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Productivity and Firm Size Distribution: Evidence from India's Organized and Unorganized Manufacturing Sectors

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Productivity and Firm Size Distribution:
Evidence from India's Organized and Unorganized Manufacturing Sectors

By

Shanthi Nataraj

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Professor Ann Harrison, Chair
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Abstract

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This dissertation examines the impacts of India's trade liberalization and a variety of other policies on productivity and employment among manufacturing firms. One main contribution of this work is that it considers not only large firms in India's organized (formal) manufacturing sector, but also small firms in the unorganized (informal) manufacturing sector. Informal firms are those that have fewer than 20 employees (10 employees if power is used), and are therefore not required to register with the government under India's Factories Act. Most of the literature on India's trade and other reforms has focused on formal firms, but the informal sector accounts for approximately 80% of manufacturing employment.

In the first chapter, I describe a unique dataset that I constructed by linking formal and informal firm-level surveys that were conducted by the Indian government. The resulting dataset provides three cross-sectional snapshots that are representative of the entire manufacturing industry during the course of the 1990's. This chapter discusses the industries in which formal and informal firms are found, examines various issues related to the size distribution of firms, and compares formal and informal firms with the same number of employees.

The second chapter examines the impact of India's trade liberalization on the productivity of manufacturing firms. Despite a large literature investigating the links between trade and productivity, there is almost no evidence on how small firms react to trade liberalization. In this chapter, I show that India's trade liberalization increased firm productivity in both the formal and informal sectors; however, the increases occurred through different channels in the two sectors. In the informal sector, I find that the liberalization of final goods tariffs increased productivity by approximately 15% during the course of the 1990's. In contrast, the increase in productivity among formal firms was driven by the liberalization of tariffs on intermediate inputs rather than final goods. Furthermore, I examine the effect of the trade liberalization on the productivity and output distributions, and I find evidence suggesting that at least part of the increase in productivity in the informal sector was driven by the exit of the smallest, least productive firms.

The third chapter investigates the phenomenon of the “missing middle” in Indian manufacturing - the fact that employment is concentrated in small and large firms, with relatively little employment in mid-sized firms (firms with 50-500 employees). A number of policies have been proposed as causes of the missing middle, but there is little quantitative evidence on how changes in these policies would affect the employment size distribution. I consider the impacts of five policies - credit availability for small firms, electricity surpluses, trade liberalization, industrial licensing, and foreign direct investment liberalization - on the employment size distribution. I find that improving India’s poor electricity supplies would mitigate the missing middle by shifting the employment size distribution towards firms with 50-1,000 employees. India’s liberalization measures of the 1990’s had mixed effects on the missing middle: the liberalization of final goods tariffs exacerbated the missing middle, while the liberalization of intermediate input tariffs mitigated it. The foreign direct investment liberalization shifted the employment size distribution towards firms with 20-500 employees, while the industrial licensing reforms shifted the distribution towards firms with 10-60 employees, and away from firms with 60 or more employees. The results also indicate that India’s labor regulations played a role in how many of these policies affected the missing middle.

For my family

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Chapter 1

An Overview of Formal and Informal Manufacturing Firms in India

India's 1948 Factories Act (Sections 2(m)(i) and 2(m)(ii)) defines a "factory" as a premises where there are 20 or more workers (10 or more workers, if power is being used). Under this Act, state governments have the power to require factories to register; registered firms are considered "organized" while unregistered firms are considered "unorganized." In 2000, India's organized manufacturing sector employed approximately 8 million people, while its unorganized manufacturing sector employed approximately 37 million, or nearly 80% of the manufacturing workforce.[1]

In the Indian context, firms in the organized sector are often referred to as "formal," while those in the unorganized sector are often referred to as "informal." Although the term "informal" may refer to a number of different situations, including firms that operate outside of government regulations and those that lack structure (Guha-Khasnobis, Kanbur and Ostrom, eds 2006), I will use the term "informal" as a synonym for "unorganized" and the term "formal" as a synonym for "organized."

Most of the research on India's manufacturing industry has focused on firms in the formal sector (Balakrishnan and Pushpangadan 1998, Krishna and Mitra 1998, Balakrishnan, Pushpangadan and Babu 2000, Hasan, Mitra and Ramaswamy 2007, Topalova 2007, Aghion, Burgess, Redding and Zilibotti 2008, Gupta, Hasan and Kumar 2009, Sivadasan 2009, among others), despite the fact that the informal sector accounts for a much greater share of employment. There are several studies that focus on India's informal sector (Das 1998, Unni 1998, Das 2000, Joshi 2003, Mukherjee 2004, for example), and very few that consider the entire manufacturing industry, including both formal and informal firms (Rani and Unni 2004, Sharma 2009).

In this work, I take advantage of firm-level surveys from both the formal and informal sectors to gain a better understanding of the firms that operate in each sector, and to examine how India's trade liberalization and other policies have affected productivity, output, and employment in both sectors.

[1] Estimates for the unorganized manufacturing sector are based on firm-level data from the 2000-01 round of the National Sample Survey Organisation's (NSSO) Unorganized Manufacture Survey, while estimates for the organized manufacturing sector are based on firm-level data from the Central Statistical Organisation's (CSO) Annual Survey of Industries (ASI), 1999-2000.

1.1 Linked Formal-Informal Firm Dataset

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 course of the 1990's. 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. I will refer to the 1989-90 surveys as the 1989 round, the 1994-95 surveys as the 1994 round, and the 1999-2000 and 2000-01 surveys as the 1999 round.

The aggregate estimates provided here will be slightly different from official estimates for two main reasons. First, I focus on manufacturing firms and exclude utilities and firms engaged in repairs. Second, I exclude firms that either reported zero (or missing) output or employment, as well as firms that were reported as closed.

1.1.1 Data Sources

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 and service providers. 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; these firms make up the "census" sector. A fraction of the smaller firms, which make up the "sample" sector, are surveyed in any given year. For sampling purposes, strata are created at the state-by-industry level, and firms are sampled within each stratum. In states designated as "industrially-backwards," all firms are surveyed, regardless of size (CSO Last checked February 15, 2010). The ASI provides multipliers for each firm, indicating the inverse sampling probability. In my analyses, I estimate aggregate and average numbers for the population of firms by weighting firm-level observations by inverse sampling multipliers.

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) point out that "deregistration" may be difficult for firms, that many closed firms still appear in the list of registered firms, and that registered firms may have decreased their employment below the 10-employee mark. 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. 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.

The informal sector is surveyed by the National Sample Survey Organisation (NSSO) through its Unorganized Manufacture Surveys (UMS). The sampling universe consists of all manufacturing firms that are not registered under Sections 2(m)(i) and 2(m)(ii) of the Factories Act, firms registered under Section 85 of the Factories Act (those that are not required to register under Sections 2(m)(i) and 2(m)(ii) of the Factories Act but that are required to do so by state government), and bidi and cigar firms that are not covered by the ASI. The NSSO surveyed informal firms 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

(NSSO 2002).

The economic census classifies small manufacturing and repair firms into three categories: Own Account Manufacturing Enterprises (OAME, employing only household labor), Directory Manufacturing Establishments (DME, employing six or more workers), and Non-Directory Manufacturing Establishments (NDME, employing five or fewer workers). In 1989, DMEs 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.

A multi-stage, stratified sampling plan is used by the NSSO; although describing the plan in detail is beyond the scope of this work, the basic process is as follows. Each state is divided into strata; rural strata are typically districts, while cities are grouped together based on population. Information from the Economic and Population Censuses is used to select first-stage sampling units (FSUs); the FSU are villages in rural areas and urban blocks in urban areas. Large villages or blocks are further sub-divided prior to sampling individual firms, and the sampling procedures also ensure that an adequate number of NDME and DME are included. Individual firms are selected within each FSU. There are several exceptions to this basic protocol in certain (usually remote) areas (NSSO 1998, NSSO 2002).

Each UMS sample consists of approximately 1% of the estimated population of informal firms. As with the ASI data, I estimate aggregate and average characteristics for the population of firms by weighting firm-level observations by inverse sampling multipliers.

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 this chapter, I include these firms in my analyses, although I find that my results are generally robust to excluding them.

1.1.2 Industrial Classification

Tables 1.1 through 1.3 show the estimated sizes of the formal and informal sectors (in terms of the number of firms, employment, and output) in each broad manufacturing industry in 1989, 1994, and 1999, respectively. Similarly, Tables 1.4 through 1.6 show the share of firms, employment, and output in each industry that are found in the formal versus the informal manufacturing sectors, while Figures 1.1 and 1.2 illustrate the share of formal and informal employment and output in each industry.

In 1989, the formal sector included approximately 87,000 firms, while the informal sector included over 13 million firms. During the 1990's, both sectors grew; by 1999, the formal sector included approximately 108,000 firms, while the informal sector included nearly 16 million firms.

The informal sector accounts for the vast majority of employment, while the formal sector accounts for the majority of output. For the formal sector, the employment estimates include production as well as non-production workers and supervisors. For the informal sector, the estimates include workers who are members of the household (paid and unpaid) as well as hired workers. The UMS surveys contain some information on full-time versus part-time work in the informal sector, but do not provide the number of hours worked by part-time employees; similarly, the ASI surveys do not specify whether workers are full-time or part-time. Therefore, the employment figures are estimates of the total number of employees, regardless of how many hours they work. Employment in the formal sector grew from approximately 7 million people in 1989 to 7.6 million in 1999, while informal employment grew from approximately 27 million to 35 million people.

There are a variety of ways of measuring output. For the purposes of this analysis, I calculate the value of output as the value of products sold plus the value of any other receipts received by the firm, which might include services performed for another enterprise, the value of own construction, or the value of electricity sold. Using this measure of output, in 1989, the formal sector produced approximately Rs. 1.6 trillion of output, while the informal sector produced approximately Rs. 254 billion of output. By 1999, the corresponding figures were Rs. 6.1 trillion or the formal sector and Rs. 1.8 trillion for the informal sector.

The ASI and UMS surveys classify firms according to India's National Industrial Classification (NIC) code. The 1989 and 1994 surveys classify firms according to a four-digit code developed in 1987 (NIC-87), while the 1999 survey classifies firms according to a five-digit code developed in 1998 (NIC-98). I have matched the classifications over time by mapping each five-digit NIC-98 code to a three-digit NIC-87 code; the firms in the dataset fall into approximately 170 different three-digit NIC-87 codes. Tables 1.1 through 1.6 and Figures 1.1 and 1.2 present data that are aggregated to 18 industries at the two-digit NIC-87 level.

The informal sector accounts for approximately 99% of all firms, 80% of employment, and 20% of output, but there is significant variation between industries. Consumer-goods oriented industries such as food processing, leather, and textile products have a greater share of informal employment and output than capital-goods oriented industries such as metals and electrical machinery. The highest shares of informal employment and output are found in the wood, wood products, furniture, and fixtures industry, in which the informal sector accounts for over 98% of employment and over 80% of output in every year. In contrast, the highest shares of formal employment and output are found in the transport equipment industry, with over 70% of employment and 90% of output in every year.

1.1.3 Firm Characteristics

The unit of observation in the ASI is generally an establishment (factory); however, firms with multiple factories in the same state, industry, and sampling frame (census versus sample sector) may submit a consolidated return for those establishments (CSO Last checked February 15, 2010). However, fewer than 5% of the observations in the sample pertain to more than one factory. The informal sector surveys do not ask whether the firm owns more than one establishment; however, the 1989 and 1994 surveys ask whether the firm is ancillary to another firm. Only 4-5% of the observations in the sample report being ancillary. Therefore, I will use the terms "firm," "establishment," and "enterprise" interchangeably in this work.

Table 1.7 summarizes information about firm ownership and organization. Panels (a) and (b) show that the majority of formal firms (95%) are privately held, largely as individual proprietorships (~20%), partnerships (~40%), private limited companies (~ 17%), public limited companies (8-9%), or family firms (5-8%). Of the formal firms that are partly or wholly government-owned, state and local governments are more likely to be owners than the central government. Panel (c) shows that in the informal sector, about 98% of firms are individual proprietorships.

Table 1.8 shows formal and informal firms' power sources. Informal firms are broken down into OAMEs, NDMEs, and DMEs. As we might expect, over 90% of formal firms use electric power, while the majority of informal firms do not. There is significant variation in power use among the different types of informal firms. In 1989, only 5% of OAMEs use electric power, while 20% use another source of power, and the remainder (nearly 75%) use no power source at all. In contrast, 43% of NDMEs use electric power, 21% use another source of power, and only 35% use no power source. These percentages remain relatively stable in 1994. Somewhat surprisingly, DMEs (which are also included in the survey in 1994) report lower rates of electric power usage than NDMEs (29% against 32%), but higher use rates for other power sources (45% against 27%).

Table 1.9 explores informal firm characteristics in greater detail. As discussed above, DMEs are not covered by the survey I use in 1989; OAMEs make up an estimated 90% of the population of firms in the 1989 survey, while NDMEs make up the remaining 10%. In 1994 and 1999, when DMEs are included, OAMEs account for 85% of the estimated population of firms, NDMEs for 10%, and DMEs for the remaining 5%.

Nearly 95% of OAMEs operate perennially, and approximately 80% are located within the household's residence. Another 12-17% have a permanent location outside the household, while approximately 5% have no fixed premises. The firm appears to be an important source of income for OAME households, with a mean contribution of 54% of the household's income. As discussed above, about 3-5% of OAMEs report being ancillary to some other firm.

Similarly, over 95% of NDMEs operate perennially. As we might expect, NDMEs are less likely to be co-located with a household (55-70% report having a permanent, offsite location, while 30-40% are located in the household), and a greater share of household income (nearly 75%) is derived from the firm. Like OAMEs, only 4% of NDMEs report being ancillary to another firm.

Somewhat surprisingly, only 82-83% of DMEs report perennial operation, while another 16-17% report operating seasonally. Over 70% have a permanent, offsite location, and nearly 80% of household income derives from the firm. Approximately 7% of DMEs report being ancillary to another firm.

While there are some differences between the informal firm characteristics reported in the three surveys, there do not appear to be any major changes in the type or location of operation during the 1990's. The fraction of firms in each category (OAME, NDME, DME) also remains fairly stable.

1.2 Firm Size Distribution

There is an extensive literature on the size distribution of firms, much of it dedicated to testing "Gibrat's Law," which implies that the firm size distribution is log-normal (Sutton (1997) provides an excellent summary of this literature). Most of the work on firm size distributions has focused on developed countries, and the existing work on developing countries, including India, suggests that many of them may have a "missing middle" - a concentration of employment among tiny firms and very large firms, with few mid-sized firms (Tybout 2000, Mazumdar and Sarkar 2008). In Chapter 3, I explore potential causes of India's missing middle. Here, I begin by documenting what the firm size distribution in India looks like, in terms of employment, capital, and output.

Figure 1.3 presents kernel density plots of employment in the formal and informal sectors in 1989, 1994, and 1999. Panel (a) shows that during the 1990's, the distribution of formal employment has shifted to the left, so that a greater share of firms have fewer than 10 employees; Kolmogorov-Smirnov tests of the equality of distributions reject ($p<0.001$) that the distributions are the same across any two years. In the informal sector (Panel (b)), the 1994 and 1999 surveys indicate the presence of relatively more firms with 5-15 employees, but this likely just reflects the inclusion of DMEs in these two surveys.

Figure 1.4 shows the distributions of capital in the formal and informal sectors. Capital values are in nominal terms and, as we might expect, the distributions shift to the right over time in both sectors. The capital size distribution is right-shifted in the formal sector relative to the informal sector, though this comparison should be cautiously interpreted, as capital is measured somewhat differently in the two sectors. In the formal sector, capital represents the depreciated book value of land and equipment. In the informal sector, capital is the estimated market value of the firm's land and equipment.

Similarly, Figure 1.5 measures output in each sector. In both sectors, output is the value of all products manufactured as well as any other receipts the firm received. Again, as we might expect, the nominal distributions of output shift to the right over time in both sectors, and formal sector output is right-shifted compared to informal sector output.

