characteristics from 1985 to 1989. Each value represents a result from a separate regression.

Table B.1: Productivity Decompositions and Policy Changes: Winsorized Productivity

	Aggregate	Average	Reallocation
	(1)	(2)	(3)
Final Goods Tariff	-.053	-.047	-.007
	(.025)**	(.028)	(.013)
Input Tariff	-.549	-.546	-.003
	(.099)***	(.109)***	(.053)
FDI Reform	.030	.049	-.019
	(.011)***	(.013)***	(.008)**
Delicensed	-.008	.002	-.010
	(.016)	(.016)	(.009)
Obs.	17074	17074	17074
R^2	.119	.11	.016

Each observation is a state-industry. Dependent variable names are given at the top of each column. "Aggregate" indicates market-share-weighted mean productivity, "Average" indicates unweighted mean productivity, and "Reallocation" indicates the covariance between market share and productivity. All specifications are fixed-effects analyses at the state-industry level, and include year dummies. Each observation is weighted by the total number of firms in the state-industry across all years, and standard errors are clustered at the state-industry level. The top and bottom 1% of TFP have been winsorized.

Table B.2: Productivity Decompositions and Policy Changes: Cost Shares Productivity

	Aggregate	Average	Reallocation
	(1)	(2)	(3)
Final Goods Tariff	-.055	-.045	-.010
	(.025)**	(.028)	(.016)
Input Tariff	-.553	-.542	-.011
	(.099)***	(.107)***	(.059)
FDI Reform	-.0004	.023	-.023
	(.010)	(.010)**	(.008)***
Delicensed	-.002	.003	-.004
	(.015)	(.016)	(.011)
Obs.	17074	17074	17074
R^2	.192	.158	.013

Each observation is a state-industry. Dependent variable names are given at the top of each column. "Aggregate" indicates market-share-weighted mean productivity, "Average" indicates unweighted mean productivity, and "Reallocation" indicates the covariance between market share and productivity. All specifications are fixed-effects analyses at the state-industry level, and include year dummies. Each observation is weighted by the total number of firms in the state-industry across all years, and standard errors are clustered at the state-industry level. TFP is estimated using a chain-linked index number method, where input shares are calculated as the share of input cost in total cost.

Table B.3: Productivity Decompositions and Policy Changes: OLS Productivity

	Aggregate	Average	Reallocation
	(1)	(2)	(3)
Final Goods Tariff	-.063	-.058	-.006
	(.024)***	(.026)**	(.012)
Input Tariff	-.473	-.413	-.060
	(.095)***	(.102)***	(.053)
FDI Reform	-.0006	.011	-.012
	(.010)	(.009)	(.007)
Delicensed	-.009	.011	-.020
	(.014)	(.015)	(.010)**
Obs.	17074	17074	17074
R^2	.133	.166	.021

Each observation is a state-industry. Dependent variable names are given at the top of each column. "Aggregate" indicates market-share-weighted mean productivity, "Average" indicates unweighted mean productivity, and "Reallocation" indicates the covariance between market share and productivity. All specifications are fixed-effects analyses at the state-industry level, and include year dummies. Each observation is weighted by the total number of firms in the state-industry across all years, and standard errors are clustered at the state-industry level. TFP is estimated using OLS.

Table B.4: Productivity Decompositions and Policy Changes: Alternative Measure of Capital

	Aggregate	Average	Reallocation
	(1)	(2)	(3)
Final Goods Tariff	-.049	-.039	-.011
	(.025)*	(.030)	(.015)
Input Tariff	-.498	-.494	-.005
	(.104)***	(.115)***	(.061)
FDI Reform	.016	.040	-.025
	(.013)	(.013)***	(.010)***
Delicensed	-.006	.005	-.011
	(.016)	(.016)	(.011)
Obs.	17074	17074	17074
R^2	.092	.086	.014

Each observation is a state-industry. Dependent variable names are given at the top of each column. "Aggregate" indicates market-share-weighted mean productivity, "Average" indicates unweighted mean productivity, and "Reallocation" indicates the covariance between market share and productivity. All specifications are fixed-effects analyses at the state-industry level, and include year dummies. Each observation is weighted by the total number of firms in the state-industry across all years, and standard errors are clustered at the state-industry level. An alternative method of deflating capital, based on the perpetual inventory method of Harrison (1994), as modified by Sivadasan (2009), is used.