1.2.1 The Size-Wage Premium

One stylized fact that emerges from the literature on firms is that larger firms pay higher wages (the so-called "size-wage premium"). There are a number of potential explanations for this phenomenon, including worker sorting, monitoring costs, and capital-labor ratios; Oi and Idson (1999) provide an excellent summary of much of the work on firm size and wages.

To what extent does the firm size-wage premium exist in the Indian manufacturing sector? It is generally assumed that the formal sector wage is higher than the informal sector wage (Marjit 2003, for example). I explore this hypothesis by focusing on linked formal-informal data from 1994, the earliest year in which the full spectrum of informal firms (including DMEs) are included in the UMS survey. First, I calculate the total per-employee labor cost by dividing the total labor bill (which includes wages as well as any benefits paid to workers) by the number of employees. Only firms that report positive labor costs are included, so the findings do not represent informal firms that only hire unpaid household workers.

Table 1.10 shows that the mean per-employee labor cost in the formal sector is nearly Rs. 28,000/year, while the mean per-employee labor cost in the informal sector is approximately Rs. 5,600/year. These figures should be cautiously interpreted for two reasons. First, the surveys do not specify how many hours each employee works. If the average informal sector employee works fewer hours than the average formal sector employee, then the difference between the two costs will be biased upwards. Second, a number of workers in the informal sector are unpaid household members, so they may be compensated in some non-monetary way.

I also attempt to estimate the wage differential between the two sectors by calculating the mean wage paid to production workers in the formal sector, and to hired workers in the informal sector. The mean wage for production workers in the formal sector is estimated by dividing the total wage bill for production workers by the number of production workers; similarly, the mean wage for hired workers in the informal sector is calculated by dividing total wages paid to hired workers by the number of hired workers. This necessarily excludes any informal firms that do not use hired workers, and is therefore not representative of the bulk of firms in the informal sector (see Section 1.1.3). Table 1.10 again confirms that the mean wage for production workers in the formal sector (Rs. 13,157) is higher than the mean wage for hired workers in the informal sector (Rs. 6,968). The formal sector premium is much lower than when total labor costs were considered, which may reflect several factors, including the likelihood that formal sector benefits are higher than informal sector benefits, and the possibility that informal firms that hire workers pay relatively high wages compared to those that do not.

To explore the size-wage premium in more detail, Figure 1.6 shows locally weighted regressions of total per-employee labor cost on firm size (employment). Two general findings emerge from this figure. First, larger firms have higher per-employee labor costs. Second, formal firms have higher per-employee labor costs than informal firms with the same number of employees. Unfortunately, since the informal and formal firm surveys do not include information about worker quality or education, I cannot determine how much of the size-wage premium, or the formal-informal-wage premium, is due to worker characteristics, and how much is due to other factors, such as monitoring costs, that differ across firms of different sizes. In Section 1.3, though, I will show that formal and informal firms with the same number of employees appear to have significantly different operations.

1.2.2 Loans and Interest Rates

Recent work on the size distribution of firms suggests that one barrier to firm growth may be credit constraints (Cabral and Mata 2003, Angelini and Generale 2008). The formal and informal firm surveys include questions regarding firms' outstanding loans and interest payments, which allow me to explore credit-related issues in the Indian manufacturing industry. For the informal sector, the survey asks about loans from traditional sources as well as non-traditional sources, including friends and relatives. Table 1.10 shows that even when such non-traditional sources are included, only 6.5% of informal firms report positive outstanding loans, compared to 72.3% of formal firms. It is unclear whether the low fraction of informal firms with outstanding loans is due to lack of demand for loans on the part of the informal firms or lack of supply on the part of lenders.

Interestingly, although the average value of outstanding loans is much larger in the formal sector than in the informal sector (Rs. 9.4 million in the formal sector versus approximately Rs. 50,000 in the informal sector), the mean interest rate paid by formal firms is higher (26.8% in the formal sector versus 16.8% in the informal sector). I impute the interest rate by dividing the amount of interest paid during the past year by the amount of outstanding loans. Average interest rates are calculated based on the subset of firms that report positive values for both outstanding loans and interest payments, so this effect is very likely due at least in part to a selection effect.

Figures 1.7 and 1.8 present locally weighted regressions of the fraction of firms with outstanding loans, the value of outstanding loans, and interest rates on firm size (employment). The regressions of outstanding loans and interest rates only include those firms with positive loans and interest rates, respectively. Panel (a) of Figure 1.7 shows that the fraction of firms that take out loans is increasing with firm size in both sectors. Only 60% of formal firms with fewer than 10 employees take out loans, while nearly all formal firms with more than 1,000 employees do so. Furthermore, small, formal firms are more likely to take out loans than informal firms with the same number of employees. Informal firms that report having more than 100 employees do appear to be more likely to take out loans than formal firms of the same size, but this segment of informal firms represents a tiny proportion of the population of informal firms (less than one-hundredth of one percent). Panel (b) shows that average loan size is also increasing with firm size.

Figure 1.8 suggests that firm size is not highly correlated with interest rates in the informal sector. In the formal sector, larger firms pay higher interest rates, and formal firms pay higher interest rates than informal firms with the same number of employees. These counterintuitive findings may again be explained by considering the selection effect; since so few informal firms, and relatively few small, formal firms take out loans, the interest rates paid by these firms are unlikely to represent the interest rates that the average small firm would pay if it were given a loan. Furthermore, since I estimate interest rates by dividing interest payments by outstanding loans, the relatively low rates may also reflect nonpayment of interest rather than low rates. A third possibility is that small firms may receive subsidized credit; the policy of extending credit to small-scale industries (SSI) is explored in more detail in Chapter 3.

1.2.3 Firm Age

The literature on firm size distribution suggests that firms grow as they age, but that the growth rate decreases with increasing size and age (Evans 1987, for example). How does the Indian firm size distribution change as firms age? To explore this issue, I focus on the employment size distribution, and divide firms into various size-age cells. Tables 1.11 and 1.12 show the estimated number and percent, respectively, of formal and informal firms in each size-age cell. Size cells were chosen to correspond to commonly used ranges, and age cells were chosen to approximately balance the number of firms in each cell. As before, I focus on the linked formal-informal dataset from 1994.

In the formal sector, approximately 60% of zero- to six-year-old firms (16,052 out of 26,359) have between 10 and 50 employees, which is consistent with the requirement that firms join the formal sector when they have 10 or more employees. The fraction of large firms is increasing with firm age. If we consider zero- to six-year-old firms, 10.3% (2,710 out of 26,359) have 100 or more employees. If we consider firms that are at least 21 years old, 18.5% (5,224 out of 28,251) have 100 or more employees.

Interestingly, the fraction of formal firms that have fewer than 10 employees is also increasing with firm age, which suggests that at least some of the formal firms with fewer than 10 employees may have started with more than 10 employees and subsequently reduced employment. Bedi and Banerjee (2007) have noted that once a firm is registered, it may be difficult for the firm to be removed from the state's registration list. These firms may also anticipate growing in the future, and may remain formal in order to avoid re-registering when they return to a size of more than 10 employees.

In the informal sector, the vast majority of firms in all age categories have between zero and four employees. The fraction of firms with five or more employees decreases with age (from 11.4% of zero- to six-year-old firms to 7% of firms 21 years or older), as does the fraction of firms with 10 or more employees (from 2.6% of zero- to six-year-old firms to 0.8% of firms 21 years or older). One explanation that is consistent with this pattern is that firms may begin in the informal sector, and those that grow to have several employees register and become part of the formal sector.

Figure 1.9 shows kernel density plots of formal and informal employment size distributions by age category. Panel (a) confirms the finding from Tables 1.11 and 1.12 that a larger fraction of formal firms 21 years and older have more than 100 employees. In contrast, Panel (b) shows that in the informal sector, it appears that older firms may be more likely to be smaller.

1.3 Comparing Formal and Informal Firms

As discussed in Section 1.1.1, although firms with fewer than 10 employees are not required to register, there are a number of formal firms with fewer than 10 employees. In 1994, an estimated 18% of formal firms had fewer than 10 employees (18,151 out of 102,359). Given the observed relationships between firm age and firm size, it is likely that at least some of these firms originally registered when they had 10 or more employees, and later reduced employment. However, approximately 10% of the formal firms with fewer than 10 employees are less than three years old, which suggests that there may be other reasons that they chose to become formal.

I investigate this issue by comparing informal and formal firms with the same number of employees, using the linked formal-informal dataset from 1994. The results in Section 1.2 indicate that formal firms pay higher wages, have higher per-employee labor costs, are more likely to take out loans, and pay higher interest rates than informal firms with the same number of employees. In Tables 1.13 and 1.14, I compare a number of firm characteristics by firm size, for firms with 1-20 employees.

Table 1.13 shows that there are many more informal firms than formal firms in every size category. There are very few formal firms with fewer than three employees, and the estimated number of formal firms peaks at 10 employees. In the informal sector, the modal number of employees is two, and the number of firms declines with firm size above two employees.

Although there appears to be an overall positive correlation between formal firm size and firm age (see Section 1.2.3), within this subsample of formal firms, average firm age is generally decreasing with firm size. The average age (nearly 31 years old) of formal firms with one employee appears to be an outlier; since there are so few formal firms with only one employee, there may be significant statistical noise associated with the characteristics of these firms. Informal firm age appears to increase from one to four employees, then to decrease with larger firm sizes, though the decline is not monotonic. If we consider firms with six or fewer employees, informal firms are generally older than formal firms, while this pattern is usually reversed among larger firms.

As discussed in Section 1.1.3, most formal firms use electric power, while most informal firms do not. Table 1.13 confirms that this pattern holds even when we compare formal and informal firms with the same number of employees. The fraction of formal firms that use power rises from nearly 70% for one-employee firms to over 90% for firms with four or more employees. The fraction of informal firms that use power ranges from approximately 5% to 25%. Informal firms with more than five employees are more likely than smaller firms to use electric power, but the relationship between firm size and the use of electric power is not monotonic in this sector.

Table 1.13 also quantifies the comparison of outstanding loans for formal and informal firms that was illustrated by Figure 1.7. The fraction of formal firms that take out loans ranges from approximately 40% to 80%, and generally increases with firm size. The fraction of informal firms that take out loans also increases with firm size, but only ranges from 3% to 50%. Similarly, when we consider firms that do take out loans, the value of outstanding loans in the formal sector is an order of magnitude higher than the value of outstanding loans in the informal sector, for firms of the same size. In general, the value of outstanding loans increases with firm size in both sectors. Again, formal firms with one employee are an outlier, with a much higher average value of loans than larger firms.

Table 1.14 shows similar comparisons of the amount of capital, the capital-employee ratio, the value of products, the value of other receipts, and the value of total output in the formal and informal sectors. In general, average values for capital, products, other receipts, and output are rising with firm employment in both sectors, and formal firms have values that are much higher than informal firms of the same size. As with outstanding loans, formal firms with one employee are an outlier in these patterns.

The capital-employee ratio is also higher in the formal sector than the informal sector, though the ratio does not necessarily rise with firm employment. In the formal sector, the capital-employee ratio first falls as employment increases from one to six employees, then appears to rise again, though not monotonically. In the informal sector, there is no clear relationship between capital-employee ratios and firm employment, though the peak capital-employee ratios are generally concentrated around the 6-9 employee range.

1.4 Conclusion

This chapter has sought to gain a better understanding of the entire manufacturing industry in India by looking at various characteristics of both formal and informal manufacturing firms. In doing so, three key points appear to be worth considering.

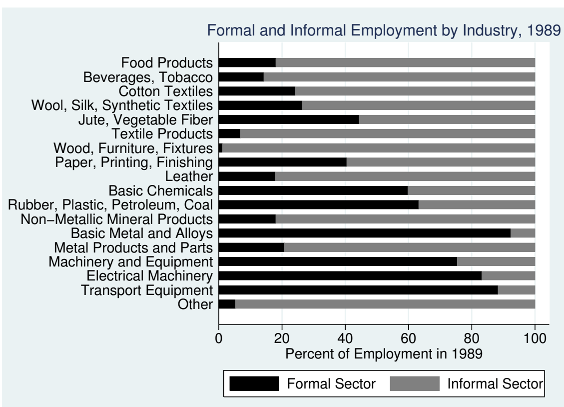
First, the informal sector is an important component of the Indian manufacturing industry, accounting for 99% of firms, 80% of employment, and 20% of output by the end of the 1990's. Most previous work has focused on the formal sector, but the size and importance of the informal sector indicate that gaining an understanding of informal firms is crucial in studying the manufacturing industry as a whole.

Second, formal and informal firms are differentiated among a number of different dimensions, not simply size. The fact that the modal number of employees among formal firms is 10 is consistent with the requirement that firms register when they have 10 employees. However, the fact that nearly 20% of registered firms have fewer than 10 employees, along with the fact that formal firms with fewer than 20 employees appear to be very different from informal firms with the same number of employees, indicate that firms are sorting into the formal and informal sectors based on more than just employment size.

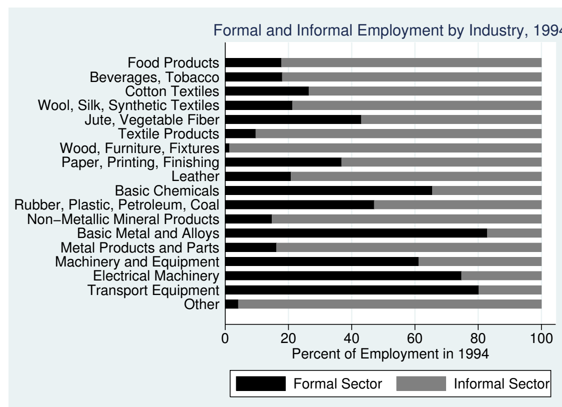
Finally, during the 1990's, the shares of employment and output in the informal sector have remained stable or risen. A number of politicians and commentators (Hensman 2001, Jhabvala and Sinha 2002, Vajpayee 2003, among others) have argued that globalization may have been responsible for increasing the share of manufacturing activity carried out by small firms. For example, at a 2003 summit, former Indian Prime Minister A.B. Vajpayee remarked, "It was also assumed that, over a period of time, the traditional sector comprising cottage industries, small trade, etc., also would get absorbed in the formal sector of the economy. This assumption has not stood the test of time. Today neither the government sector nor the organized industry can generate significant number of employment opportunities....We should also recognize that the size and the scope of the informal sector have vastly expanded - not shrunk - because of the forces of liberalization and globalisation...." (Vajpayee 2003).

Despite such claims, though, there is little quantitative evidence on the links between India's industrial and trade liberalizations and informality, or on whether the Indian reforms affected small, informal firms at all. In the next two chapters, I explore the extent to which India's trade liberalization and other policies have affected productivity, output, and employment among both formal and informal firms.

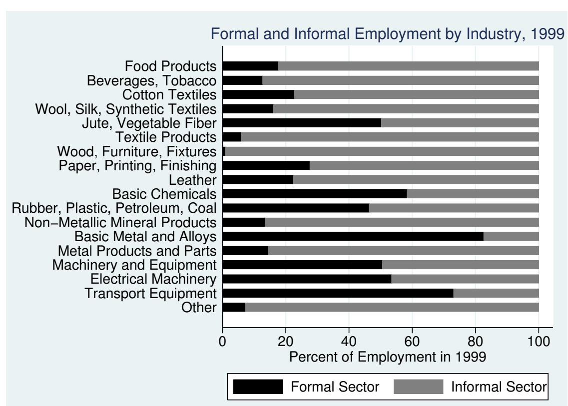
Figure 1.1: Employment by Industry



(a) 1989



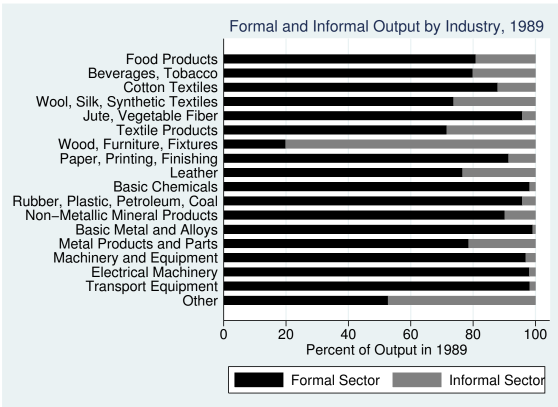
(b) 1994



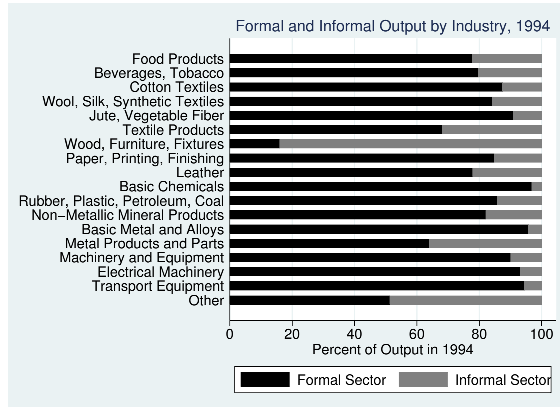
(c) 1999

Panels (a), (b), and (c) show the estimated percent of employment in the formal and informal sectors in 1989, 1994, and 1999, respectively, by 2-digit National Industrial Classification (NIC-87) code. Source: Author's calculations based on unit-level data from the Annual Survey of Industries (ASI) and Unorganised Manufacture Survey (UMS).

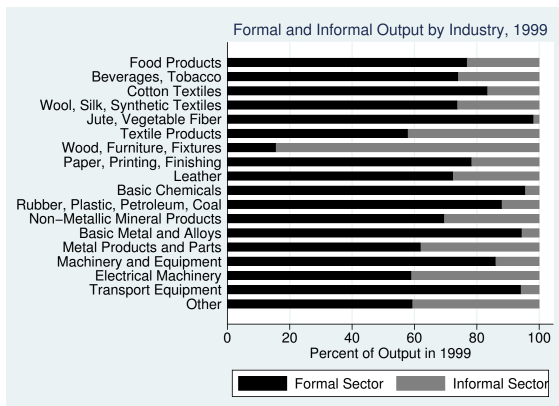
Figure 1.2: Output by Industry



(a) 1989



(b) 1994

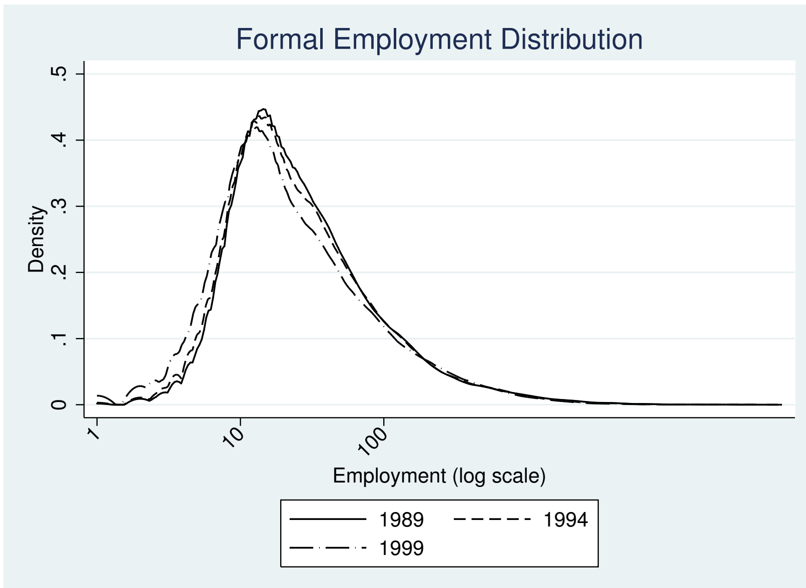


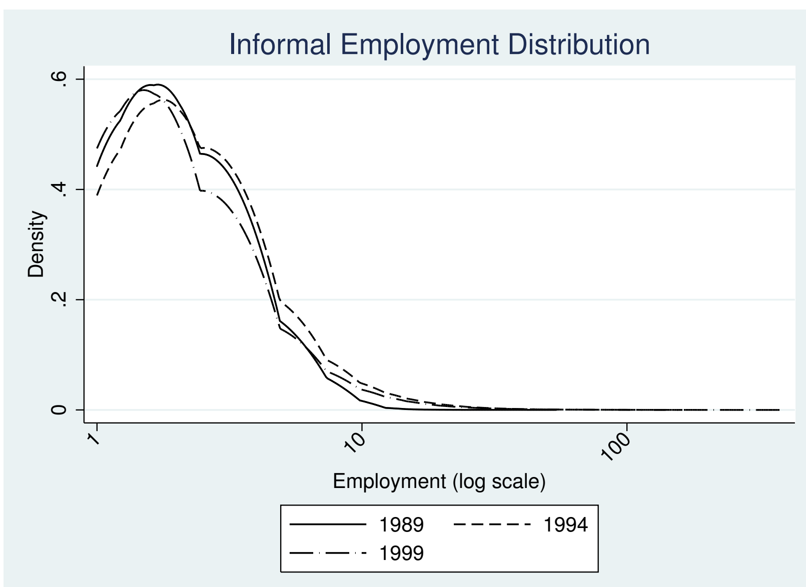
(c) 1999

Panels (a), (b), and (c) show the estimated percent of output in the formal and informal sectors in 1989, 1994, and 1999, respectively, by 2-digit National Industrial Classification (NIC-87) code. Source: Author's calculations based on unit-level data from the Annual Survey of Industries (ASI) and Unorganised Manufacture Survey (UMS).

Figure 1.3: Distribution of Employment

(a) Formal Employment Distribution



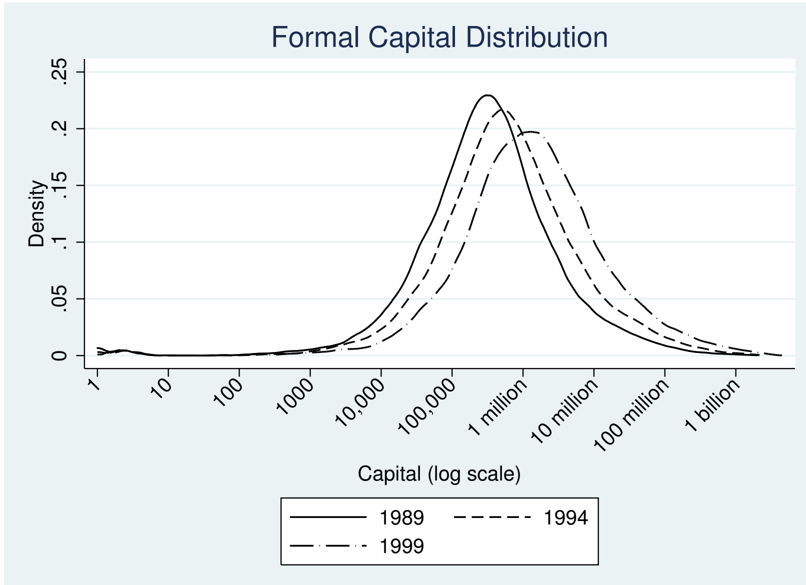


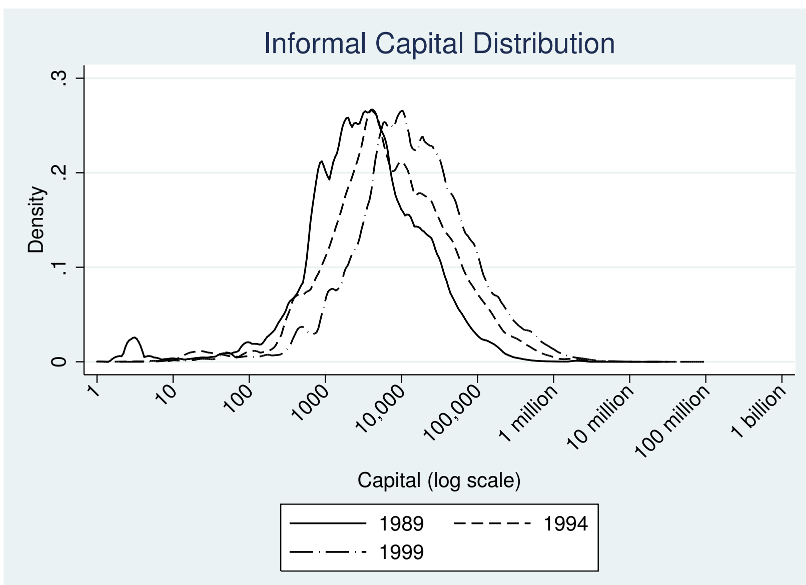
(b) Informal Employment Distribution

Panels (a) and (b) show the distribution of employment in the formal and informal sectors, respectively, in 1989, 1994, and 1999. All formal sector densities employ an Epanechnikov kernel and Silverman's optimal bandwidth. All informal sector densities employ an Epanechnikov kernel and a bandwidth of 0.4. Source: Author's calculations based on unit-level data from the Annual Survey of Industries (ASI) and Unorganised Manufacture Survey (UMS).

Figure 1.4: Distribution of Capital

(a) Formal Capital Distribution



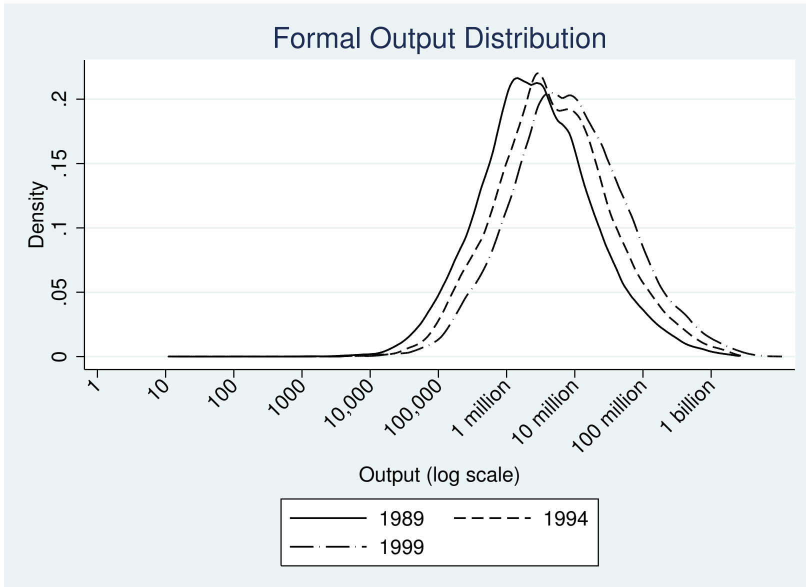


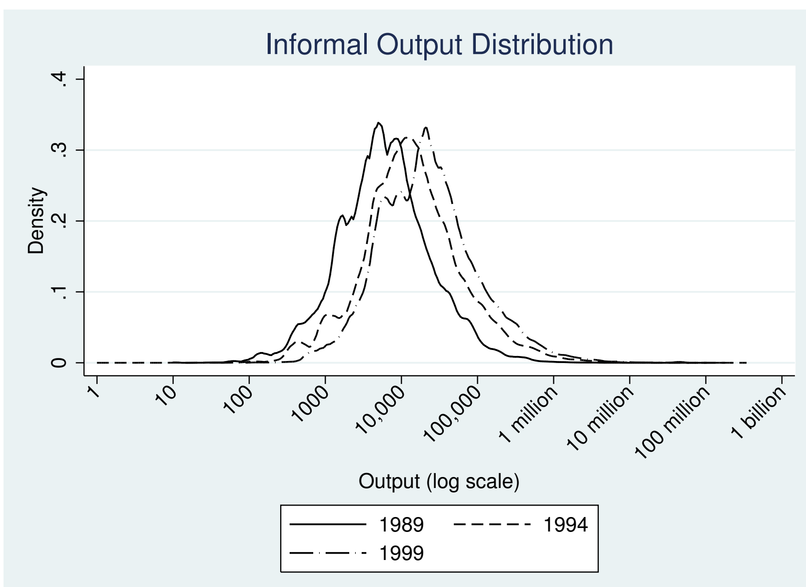
(b) Informal Capital Distribution

Panels (a) and (b) show the distribution of capital in the formal and informal sectors, respectively, in 1989, 1994, and 1999. All densities employ an Epanechnikov kernel and Silverman's optimal bandwidth. Capital values are in nominal rupees. Source: Author's calculations based on unit-level data from the Annual Survey of Industries (ASI) and Unorganised Manufacture Survey (UMS).

Figure 1.5: Distribution of Output

(a) Formal Output Distribution

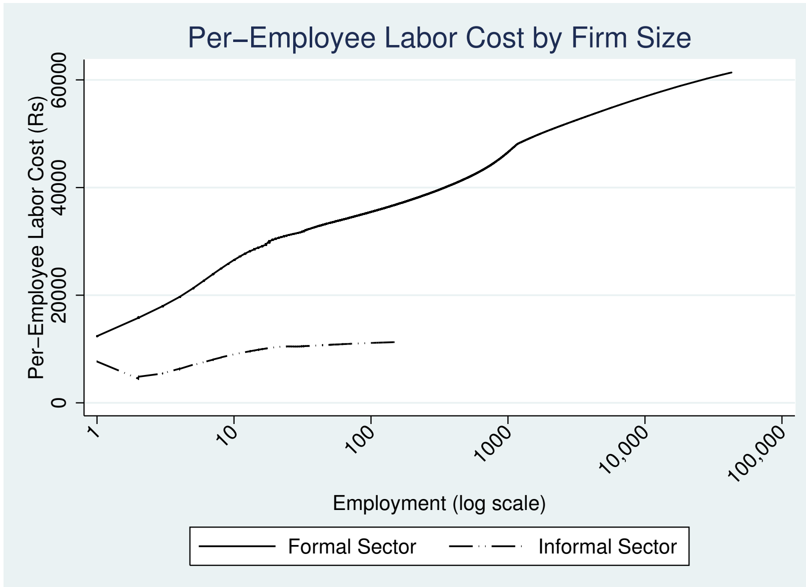




(b) Informal Output Distribution

Panels (a) and (b) show the distribution of output in the formal and informal sectors, respectively, in 1989, 1994, and 1999. All densities employ an Epanechnikov kernel and Silverman's optimal bandwidth. Output values are in nominal rupees. Source: Author's calculations based on unit-level data from the Annual Survey of Industries (ASI) and Unorganised Manufacture Survey (UMS).