Table B.5: Productivity Decompositions and Policy Changes: 1986- 1998

	Aggregate	Average	Reallocation
	(1)	(2)	(3)
Final Goods Tariff	-.040	-.041	.0009
	(.022)*	(.023)*	(.015)
Input Tariff	-.250	-.268	.018
	(.108)**	(.104)***	(.074)
FDI Reform	.023	.034	-.010
	(.014)*	(.011)***	(.012)
Delicensed	-.0006	-.003	.002
	(.014)	(.011)	(.012)
Obs.	10666	10666	10666
R^2	.035	.045	.02

Each observation is a state-industry. Dependent variable names are given at the top of each column. "Aggregate" indicates market-share-weighted mean productivity, "Average" indicates unweighted mean productivity, and "Reallocation" indicates the covariance between market share and productivity. All specifications are fixed-effects analyses at the state-industry level, and include year dummies. Each observation is weighted by the total number of firms in the state-industry across all years, and standard errors are clustered at the state-industry level. Only firm-level data from 1986 to 1998 (policy variables from 1985 to 1997) are included.

Table B.6: Productivity Decompositions and Policy Changes: Alternative Measure of Input Tariffs

	Aggregate	Average	Reallocation
	(1)	(2)	(3)
Final Goods Tariff	.010	.035	-.025
	(.016)	(.024)	(.019)
Input Tariff	-.902	-.991	.089
	(.110)***	(.108)***	(.061)
FDI Reform	.020	.043	-.024
	(.013)	(.014)***	(.009)**
Delicensed	-.015	-.003	-.012
	(.016)	(.015)	(.011)
Obs.	17074	17074	17074
R^2	.105	.104	.014

Each observation is a state-industry. Dependent variable names are given at the top of each column. "Aggregate" indicates market-share-weighted mean productivity, "Average" indicates unweighted mean productivity, and "Reallocation" indicates the covariance between market share and productivity. All specifications are fixed-effects analyses at the state-industry level, and include year dummies. Each observation is weighted by the total number of firms in the state-industry across all years, and standard errors are clustered at the state-industry level. Input tariffs are constructed based on the manufacturing sector only.

Table B.7: Productivity Decompositions and Policy Changes: Removing Outlying Tariff Changes

	Aggregate	Average	Reallocation
	(1)	(2)	(3)
Final Goods Tariff	-.057	-.046	-.011
	(.026)**	(.030)	(.015)
Input Tariff	-.552	-.549	-.003
	(.105)***	(.115)***	(.061)
FDI Reform	.023	.047	-.025
	(.014)*	(.014)***	(.010)**
Delicensed	-.008	.003	-.011
	(.017)	(.017)	(.011)
Obs.	16898	16898	16898
R^2	.087	.083	.014

Each observation is a state-industry. Dependent variable names are given at the top of each column. "Aggregate" indicates market-share-weighted mean productivity, "Average" indicates unweighted mean productivity, and "Reallocation" indicates the covariance between market share and productivity. All specifications are fixed-effects analyses at the state-industry level, and include year dummies. Each observation is weighted by the total number of firms in the state-industry across all years, and standard errors are clustered at the state-industry level. The two industries that do not fit the overall pattern shown in Figure 1 are excluded.

Table B.8: Productivity Decompositions and Policy Changes: Without State-Industry Weights

	Aggregate	Average	Reallocation
	(1)	(2)	(3)
Final Goods Tariff	-.059	-.050	-.009
	(.018)***	(.020)**	(.015)
Input Tariff	-.712	-.673	-.039
	(.089)***	(.098)***	(.064)
FDI Reform	.050	.069	-.020
	(.011)***	(.012)***	(.009)**
Delicensed	-.026	-.023	-.003
	(.012)**	(.013)*	(.010)
Obs.	17074	17074	17074
R^2	.056	.048	.003

Each observation is a state-industry. Dependent variable names are given at the top of each column. "Aggregate" indicates market-share-weighted mean productivity, "Average" indicates unweighted mean productivity, and "Reallocation" indicates the covariance between market share and productivity. All specifications are fixed-effects analyses at the state-industry level, and include year dummies. Each observation is given equal weight, and standard errors are clustered at the state-industry level.