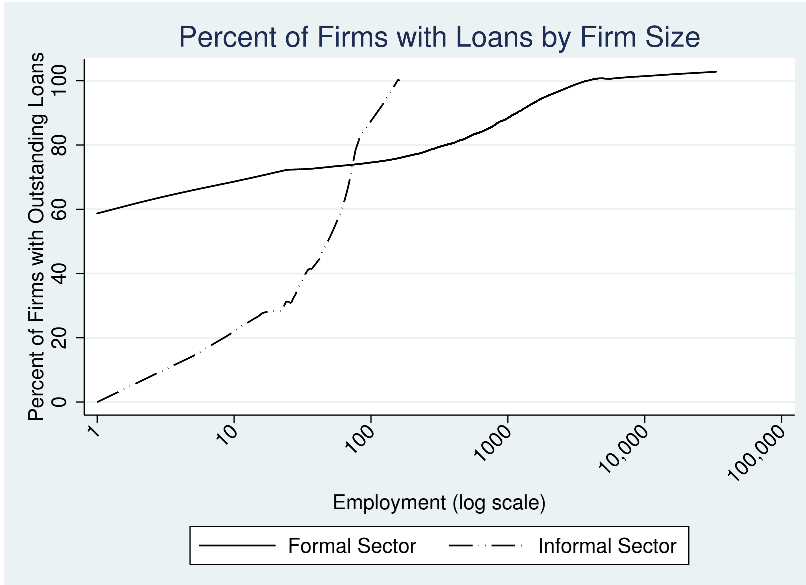
Figure 1.6: Labor Costs by Firm Size

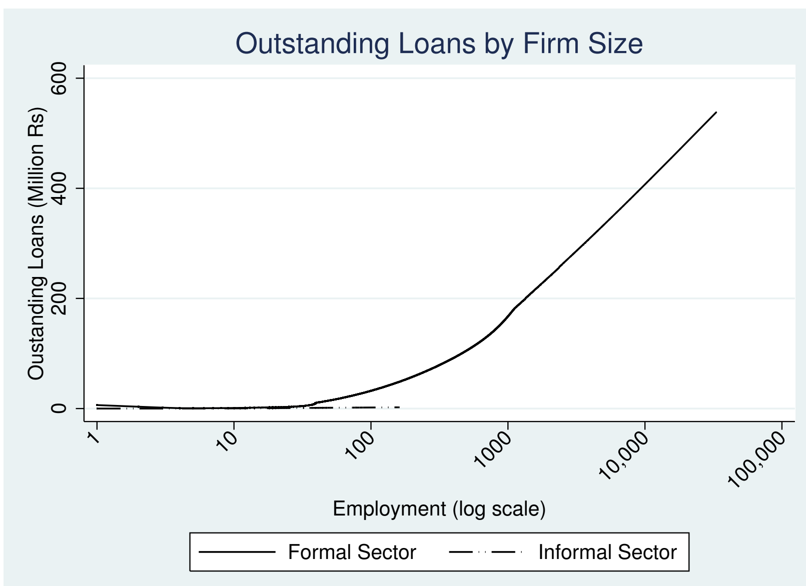


Locally weighted regressions of labor costs per employee on firm size, estimated using running-line least-squares smoothing with a bandwidth of 0.8. Labor costs are only calculated for firms that report positive labor costs (e.g., firms, typically in the informal sector, that only use unpaid household labor are not included). The top and bottom 5% of firm-level, per-employee labor costs are dropped in order to minimize the influence of outliers. Source: Author's calculations based on unit-level data from the Annual Survey of Industries (ASI) and Unorganised Manufacture Survey (UMS).

Figure 1.7: Outstanding Loans by Firm Size

(a) Percent of Firms with Outstanding Loans by Firm Size

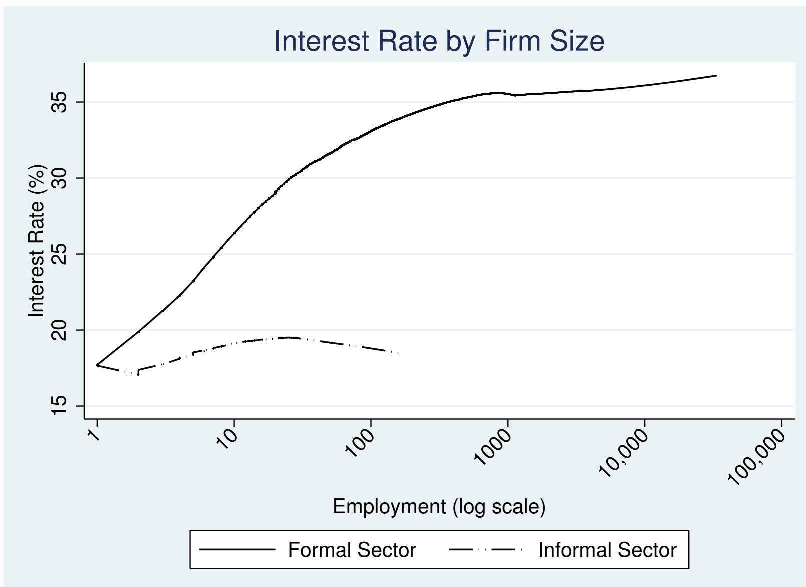




(b) Amount of Outstanding Loans by Firm Size

Panels (a) and (b) show locally weighted regressions of the fraction of firms that have outstanding loans, and the amount of outstanding loans, respectively, on firm size. All locally weighted regressions employ running-line least-squares smoothing with a bandwidth of 0.8. In Panel (b), only firms with positive values of outstanding loans are included. Source: Author's calculations based on unit-level data from the Annual Survey of Industries (ASI) and Unorganised Manufacture Survey (UMS).

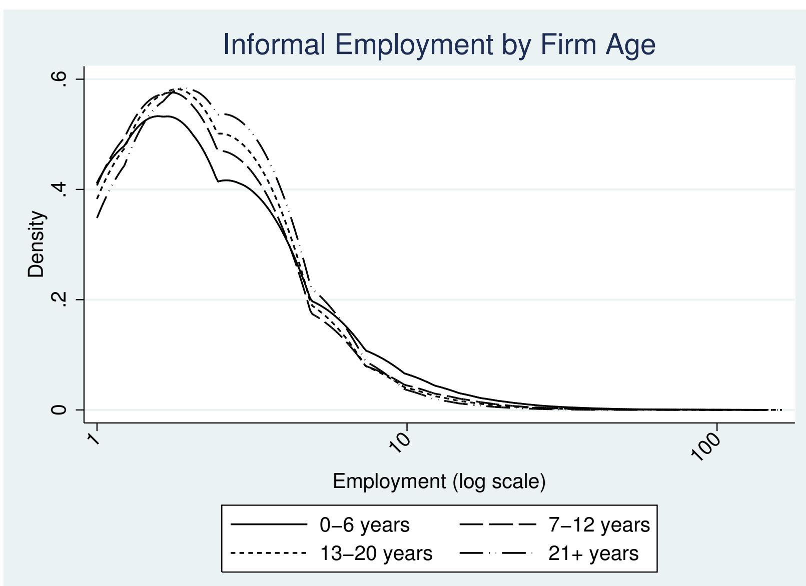
Figure 1.8: Interest Rate by Firm Size



Locally weighted regressions of interest rate on firm size, estimated using running-line least-squares smoothing with a bandwidth of 0.8. Interest rates are only calculated for firms with positive values of outstanding loans and interest payments. The top and bottom 5% of firm-level interest rates are dropped in order to minimize the influence of outliers. Source: Author's calculations based on unit-level data from the Annual Survey of Industries (ASI) and Unorganised Manufacture Survey (UMS).

Figure 1.9: Distribution of Employment by Firm Age

(a) Formal Employment Distribution by Firm Age



(b) Informal Employment Distribution by Firm Age

Panels (a) and (b) show the distribution of employment in the formal and informal sectors, respectively, by firm age. All formal sector densities employ an Epanechnikov kernel and Silverman's optimal bandwidth. All informal sector densities employ an Epanechnikov kernel and a bandwidth of 0.4. Source: Author's calculations based on unit-level data from the Annual Survey of Industries (ASI) and Unorganised Manufacture Survey (UMS).

Table 1.1: Formal and Informal Firms, Employment and Output by Industry: 1989

	Formal Sector			Informal Sector		
	No. Firms	**No. Employees**	**Output (million Rs)**	**No. Firms**	**No. Employees**	**Output (million Rs)**
Food Products	17,123	1,103,550	328,027	2,304,605	5,012,064	77,640
Beverages, Tobacco	2,533	518,683	42,714	1,978,006	3,120,787	10,742
Cotton Textiles	6,175	860,941	126,235	1,270,806	2,694,807	17,454
Wool, Silk, Synthetic Textiles	3,039	288,437	81,162	295,901	807,219	28,943
Jute, Vegetable Fiber	287	212,099	14,959	134,283	265,669	657
Textile Products	2,872	165,368	37,046	1,085,706	2,270,035	14,712
Wood, Furniture, Fixtures	3,080	75,695	8,233	3,283,097	6,291,958	33,223
Paper, Printing, Finishing	4,743	276,689	62,639	149,932	407,049	5,933
Leather	1,117	104,254	22,868	295,004	481,234	6,989
Basic Chemicals	6,007	561,648	233,936	169,193	377,678	4,519
Rubber, Plastic, Petroleum, Coal	4,596	232,896	88,901	58,232	135,402	3,903
Non-Metallic Mineral Products	7,819	438,325	78,146	797,956	1,992,726	8,529
Basic Metal and Alloys	5,211	595,303	182,017	15,284	49,236	1,655
Metal Products and Parts	6,077	222,770	49,886	379,170	849,608	13,621
Machinery and Equipment	7,129	427,550	109,724	71,677	139,262	3,494
Electrical Machinery	4,275	381,685	123,794	23,574	77,154	2,450
Transport Equipment	3,276	462,084	80,852	23,401	61,084	1,508
Other	1,538	89,661	20,208	751,905	1,590,718	18,108
Total	86,898	7,017,639	1,691,348	13,087,732	26,623,690	254,080

Estimated number of firms, employees, and output in the formal versus informal sectors in 1989, by 2-digit National Industrial Classification (NIC-87) code. Source: Author's calculations based on unit-level data from the Annual Survey of Industries (ASI) and Unorganised Manufacture Survey (UMS).

Table 1.2: Formal and Informal Firms, Employment and Output by Industry: 1994

	Formal Sector			Informal Sector		
	No. Firms	**No. Employees**	**Output (million Rs)**	**No. Firms**	**No. Employees**	**Output (million Rs)**
Food Products	18,943	1,223,072	652,644	2,318,490	5,634,352	186,120
Beverages, Tobacco	2,900	591,660	79,843	1,335,098	2,687,859	20,412
Cotton Textiles	7,329	785,958	274,815	773,709	2,182,915	39,462
Wool, Silk, Synthetic Textiles	3,385	325,916	169,762	333,839	1,206,377	32,038
Jute, Vegetable Fiber	373	186,820	23,929	86,555	247,218	2,405
Textile Products	5,137	325,625	114,475	1,071,358	3,042,555	53,706
Wood, Furniture, Fixtures	3,198	73,041	15,115	2,787,249	5,383,530	79,451
Paper, Printing, Finishing	5,319	323,695	132,376	173,772	555,728	23,856
Leather	1,668	132,526	56,918	203,515	504,378	16,172
Basic Chemicals	7,669	667,562	456,238	140,738	351,052	14,965
Rubber, Plastic, Petroleum, Coal	6,000	291,323	182,215	83,980	326,864	30,268
Non-Metallic Mineral Products	9,212	450,742	160,398	826,454	2,592,677	34,985
Basic Metal and Alloys	5,816	596,740	316,726	34,070	123,274	13,818
Metal Products and Parts	6,853	248,845	101,991	445,899	1,283,741	57,627
Machinery and Equipment	7,752	447,955	190,155	93,614	283,913	20,978
Electrical Machinery	5,171	433,820	250,572	28,887	146,685	18,705
Transport Equipment	3,776	513,094	152,890	27,893	126,572	8,823
Other	1,859	121,179	67,702	1,111,558	2,795,564	64,264
Total	102,359	7,739,573	3,398,764	11,876,678	29,475,253	718,057

Estimated number of firms, employees, and output in the formal versus informal sectors in 1994, by 2-digit National Industrial Classification (NIC-87) code. Source: Author's calculations based on unit-level data from the Annual Survey of Industries (ASI) and Unorganised Manufacture Survey (UMS).

Table 1.3: Formal and Informal Firms, Employment and Output by Industry: 1999

	Formal Sector			Informal Sector		
	No. Firms	**No. Employees**	**Output (million Rs)**	**No. Firms**	**No. Employees**	**Output (million Rs)**
Food Products	20,671	1,264,187	1,286,428	2,509,811	5,886,828	386,203
Beverages, Tobacco	2,912	528,801	130,286	2,219,960	3,642,051	45,626
Cotton Textiles	5,465	594,820	394,741	698,846	2,026,111	78,364
Wool, Silk, Synthetic Textiles	2,702	217,517	159,176	379,746	1,130,229	56,505
Jute, Vegetable Fiber	1,052	276,943	101,536	135,042	274,097	1,858
Textile Products	5,721	434,733	257,898	3,783,660	6,976,753	187,134
Wood, Furniture, Fixtures	2,836	51,185	24,879	2,964,574	5,509,697	134,372
Paper, Printing, Finishing	5,857	273,547	211,316	226,092	716,390	58,424
Leather	1,454	103,898	71,899	158,947	359,722	27,342
Basic Chemicals	8,455	725,799	965,192	198,155	517,404	44,925
Rubber, Plastic, Petroleum, Coal	6,952	344,361	375,715	117,151	398,053	50,855
Non-Metallic Mineral Products	9,900	426,622	268,654	707,431	2,747,334	117,471
Basic Metal and Alloys	6,153	608,805	512,615	36,845	128,248	30,102
Metal Products and Parts	7,177	257,725	170,275	598,767	1,526,667	104,129
Machinery and Equipment	8,123	436,703	295,746	144,273	427,070	47,811
Electrical Machinery	5,394	384,142	425,131	80,237	334,398	295,005
Transport Equipment	4,314	455,936	342,503	37,648	167,996	21,143
Other	2,609	176,303	154,630	947,673	2,251,898	105,666
Total	107,747	7,562,027	6,148,622	15,944,856	35,020,946	1,792,934

Estimated number of firms, employees, and output in the formal versus informal sectors in 1999, by 2-digit National Industrial Classification (NIC-87) code. Source: Author's calculations based on unit-level data from the Annual Survey of Industries (ASI) and Unorganised Manufacture Survey (UMS).

Table 1.4: Share of Firms, Employment and Output in the Formal versus Informal Sectors by Industry: 1989

	Formal Sector			Informal Sector		
	% Firms	**% Employees**	**% Output**	**% Firms**	**% Employees**	**% Output**
Food Products	0.7	18.0	80.9	99.3	82.0	19.1
Beverages, Tobacco	0.1	14.3	79.9	99.9	85.7	20.1
Cotton Textiles	0.5	24.2	87.9	99.5	75.8	12.1
Wool, Silk, Synthetic Textiles	1.0	26.3	73.7	99.0	73.7	26.3
Jute, Vegetable Fiber	0.2	44.4	95.8	99.8	55.6	4.2
Textile Products	0.3	6.8	71.6	99.7	93.2	28.4
Wood, Furniture, Fixtures	0.1	1.2	19.9	99.9	98.8	80.1
Paper, Printing, Finishing	3.1	40.5	91.3	96.9	59.5	8.7
Leather	0.4	17.8	76.6	99.6	82.2	23.4
Basic Chemicals	3.4	59.8	98.1	96.6	40.2	1.9
Rubber, Plastic, Petroleum, Coal	7.3	63.2	95.8	92.7	36.8	4.2
Non-Metallic Mineral Products	1.0	18.0	90.2	99.0	82.0	9.8
Basic Metal and Alloys	25.4	92.4	99.1	74.6	7.6	0.9
Metal Products and Parts	1.6	20.8	78.6	98.4	79.2	21.4
Machinery and Equipment	9.0	75.4	96.9	91.0	24.6	3.1
Electrical Machinery	15.3	83.2	98.1	84.7	16.8	1.9
Transport Equipment	12.3	88.3	98.2	87.7	11.7	1.8
Other	0.2	5.3	52.7	99.8	94.7	47.3
Overall	0.7	20.9	86.9	99.3	79.1	13.1

Estimated percent of firms, employees, and output in the formal sector versus the informal sector in 1989, by 2-digit National Industrial Classification (NIC-87) code. Source: Author's calculations based on unit-level data from the Annual Survey of Industries (ASI) and Unorganised Manufacture Survey (UMS).

Table 1.5: Share of Firms, Employment and Output in the Formal versus Informal Sectors by Industry: 1994

	Formal Sector			Informal Sector		
	% Firms	**% Employees**	**% Output**	**% Firms**	**% Employees**	**% Output**
Food Products	0.8	17.8	77.8	99.2	82.2	22.2
Beverages, Tobacco	0.2	18.0	79.6	99.8	82.0	20.4
Cotton Textiles	0.9	26.5	87.4	99.1	73.5	12.6
Wool, Silk, Synthetic Textiles	1.0	21.3	84.1	99.0	78.7	15.9
Jute, Vegetable Fiber	0.4	43.0	90.9	99.6	57.0	9.1
Textile Products	0.5	9.7	68.1	99.5	90.3	31.9
Wood, Furniture, Fixtures	0.1	1.3	16.0	99.9	98.7	84.0
Paper, Printing, Finishing	3.0	36.8	84.7	97.0	63.2	15.3
Leather	0.8	20.8	77.9	99.2	79.2	22.1
Basic Chemicals	5.2	65.5	96.8	94.8	34.5	3.2
Rubber, Plastic, Petroleum, Coal	6.7	47.1	85.8	93.3	52.9	14.2
Non-Metallic Mineral Products	1.1	14.8	82.1	98.9	85.2	17.9
Basic Metal and Alloys	14.6	82.9	95.8	85.4	17.1	4.2
Metal Products and Parts	1.5	16.2	63.9	98.5	83.8	36.1
Machinery and Equipment	7.6	61.2	90.1	92.4	38.8	9.9
Electrical Machinery	15.2	74.7	93.1	84.8	25.3	6.9
Transport Equipment	11.9	80.2	94.5	88.1	19.8	5.5
Other	0.2	4.2	51.3	99.8	95.8	48.7
Overall	0.9	20.8	82.6	99.1	79.2	17.4

Estimated percent of firms, employees, and output in the formal sector versus the informal sector in 1994, by 2-digit National Industrial Classification (NIC-87) code. Source: Author's calculations based on unit-level data from the Annual Survey of Industries (ASI) and Unorganised Manufacture Survey (UMS).

Table 1.6: Share of Firms, Employment and Output in the Formal versus Informal Sectors by Industry: 1999

	Formal Sector			**Informal Sector**		
	% Firms	**% Employees**	**% Output**	**% Firms**	**% Employees**	**% Output**
Food Products	0.8	17.7	76.9	99.2	82.3	23.1
Beverages, Tobacco	0.1	12.7	74.1	99.9	87.3	25.9
Cotton Textiles	0.8	22.7	83.4	99.2	77.3	16.6
Wool, Silk, Synthetic Textiles	0.7	16.1	73.8	99.3	83.9	26.2
Jute, Vegetable Fiber	0.8	50.3	98.2	99.2	49.7	1.8
Textile Products	0.2	5.9	58.0	99.8	94.1	42.0
Wood, Furniture, Fixtures	0.1	0.9	15.6	99.9	99.1	84.4
Paper, Printing, Finishing	2.5	27.6	78.3	97.5	72.4	21.7
Leather	0.9	22.4	72.4	99.1	77.6	27.6
Basic Chemicals	4.1	58.4	95.6	95.9	41.6	4.4
Rubber, Plastic, Petroleum, Coal	5.6	46.4	88.1	94.4	53.6	11.9
Non-Metallic Mineral Products	1.4	13.4	69.6	98.6	86.6	30.4
Basic Metal and Alloys	14.3	82.6	94.5	85.7	17.4	5.5
Metal Products and Parts	1.2	14.4	62.1	98.8	85.6	37.9
Machinery and Equipment	5.3	50.6	86.1	94.7	49.4	13.9
Electrical Machinery	6.3	53.5	59.0	93.7	46.5	41.0
Transport Equipment	10.3	73.1	94.2	89.7	26.9	5.8
Other	0.3	7.3	59.4	99.7	92.7	40.6
Overall	0.7	17.8	77.4	99.3	82.2	22.6

Estimated percent of firms, employees, and output in the formal sector versus the informal sector in 1999, by 2-digit National Industrial Classification (NIC-87) code. Source: Author's calculations based on unit-level data from the Annual Survey of Industries (ASI) and Unorganised Manufacture Survey (UMS).

Table 1.7: Firm Ownership and Organization

	% Firms 1989	% Firms 1994
Individual Proprietorship	18.9	21.4
Joint Family	8.4	5.5
Partnership	43.3	40.0
Public Limited Company	7.8	9.3
Private Limited Company	16.6	18.9
Government Departmental Enterprises	1.4	1.6
Public Corporation by Special Act of Parliament or State Legislature	0.7	0.7
Co-Operative Society	2.4	2.1
Others	0.4	0.5
Total	100.0	100.0

(a) Formal Sector Organization

	% Firms 1989	% Firms 1994
Wholly Central Government	0.7	0.6
Wholly State and/or Local Government	1.6	1.4
Central Government and State and/or Local Government Jointly	0.7	0.7
Joint Sector Public	0.9	0.5
Joint Sector Private	1.4	0.3
Wholly Private Ownership	94.6	96.6
Total	100.0	100.0

(b) Formal Sector Ownership

	% Firms 1989	% Firms 1994	% Firms 1999
Proprietary	98.5	97.8	98.4
Partnership with Members of the Household	0.9	1	0.9
Partnership with Multiple Households	0.5	0.6	0.6
Co-operative Society	0.0	0.0	0.0
Others	0.0	0.0	0.0
Total	100.0	100.0	100.0

(c) Informal Sector Organization

Estimated percentages of formal and informal firms with different ownership and organization structures. Source: Author's calculations based on unit-level data from the Annual Survey of Industries (ASI) and Unorganised Manufacture Survey (UMS).

Table 1.8: Share of Firms Using Various Power Sources

	1989	**1994**
% Using Electric Power	91.7	93.1
% Using Other Power	3.3	2.5
% Using No Power	4.9	4.4
Total	100.0	100.0

(a) Formal Sector

	1989			**1994**		
	OAME	**NDME**	**DME**	**OAME**	**NDME**	**DME**
% Using Electric Power	5.4	43.4	–	5.1	31.7	28.6
% Using Other Power	20.6	21.3	–	25.2	26.8	45.3
% Using No Power	74.0	35.2	–	69.7	41.5	26.1
Total	100.0	100.0	100.0	100.0	100.0	100.0

(b) Informal Sector

Estimated percentages of formal and informal firms using electric power, another power source, or no power source. OAME = Own Account Manufacturing Enterprise (informal enterprise that does not employ hired workers on a regular basis). NDME = Non-Directory Manufacturing Establishment (informal enterprise that employs five or fewer workers). DME = Directory Manufacturing Establishment (informal enterprise that employs six or more workers). Source: Author's calculations based on unit-level data from the Annual Survey of Industries (ASI) and Unorganised Manufacture Survey (UMS).

Table 1.9: Informal Firm Characteristics

	1989			1994			1999		
	OAME	**NDME**	**DME**	**OAME**	**NDME**	**DME**	**OAME**	**NDME**	**DME**
% of Informal Firms	90.3	9.7	N/A	85.1	9.9	4.9	85.8	10.3	4.0
% Household Income from Firm	54.0	72.0	N/A	54.0	74.0	78.0	N/A	N/A	N/A
% Firms with No Fixed Location	5.5	2.9	N/A	5.7	2.9	1.1	5.0	1.8	0.1
% Firms Located in Residence	82.5	42.2	N/A	80.2	40.9	27.5	77.5	27.1	22.3
% Firms Located Offsite	12.1	54.9	N/A	14.1	56.2	71.4	17.5	71.1	77.6
% Firms Ancillary	5.9	4.1	N/A	3.3	4.6	7.2	N/A	N/A	N/A
% Firms Perennial	94.2	96.2	N/A	95.1	95.8	82.9	92.7	95.7	83.8
% Firms Seasonal	5.4	3.4	N/A	3.4	3.9	17.1	6.0	4.2	16.1
% Firms Casual	0.4	0.2	N/A	1.1	0.3	0.1	1.3	0.1	0.1

Various characteristics of informal firms. The first row presents the percentages of informal firms of each type (OAME, NDME, DME) in each year. The second row shows the mean fraction of household income derived from the firm. Subsequent rows show the percentages of firms with various locations (no fixed location, located in residence, located offsite) as well as the percentages of firms that are ancillary to another firm, and the percentages of firms that have different operating timeframes (perennial, seasonal, casual). OAME = Own Account Manufacturing Enterprise (enterprise that does not employ hired workers on a regular basis). NDME = Non-Directory Manufacturing Establishment (enterprise that employs five or fewer workers). DME = Directory Manufacturing Establishment (enterprise that employs six or more workers). Source: Author's calculations based on unit-level data from the Unorganised Manufacture Survey (UMS).

Table 1.10: Labor Costs, Wages, Loans and Interest Rates

	Formal	**Informal**
Mean Per-Employee Labor Cost (Rs.)	27,999	5,609
Mean Per-Worker Wages (Rs.)	13,157	6,968
Firms with Outstanding Loans (%)	72.3	6.5
Mean Outstanding Loan (Rs.)	9,423,206	49,691
Mean Interest Rate (%)	26.8	16.8

Estimates of mean labor costs, wages, outstanding loans, and interest rates for formal and informal firms, 1994. Labor costs are calculated by dividing total reported labor cost by total number of employees; only firms that report positive labor costs are included. Wages are calculated by dividing total amount spent on production workers by number of production workers (formal sector) and wages paid to hired workers by number of hired workers (informal sector); only firms that report hiring production workers/hired workers are included. To calculate average outstanding loans, only firms with positive values of outstanding loans are included. Interest rates are calculated by dividing interest paid over the past year by outstanding loan amount; only firms that report positive values of outstanding loans and interest payments are included. The top and bottom 5% of wages and interest rates were dropped to mitigate the influence of outlying values. Source: Author's calculations based on unit-level data from the Annual Survey of Industries (ASI) and Unorganised Manufacture Survey (UMS).

Table 1.11: Number of Firms by Age and Size

	Size (No. Employees)								
Age (Years)	**0-4**	**5-9**	**10-19**	**20-49**	**50-99**	**100-249**	**250-499**	**500+**	**Total**
0-6	522	3,449	8,178	7,874	3,627	2,045	464	201	26,359
6-12	584	3,592	7,709	7,438	3,050	1,797	528	309	25,006
13-20	680	3,701	7,405	6,254	2,542	1,553	499	368	23,003
21+	991	4,629	7,503	6,777	3,126	2,625	1,110	1,489	28,251
Total	2,777	15,372	30,795	28,343	12,345	8,020	2,601	2,367	102,619

(a) Number of Formal Firms

	Size (No. Employees)								
Age (Years)	**0-4**	**5-9**	**10-19**	**20-49**	**50-99**	**100-249**	**250-499**	**500+**	**Total**
0-6	3,417,079	341,182	82,752	15,723	1,972	15	0	0	3,858,723
7-12	2,653,332	179,448	39,405	4,612	640	85	0	0	2,877,522
13-20	1,872,187	119,133	22,115	3,447	317	133	0	0	2,017,331
21+	2,915,938	193,910	23,930	925	57	62	0	0	3,134,821
Total	10,858,536	833,673	168,201	24,707	2,985	295	0	0	11,888,398

(b) Number of Informal Firms

Estimated number of firms in various firm age by firm size categories. Firm size is measured as the number of employees. Source: Author's calculations based on unit-level data from the Annual Survey of Industries (ASI) and Unorganised Manufacture Survey (UMS).

Table 1.12: Percent of Firms by Age and Size

	Size (No. Employees)								
Age (Years)	**0-4**	**5-9**	**10-19**	**20-49**	**50-99**	**100-249**	**250-499**	**500+**	**Total**
0-6	0.5%	3.4%	8.0%	7.7%	3.5%	2.0%	0.5%	0.2%	25.7%
7-12	0.6	3.5	7.5	7.2	3.0	1.8	0.5	0.3	24.4
13-20	0.7	3.6	7.2	6.1	2.5	1.5	0.5	0.4	22.4
21+	1.0	4.5	7.3	6.6	3.0	2.6	1.1	1.5	27.5
Total	2.7	15.0	30.0	27.6	12.0	7.8	2.5	2.3	100.0

(a) % Formal Firms

	Size (No. Employees)								
Age (Years)	**0-4**	**5-9**	**10-19**	**20-49**	**50-99**	**100-249**	**250-499**	**500+**	**Total**
0-6	28.7%	2.9%	0.7%	0.1%	0.0%	0.0%	0.0%	0.0%	32.5%
7-12	22.3	1.5	0.3	0.0	0.0	0.0	0.0	0.0	24.2
13-20	15.7	1.0	0.2	0.0	0.0	0.0	0.0	0.0	17.0
21+	24.5	1.6	0.2	0.0	0.0	0.0	0.0	0.0	26.4
Total	91.3	7.0	1.4	0.2	0.0	0.0	0.0	0.0	100.0

(b) % Informal Firms

Estimated percentages of firms in various firm age by firm size categories. Firm size is measured as the number of employees. Source: Author's calculations based on unit-level data from the Annual Survey of Industries (ASI) and Unorganised Manufacture Survey (UMS).

Table 1.13: Comparing Formal and Informal Firms: Numbers and Characteristics

	No. Firms		Firm Age		% Use Electric Power		% Have Loans		Outstanding Loans	
No. Emp.	**Formal**	**Informal**	**Formal**	**Informal**	**Formal**	**Informal**	**Formal**	**Informal**	**Formal**	**Informal**
1	108	3,698,053	30.9	18.0	68.8	5.4	59.6	3.5	8,919	0
2	380	4,562,835	19.6	23.8	78.0	5.4	39.7	5.3	295	0
3	895	1,808,827	19.0	24.0	87.6	4.5	47.3	7.8	278	1
4	1,393	795,722	20.1	25.6	94.3	5.5	48.5	8.8	296	2
5	2,138	363,220	18.6	21.4	92.6	6.0	55.6	14.3	354	10
6	2,586	198,106	16.9	18.2	95.3	5.4	60.1	16.6	390	18
7	3,159	133,603	19.0	15.7	95.0	8.7	64.3	18.4	434	27
8	3,602	85,892	17.0	15.4	95.8	7.7	66.5	23.1	458	38
9	3,890	52,974	16.0	13.6	94.8	14.8	67.5	21.9	475	43
10	4,114	46,548	16.0	13.8	95.2	8.9	69.9	18.6	598	33
11	3,729	36,923	16.1	12.0	96.1	10.4	70.7	26.8	701	41
12	3,616	19,700	16.0	13.1	95.0	16.0	72.1	20.7	697	44
13	3,502	18,217	17.0	10.2	94.6	24.1	71.9	16.5	719	50
14	3,223	10,401	14.5	13.9	94.4	9.9	73.6	20.1	964	101
15	3,037	7,728	14.6	20.1	95.8	22.9	76.4	26.8	960	32
16	2,785	10,676	14.3	8.5	96.0	9.9	77.2	35.3	1,107	71
17	2,472	9,205	14.3	9.9	95.5	6.4	74.9	56.3	1,015	94
18	2,325	3,420	14.7	10.3	94.3	12.5	76.0	29.1	1,299	100
19	1,994	5,396	15.4	7.2	95.1	3.6	78.1	49.1	1,345	177
20	1,947	3,357	15.2	9.1	94.3	9.0	75.6	20.6	1,216	48

Comparison of various characteristics (estimated number of firms, mean firm age, percentages of firms that use electric power and have outstanding loans, and mean outstanding loans) of formal and informal firms with the same number of employees, 1994. The value of outstanding loans is in thousands of Rupees; only firms that report positive values of outstanding loans are used in calculating mean outstanding loans. Source: Author's calculations based on unit-level data from the Annual Survey of Industries (ASI) and Unorganised Manufacture Survey (UMS).

Table 1.14: Comparing Formal and Informal Firms: Capital and Output

	Capital		Capital-Employee Ratio		Products		Other Receipts		Total Output	
No. Emp.	**Formal**	**Informal**	**Formal**	**Informal**	**Formal**	**Informal**	**Formal**	**Informal**	**Formal**	**Informal**
1	1015	14	1015	14	572	8	195	8	768	16
2	299	16	149	8	471	17	157	8	629	25
3	335	28	112	9	390	29	136	12	525	42
4	330	56	82	14	1140	61	134	20	1274	81
5	290	113	58	23	1012	119	204	39	1216	158
6	318	193	53	32	1344	213	175	62	1519	275
7	374	224	53	32	1820	223	204	95	2025	318
8	470	267	59	33	2144	374	267	77	2411	451
9	443	322	49	36	2647	593	240	116	2887	709
10	590	291	59	29	3274	409	321	99	3595	508
11	706	217	64	20	3892	635	369	96	4261	731
12	655	295	55	25	3971	376	424	85	4395	461
13	756	245	58	19	4481	537	442	147	4924	684
14	888	353	63	25	5730	1084	470	184	6199	1268
15	910	291	61	19	6301	590	540	117	6841	707
16	1021	381	64	24	7131	814	520	196	7650	1010
17	982	305	58	18	6491	288	565	255	7056	542
18	1152	559	64	31	7648	1059	656	199	8304	1258
19	1280	439	67	23	7765	659	673	301	8438	960
20	1619	361	81	18	8642	1027	650	118	9292	1145

Comparison of various characteristics (mean values of capital, capital-employee ratio, products, other receipts, and total output) of formal and informal firms with the same number of employees, 1994. All values are in thousands of Rupees. The capital-employee ratio is capital divided by the number of employees. Source: Author's calculations based on unit-level data from the Annual Survey of Industries (ASI) and Unorganised Manufacture Survey (UMS).

Chapter 2

The Impact of Trade Liberalization on Productivity and Firm Size

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 chapter, 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 approximately 80% of Indian manufacturing employment. 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 16%, 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 over 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 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 study, 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 (output) distributions empirically, I employ a quantile regression technique that allows me to simulate and compare the densities 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 entry of informal firms into non-comparative-advantage 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.

This study contributes to the empirical literature on trade and firm productivity. Theory suggests that trade liberalization may either increase or decrease productivity.[1] 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, formal 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 et al. (2000) do not, even though both use data on large firms in a similar set of industries. More recently, Sivadasan (2009) 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.[2] My difference-in-differences strategy is similar to hers, and I

[1] 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 2.1 for a description of how two such models - DR-M and MO - yield contrasting predictions).

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

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 study 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 chapter is organized as follows. Section 2.1 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 2.2 presents an overview of India's trade liberalization and discusses the tariff data that I use, while Section 2.3 provides an overview of the combined formal and informal firm dataset. Section 2.4 presents the empirical strategy and results, and Section 2.5 concludes.

2.1 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.

2.1.1 Free Entry Equilibrium with Costly Trade

2.1.1.1 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.[3]

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:

$$DR\,and\,MO : G(\phi) = 1 - [b/\phi]^{\beta}, \phi > b \tag{2.1}$$

2.1.1.2 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:

$$DR : q(\nu) = RP^{\sigma-1}[p(\nu)]^{-\sigma}, q_m(\nu') = RP^{\sigma-1}[\tau_H p_m(\nu')]^{-\sigma} \tag{2.2}$$

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:

$$MO : q(\nu) = \frac{\alpha - p(\nu) - \eta Q}{\gamma} \tag{2.3}$$

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.

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

[3] 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.

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.

2.1.1.3 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:

$$DR: q_D = \frac{f[\sigma-1]}{[\phi^*]^{\sigma-1}}\phi^\sigma \qquad q_X = \frac{f_{exp}[\sigma-1]}{[\phi_x^*]^{\sigma-1}}\phi^\sigma \tag{2.4}$$

$$MO: q_D = \frac{L_H}{2\gamma}[\frac{1}{\phi^*} - \frac{1}{\phi}] \qquad q_X = \frac{L_F}{2\gamma}\tau_F[\frac{1}{\phi_x^*} - \frac{1}{\phi}] \tag{2.5}$$

In Equation 2.4, f is the fixed cost of production, while in Equation 2.5, L_H and L_F are the sizes of the Home and Foreign markets. Note that Equations 2.4 and 2.5 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 (output). Let average productivity be a simple, unweighted function of the productivity of surviving firms; then the average productivity in both models is:[4]

$$DR\,and\,MO: \overline{\phi} = \frac{\int_{\phi^*}^{\infty}\phi dG(\phi)}{1-G(\phi^*)} = \frac{\beta\phi^*}{\beta-1} \tag{2.6}$$

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:

$$DR: \overline{q_D} = \frac{f[\sigma-1]\beta}{\beta-\sigma}\phi^* \qquad \overline{q_X} = \frac{f_{exp}[\sigma-1]\beta}{\beta-\sigma}\phi_x^* \tag{2.7}$$

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

$$MO : \overline{q_D} = \frac{L^H}{2\gamma} \frac{1}{[\beta + 1]} \frac{1}{\phi^*} \qquad \overline{q_X} = \frac{L^F}{2\gamma} \frac{1}{[\beta + 1]} \tau^F \frac{1}{\phi_x^*} \tag{2.8}$$

In DR-M, average domestic firm size (output) increases with a rise in the domestic productivity cutoff ϕ^*, whereas the opposite occurs in MO. Equations 2.4 and 2.5 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.

2.1.2 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 (output), 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 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 2.6, 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 2.7 and 2.8, 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:

$$DR : q_D(\phi = \phi^*) = f[\sigma - 1]\phi^* \tag{2.9}$$

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 2.5). Therefore, the left tail of the size distribution does not shift.

Right tail of the firm size (output) distribution. In DR-M, Equation 2.4 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 2.5 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.[5]

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

Table 2.1 summarizes these predictions. In the following sections, I describe how I will look for evidence of these effects in the Indian case.

2.2 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,

[5] 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.

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 foreign direct investment (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 two sources: first, the Government of India's Customs Tariff Working Schedules, and second, the Trade Analysis and Information System (TRAINS) database maintained by the United Nations Conference on Trade and Development (UNCTAD). Both sources provide rates 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 2.2 shows average final goods tariffs for broad manufacturing industry groups in 1989, 1994, and 1999. Panel (a) of Figure 2.1 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 2.1). 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 2.3.1, 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).

Tables 2.3 and 2.4 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, Table 2.5 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.[6]

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 2.1 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 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.

2.3 Data Sources

As discussed in Chapter 1, I have constructed a linked formal-informal firm database that provides three snapshots of the entire manufacturing industry during the period of the trade reforms. For the analyses in this chapter, I classify firms as formal if they appear in the organized sector survey (ASI), regardless of their employment size. Formal firms with fewer than 10 employees may include firms that used to have 10 or more employees and subsequently shrank, firms that plan to grow, or firms that have closed. I exclude firms that are reported to be closed, but I retain other organized (formal) firms that have fewer than 10 employees. Similarly, a few firms in the unorganized sector survey (approximately 0.5% in each year) report having more than 20 employees. 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 to the dataset described in Chapter 1 is in defining manufacturing firms as those that produce physical products. A number of firms in both sectors (though predominantly in the informal sector) do not report revenue from selling products; the source of their revenue is uncertain, but likely comes from providing services. I restrict my analysis to firms that use raw materials to produce physical products in order to improve the comparability of the formal

[6] 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 1950's by its Second Five-Year Plan, and that industrial protection patterns have not significantly changed since then.

and informal datasets and to focus on manufacturing firms.[7] I then combine the firm-level data with tariff data (discussed in Section 2.2) at the 3-digit NIC-87 industry level using the concordance table developed by Debroy and Santhanam (1993).

Table 2.6 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 (2009).[8] Output is the total value of manufactured products, deflated using industry-level price deflators.[9] 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 2.2).

2.3.1 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:

$$\begin{aligned} TFP_{ijt} \quad = \quad & \underbrace{(q_{ijt} - \overline{q_{jt}})}_{deviation\,from\,avg.\,q} \quad + \underbrace{\sum_{r=2}^{t}(\overline{q_{jr}} - \overline{q_{jr-1}})}_{yearly\,change\,in\,q} \\ & -[\underbrace{\sum_{k=1}^{K}\frac{1}{2}(S_{ijt}^{k} + \overline{S_{jt}^{k}})(k_{ijt} - \overline{k_{jt}})}_{deviation\,from\,avg.\,k} + \underbrace{\sum_{r=2}^{t}\sum_{k=1}^{K}\frac{1}{2}(\overline{S_{jr}^{k}} + \overline{S_{jr-1}^{k}})(\overline{k_{jr}} - \overline{k_{jr-1}})}_{yearly\,change\,in\,k}\,] \end{aligned} \qquad (2.10)$$

where
q_{ijt}=log of output
S_{ijt}^{k}=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

[7] 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.

[8] 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 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 $K_{jt}/K_{j,1989}$.

[9] As a robustness check, in Section 2.4.4 I use the method suggested by Hsieh and Klenow (2009) to account for differential firm pricing by assuming particular values for the elasticity of substitution between goods.

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).[10]

Panels (a)-(d) of Figure 2.2 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 just above 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.

2.4 Empirical Strategy and Results

2.4.1 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:

$$y_{ijt} = \beta_1 \tau_{jt} + \beta_2 \tau_{jt}^I + X_{ijt} + \alpha_j + \alpha_t + \varepsilon_{ijt} \tag{2.11}$$

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_{jt}^I=input tariff, as a negative fraction
X_{ijt}=firm characteristics
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. Since I am interested in estimating the effects

[10]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.

of trade on the population of firms, I use the multipliers to re-weight firm-level observations in all of my analyses.

Table 2.7 presents results. All specifications include year and industry fixed effects, and standard errors are clustered at the state-industry level.[11] Column (1) includes only final goods tariffs (not 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 0.31, or 15.5% 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 (8) 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 approximately 5%, but increases average informal sector productivity by 16%. The firm-level controls included in Columns (5) and (8) indicate that new firms (firms that have operated for fewer than three years) are less productive in both the formal and informal sectors, that informal firms that do not use electric power are less productive than other informal firms, and that urban firms are more productive than rural firms.

Table 2.8 shows similar results for firm size (output). When controlling for input tariffs, a 50 percentage point fall in final goods tariffs increases average firm size by approximately 25%. Average formal firm size decreases by approximately 16%, while average informal firm size increases by approximately 26%. 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 average productivity and firm size (output) 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 average productivity by 32% and average firm size (output) by 55% 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.

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

I now explore whether changes in the productivity and firm size (output) distributions are consistent with the entry/exit and reallocation mechanisms suggested by the DR-M and MO models. In

[11] The standard errors are similar, and significance levels do not change, when I use the multi-way clustering method developed by Cameron, Gelbach and Miller (2006) to account for within-industry clustering across states, as well as within-state clustering across industries.

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 2.4.1 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.

I use a quantile regression (QR) framework to estimate the effects of final goods tariffs on various percentiles of the productivity and firm size (output) distributions. Let $z'_{ijt} = (\tau_{jt}, \tau^I_{jt}, \alpha'_j, \alpha'_t)'$, and Equation 2.11 can be modified to allow the effects of the covariates to vary across percentiles:

$$y_{ijt} = z'_{ijt}\beta_\theta + \varepsilon_{\theta_{ijt}} \tag{2.12}$$

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:

$$Q_\theta(y_{ijt}|z_{ijt}) \equiv \inf\{y|F_{ijt}(y|z) \geq \theta\} = z'_{ijt}\beta(\theta) \tag{2.13}$$

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:

$$n^{-1}\sum_{i=1}^{n}\rho_\theta(y_{ijt} - z'_{ijt}\beta_\theta), \quad \rho_\theta(u) = \begin{cases}\theta u & u > 0\\ (\theta-1)u & u \leq 0\end{cases} \tag{2.14}$$

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:

$$\frac{\partial Q_\theta(y_{ijt}|z_{ijt})}{\partial z^k_{ijt}} = \widehat{\beta^k_\theta} \tag{2.15}$$

I conduct quantile regressions for TFP and firm size in the formal and informal sectors individually, at every 5th percentile of the distributions.[12] As in the baseline analysis, I use the multipliers to re-weight firm-level observations in the quantile regression framework.

Figures 2.3 and 2.4 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.[13] 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.

[12] 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.

[13] 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 $\sqrt{m/n}$.

Panel (a) of Figure 2.3 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, most of which are found in the informal sector (see Panel (d) of Figure 2.2). I would not have found this result if I had only considered formal firms; Panel (b) of Figure 2.3 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.

Figure 2.4 indicates that firm size (output) 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 (output) 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.[14] 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 2.5 shows the simulated productivity densities. When final goods tariff fall, the TFP density in the informal sector shifts right, while the density in the formal sector shifts left. Kolmogorov-Smirnov tests for the equality of distributions strongly reject that the 1989 and counterfactual 1999 densities are the same, for both the informal and formal sectors. Since there is considerable overlap between the productivity 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 density offsets the left shift in the formal sector productivity density 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 2.6 show the counterfactual firm size (output) densities and the

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

changes in densities (1999 minus 1989). In this case, there is little overlap between the two sectors' firm sizes, so the rightward shift of the informal sector complements the leftward shift of the formal 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 density, there is virtually no effect, which is consistent with the results shown in Figure 2.4.

Table 2.9 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 productivity and firm size (output) both increase. Informal firms constitute the bulk of the least productive firms (see Panel (d) of Figure 2.2); 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.

2.4.3 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 (output) 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 formal firms face barriers to exit; 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, while the amendments regulating disputes may affect output to a greater extent.[15] If labor regulations are responsible for creating barriers to exit for formal firms, then I would expect

[15] In related work, Hasan et al. (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.

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. This information is available for all three years in the formal sector, and for 1989 and 1994 in the informal sector. 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:

$$s_{jst} = \beta_1 \tau_{jt} + \beta_2 \tau_{jt}^I + \alpha_j + \alpha_s + \alpha_t + \varepsilon_{jst} \tag{2.16}$$

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 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 2.10 presents results. Columns (1)-(4) present results for the formal sector from 1989 to 1994, Columns (5)-(8) present results for the formal sector from 1989 to 1999, and Columns (9)-(12) present results for the informal sector from 1989 to 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 2.16 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 2.11 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):[16]

$$RCA = \frac{X_j^{India} / \sum_j X_j^{India}}{X_j^{World} / \sum_j X_j^{World}} \tag{2.17}$$

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

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 2.11 present results. I find that the fall in final goods tariffs is associated with net entry of formal firms into RCA industries, and the net entry of informal firms into non-RCA industries. This suggests that at least part of the drop in productivity in the formal sector may be due to the entry 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 2.7 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 2.11 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.

The net entry of firms into the formal sector in comparative-advantage industries is consistent with the idea that trade liberalization might encourage firms to formalize 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 Table 2.7 indicates 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 formal firms, even in non-comparative-advantage industries, 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.

2.4.4 Robustness Checks

In this section (as well as in Appendices 2.A and 2.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 alternate index number methods. I then develop two additional estimates of TFP based on one-stage and two-stage ordinary least squares (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 (2009). 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 2.A discusses each of these productivity measures in detail, and Table 2.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 2.2, 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 2.B.1, I find some evidence that NTB liberalization magnifies the effect of the fall in tariffs on firm productivity in both sectors.

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 2.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 2.2, 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 2.2 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.

2.5 Conclusion

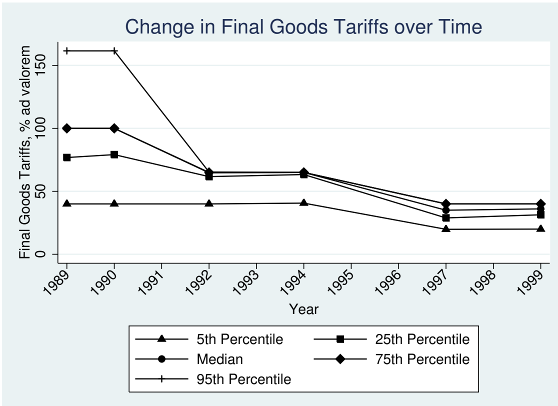
This study is the first to consider the effects of India's tariff liberalization on the entire manufacturing industry, including large, formal firms, as well as small, informal firms. I construct a unique dataset that combines firm-level data on formal and informal firms from 1989, 1994, and 1999, a 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 study is to show that the increase in average productivity is driven by the informal sector: the fall in final goods tariffs raises productivity by approximately 16% in the informal sector while lowering productivity by approximately 5% in the formal sector. However, I also find that the concurrent fall in input tariffs increases average productivity by over 30% among formal firms. Therefore, the overall effect of the trade reforms is to increase productivity in both sectors.

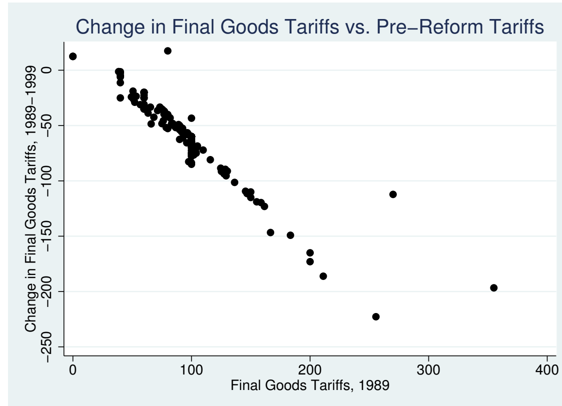
I then employ quantile regression techniques to examine whether changes in the distributions of productivity and firm size (output) are consistent with entry and exit among the smallest, least productive firms, as well as a reallocation of market share among surviving firms, as suggested by two recent 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 (output) 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 80% of India's manufacturing workers, understanding how trade reforms affect this sector is a key component in understanding India's post-reform growth.

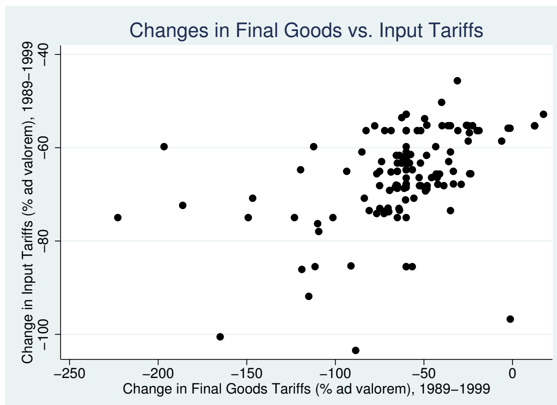
Figure 2.1: Tariff Reforms



(a) Change in Final Goods Tariffs



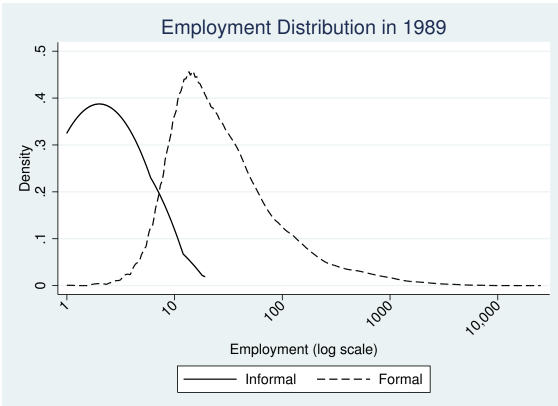
(b) Change in Tariffs vs. Pre-Reform Tariffs



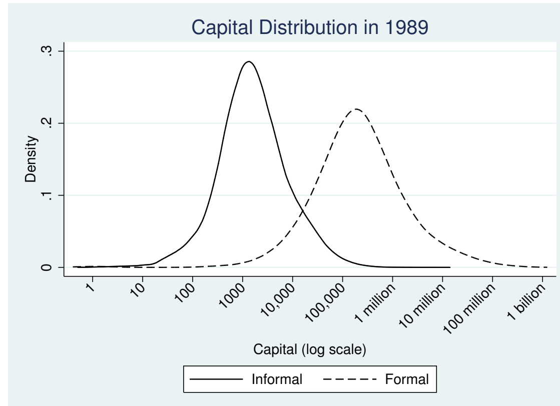
(c) Changes in Final Goods vs. Input Tariffs

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.

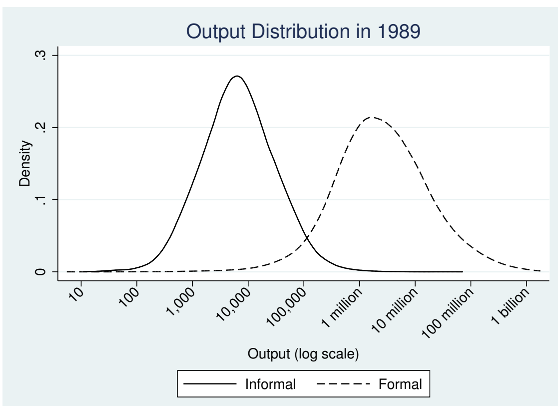
Figure 2.2: Distributions of Key Variables in the Formal and Informal Sectors



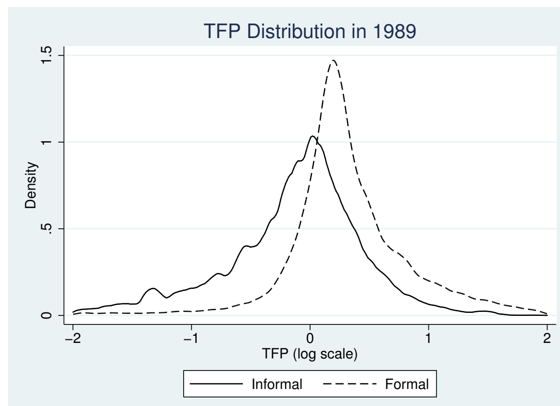
(a) Employment



(b) Capital



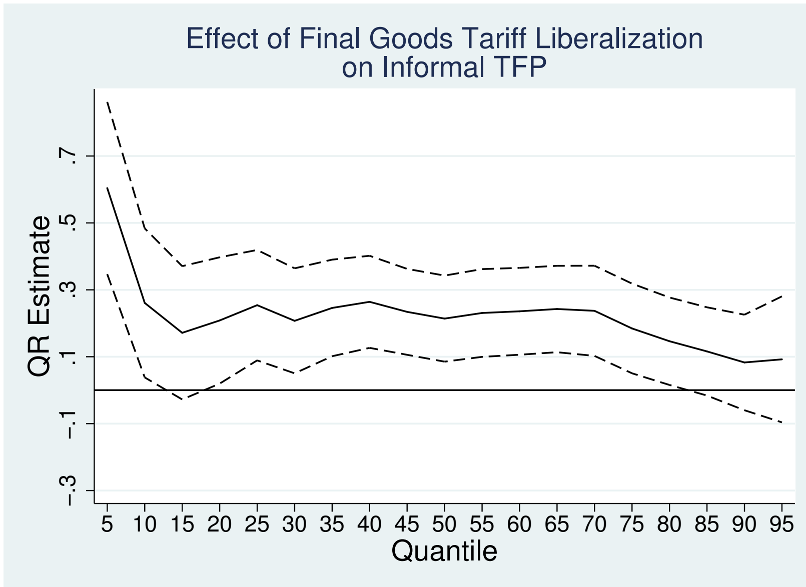
(c) Output



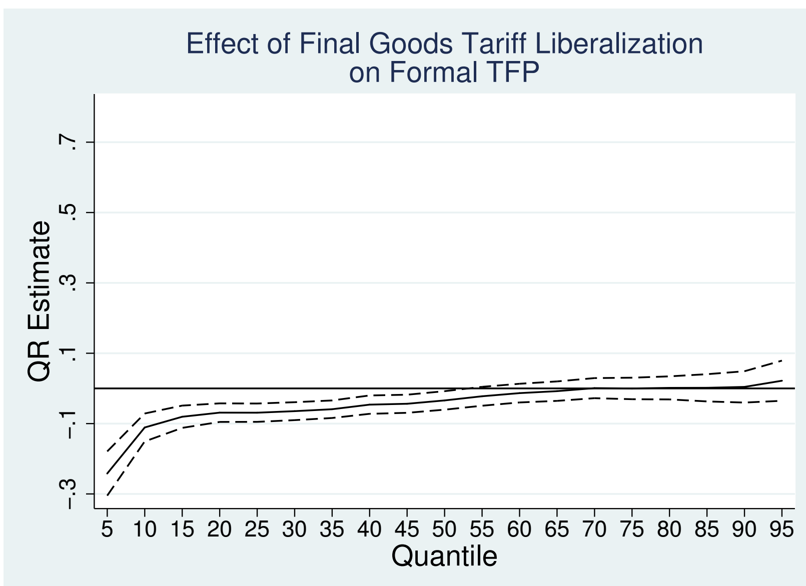
(d) Total Factor Productivity

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 unit-level data from the Annual Survey of Industries (ASI) and Unorganised Manufacture Survey (UMS).

Figure 2.3: Effect of a Fall in Final Goods Tariffs on Various Quantiles of the Productivity Distributions



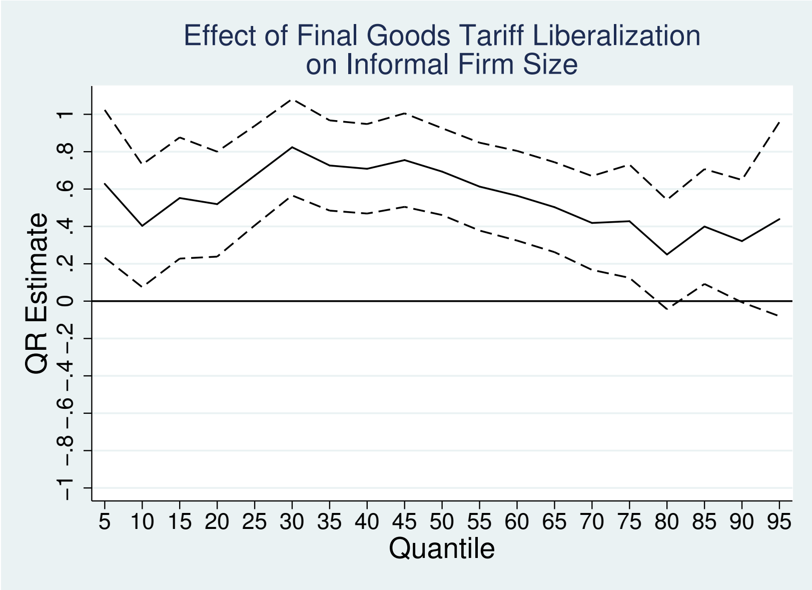
(a) Informal Sector



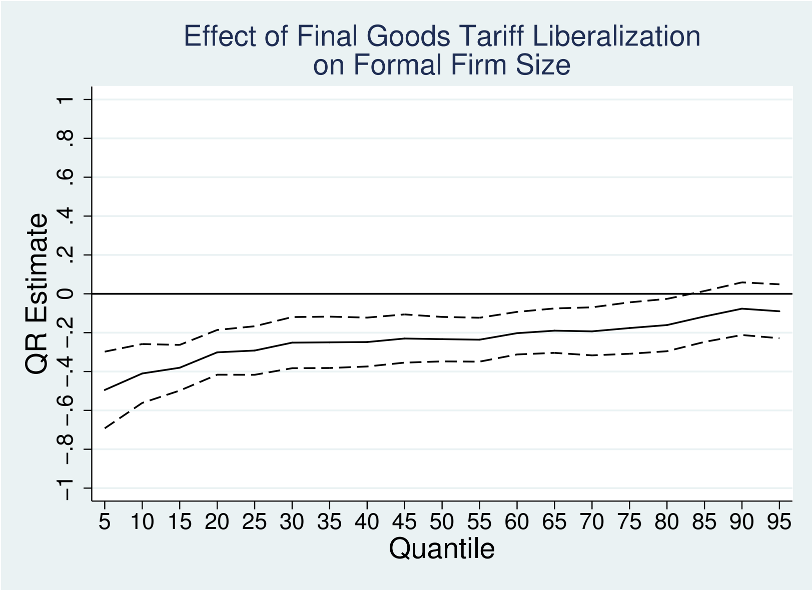
(b) Formal Sector

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 2.4: Effect of a Fall in Final Goods Tariffs on Various Quantiles of the Firm Size (Output) Distributions



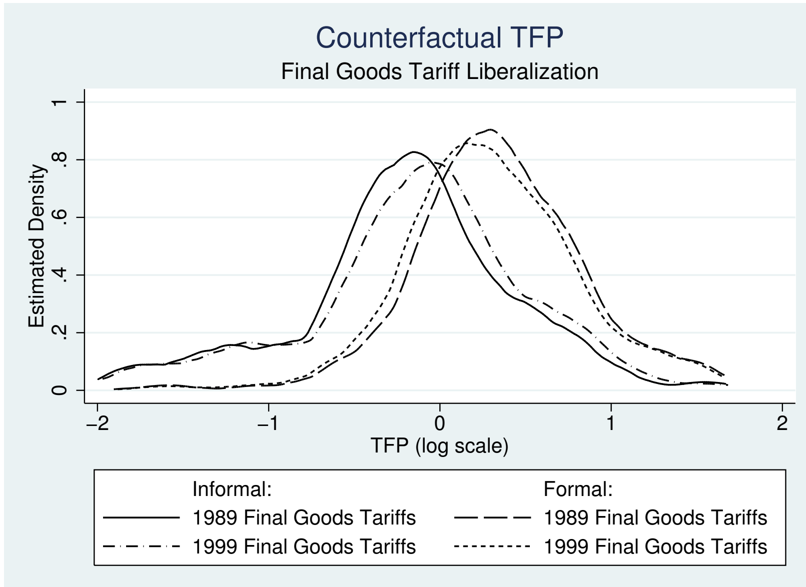
(a) Informal Sector



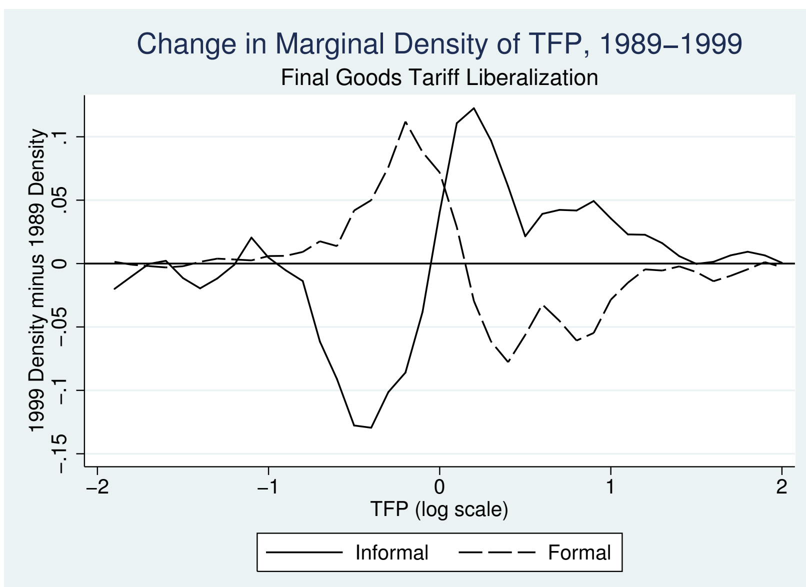
(b) Formal Sector

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 2.5: Simulated Pre-Reform and Post-Reform Productivity Densities



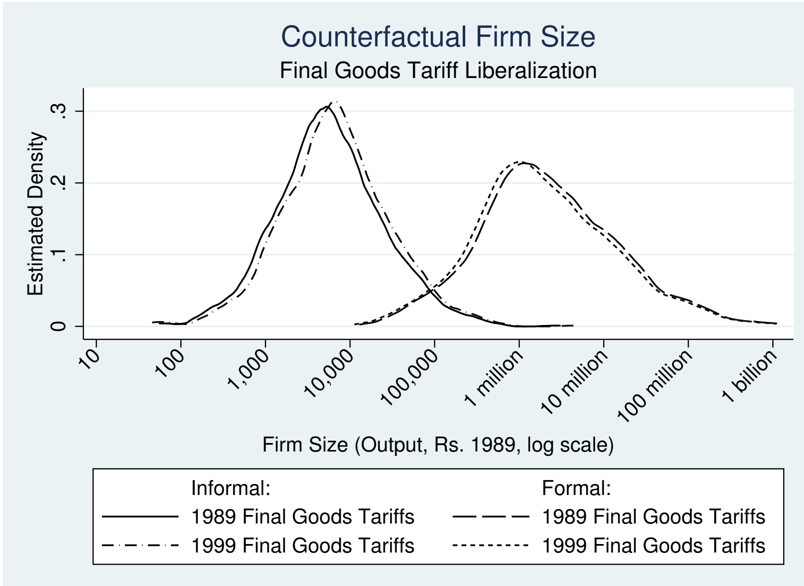
(a) Simulated Productivity Densities



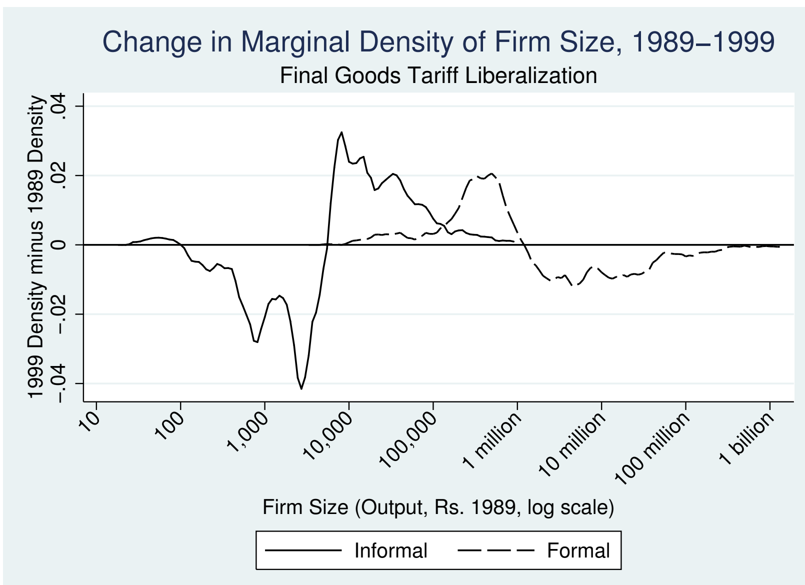
(b) Changes in Productivity Densities

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 2.6: Simulated Pre-Reform and Post-Reform Firm Size (Output) Densities



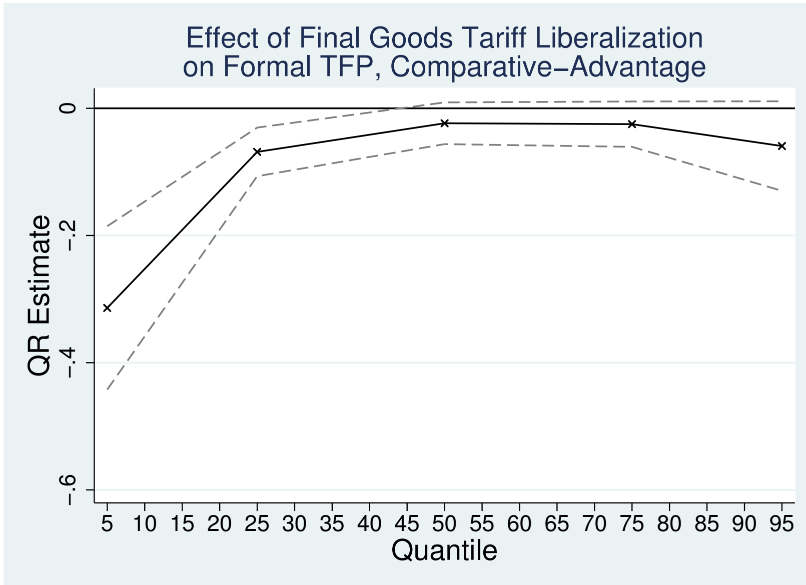
(a) Simulated Firm Size (Output) Densities



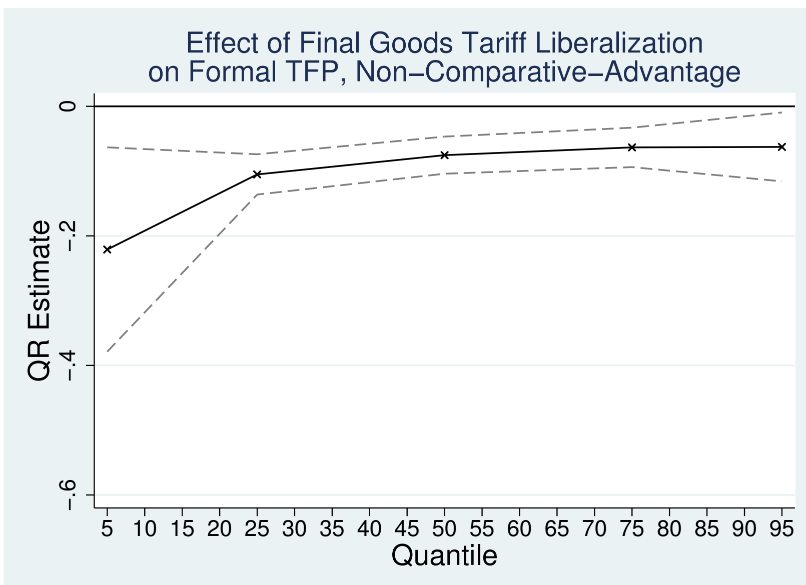
(b) Changes in Firm Size (Output) Densities

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 2.7: 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.

Table 2.1: 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 (output)	-/+	-/+
Left tail of firm size (output) distribution	+	0
Right tail of firm size (output) distribution	-/+	-/+
Change in size (output) of largest firms relative to mid-sized firms	Less negative	Less positive

Summary of predicted changes in the productivity and firm size (output) 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 2.2: 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 and the Trade Analysis and Information System (TRAINS) database maintained by the United Nations Conference on Trade and Development (UNCTAD).

Table 2.3: Tariff Changes and Pre-Reform Industrial Characteristics: Informal Sector

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

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
log(Average TFP)	-0.017						0.024
	(0.17)						(0.28)
log(Average Firm Size)		0.013					0.022
		(0.027)					(0.051)
log(Average K-L Ratio)			0.0046				-0.020
			(0.028)				(0.056)
log(Average Wage)				-0.0031			-0.036
				(0.070)			(0.072)
Export Share in Output					0.0036		0.0063
					(0.027)		(0.012)
log(No. Firms)						-0.013	-0.015
						(0.013)	(0.020)
Observations	135	135	135	135	135	135	135
R^2	0.000	0.002	0.000	0.000	0.000	0.008	0.011

Correlation between pre-reform, informal sector characteristics in 1989 and tariff changes from 1989-1999. "K-L Ratio" is capital per employee. Standard errors are in parentheses. *, **, and *** represent significance at the 10%, 5% and 1% levels, respectively.

Table 2.4: Tariff Changes and Pre-Reform Industrial Characteristics: Formal Sector

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

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
log(Avg. TFP)	0.063							0.11
	(0.10)							(0.11)
log(Avg. Firm Size)		0.054**						0.034
		(0.026)						(0.034)
log(Avg. K-L Ratio)			0.091**					0.11***
			(0.040)					(0.043)
log(Avg. Wage)				0.11				-0.064
				(0.088)				(0.11)
Export Share in Output					0.0035			0.021
					(0.027)			(0.016)
log(No. Firms)						0.038*		0.049
						(0.023)		(0.036)
C4 Ratio							-0.19	-0.083
							(0.16)	(0.22)
Observations	138	138	138	138	138	138	138	138
R^2	0.003	0.030	0.037	0.011	0.000	0.020	0.010	0.094

Correlation between pre-reform, formal sector characteristics in 1989 and tariff changes from 1989-1999. "K-L Ratio" is capital per employee. "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 2.5: Tariff Changes and Pre-Reform Changes in Industrial Characteristics: Formal Sector

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

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
log(Average TFP)	0.023							0.024
	(0.033)							(0.041)
log(Average Firm Size)		0.011						0.023
		(0.058)						(0.059)
log(Average K-L Ratio)			-0.023					-0.057
			(0.079)					(0.064)
log(Average Wage)				0.14				0.12
				(0.17)				(0.21)
Export Share in Output					0.14			0.15
					(0.32)			(0.15)
log(No. Firms)						-0.0087		-0.030
						(0.055)		(0.081)
C4 Ratio							-0.089	-0.26
							(0.23)	(0.32)
Observations	122	122	122	122	122	122	122	122
R^2	0.004	0.000	0.001	0.005	0.002	0.000	0.001	0.017

Correlation between *changes* in pre-reform, formal sector characteristics from 1986-1989 and tariff changes from 1989-1999. "K-L Ratio" is capital per employee. "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 2.6: Summary Statistics for Firm-Level Data

	Mean	St. Dev.	Minimum	Maximum
Formal Sector				
Labor (number of Employees)	139.58	604.67	1	40,473
Capital (thousands of Rs. 1989)	5,539	29,000	0.00	1,150,000
Material (thousands of Rs. 1989)	27,600	86,400	0.01	1,940,000
Output (thousands of Rs. 1989)	32,000	106,000	0.00	5,160,000
No. Observations	97,118			
Informal Sector				
Labor (number of Employees)	3.12	2.51	1	20
Capital (thousands of Rs. 1989)	25.62	101.19	0.00	12,900
Material (thousands of Rs. 1989)	111.69	716.84	0.00	73,200
Output (thousands of Rs. 1989)	119.99	642.21	0.01	69,700
No. Observations	184,239			

Summary statistics for formal and informal firm-level data. Only firms that use material inputs and receive revenue from products are included. Data from 1989, 1994 and 1999 are pooled. Capital, material and output are deflated as discussed in Section 2.3. Source: Author's calculations based on unit-level data from the Annual Survey of Industries (ASI) and Unorganised Manufacture Survey (UMS).

Table 2.7: Effect of a Fall in Tariffs on Average Productivity

Dependent Variable: Log of Total Factor Productivity

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All	All	Formal	Formal	Formal	Informal	Informal	Informal
Fall in Final Goods Tariffs	0.39***	0.31***	0.0065	-0.11***	-0.12***	0.40***	0.32***	0.32***
	(0.074)	(0.088)	(0.020)	(0.024)	(0.025)	(0.075)	(0.091)	(0.088)
Fall in Input Tariffs		0.57		0.65***	0.70***		0.59	0.52
		(0.54)		(0.096)	(0.10)		(0.57)	(0.55)
New Firm					-0.085***			-0.10***
					(0.013)			(0.025)
Public Firm					0.016			
					(0.015)			
No Electric Power					-0.030			-0.21***
					(0.040)			(0.026)
Urban					0.032***			0.19***
					(0.0072)			(0.034)
Observations	280202	280202	96942	96942	87340	183260	183260	183192
R^2	0.086	0.086	0.256	0.258	0.263	0.087	0.088	0.117

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 2.8: Effect of a Fall in Tariffs on Firm Size (Output)

Dependent Variable: Log of Firm Size (Output)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All	All	Formal	Formal	Formal	Informal	Informal	Informal
Fall in Final Goods Tariffs	0.66***	0.51***	-0.12**	-0.32***	-0.35***	0.70***	0.53***	0.57***
	(0.15)	(0.18)	(0.051)	(0.061)	(0.068)	(0.15)	(0.19)	(0.17)
Fall in Input Tariffs		1.01		1.11***	1.19***		1.16	0.86
		(0.97)		(0.21)	(0.24)		(1.02)	(0.90)
New Firm					-0.13***			-0.16***
					(0.035)			(0.045)
Public Firm					0.85***			
					(0.061)			
No Electric Power					-0.98***			-1.00***
					(0.13)			(0.057)
Urban					-0.24***			0.64***
					(0.032)			(0.059)
Observations	281496	281496	97118	97118	87513	184378	184378	184310
R^2	0.401	0.402	0.193	0.194	0.213	0.393	0.394	0.475

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 2.9: 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 (output)	-/+	-/+	+	-	+
Left tail of firm size (output) distribution	+	0	+	-	+
Right tail of firm size (output) distribution	-/+	-/+	+	-	-
Change in size (output) 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 (output) 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 2.10: Effect of a Fall in Tariffs on the Number of Survivors

Dependent Variable: Log of the Number of Survivors

	(1) Formal 89-94	(2) Formal 89-94	(3) Formal 89-94	(4) Formal 89-94	(5) Formal 89-99	(6) Formal 89-99	(7) Formal 89-99	(8) Formal 89-99	(9) Informal 89-94	(10) Informal 89-94	(11) Informal 89-94	(12) Informal 89-94
Fall in FG Tariffs	-0.0075	-0.030	-0.011	-0.033	-0.070	-0.070	-0.035	-0.071	-0.10	-0.024	-0.28*	-0.036
	(0.044)	(0.047)	(0.054)	(0.047)	(0.048)	(0.054)	(0.056)	(0.055)	(0.13)	(0.15)	(0.16)	(0.15)
Fall in Tariffs x Labor		0.0100				0.021				0.14**		
		(0.018)				(0.017)				(0.057)		
Fall in Tariffs x Adjust			-0.038				-0.070				0.62***	
			(0.059)				(0.055)				(0.15)	
Fall in Tariffs x Dispute				0.048				0.031				0.20
				(0.054)				(0.054)				(0.13)
Observations	4797	3912	3912	3912	6408	5232	5232	5232	3633	2765	2765	2765
R^2	0.623	0.637	0.637	0.637	0.578	0.574	0.574	0.574	0.582	0.577	0.578	0.577

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. "FG" indicates final goods 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 2.11: 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	-0.048	-0.078	-0.086	-0.039	-0.089	0.21*	0.26**	0.18	0.091	0.18
	(0.051)	(0.053)	(0.060)	(0.062)	(0.062)	(0.11)	(0.11)	(0.12)	(0.13)	(0.12)
Fall in Tariffs x RCA		0.18***	0.26***	0.27***	0.27***		-0.21*	-0.31**	-0.36**	-0.29**
		(0.064)	(0.071)	(0.095)	(0.073)		(0.13)	(0.14)	(0.18)	(0.14)
Fall in Tariffs x Labor			0.021					0.088*		
			(0.019)					(0.046)		
Fall in Tariffs x Adjust				-0.090					0.25*	
				(0.064)					(0.14)	
Fall in Tariffs x Dispute					0.075					0.089
					(0.065)					(0.11)
Fall in Tariffs x RCA x Labor			-0.10**					-0.048		
			(0.043)					(0.095)		
Fall in Tariffs x RCA x Adjust				-0.027					0.097	
				(0.14)					(0.26)	
Fall in Tariffs x RCA x Dispute					-0.24*					-0.23
					(0.13)					(0.23)
Observations	6762	6762	5404	5404	5404	6029	6029	4480	4480	4480
R^2	0.597	0.597	0.607	0.605	0.605	0.573	0.573	0.572	0.572	0.573

Unit of analysis is a state-by-industry cluster. Final goods tariffs are measured as negative fractions, 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 2.A: Alternate Productivity Measures

As discussed in Section 2.3.1, 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 productivity measures.

The baseline TFP index number method allows cost shares to vary across industries, but requires them to be the same for the formal and informal sectors. The first robustness check allows cost shares to vary across the formal and informal sectors. Second, 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.[17] The results of the three index number methods (cost shares that are the same for the formal and informal sectors, cost shares that vary across the formal and informal sectors, and revenue shares) are shown in Columns (1), (2), and (3) of Tables 2.A.1 and 2.A.2. A 50 percentage point fall in final goods tariffs reduces average TFP in the formal sector by 3-8%, while increasing average TFP in the informal sector by around 16-17%. 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:

$$q_{ijt} = \beta_0 + \beta_l l_{ijt} + \beta_m m_{ijt} + \beta_k k_{ijt} + \mu_{ijt} \tag{2.18}$$

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:

$$\widehat{tfp_{ijt}} \equiv q_{ijt} - \widehat{\beta}_0 - \widehat{\beta}_l l_{ijt} - \widehat{\beta_m} m_{ijt} - \widehat{\beta}_k k_{ijt} \tag{2.19}$$

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

$$\widehat{tfp_{ijt}} = \beta_1 \tau_{jt} + \beta_2 \tau^I_{jt} + \alpha_j + \alpha_t + \varepsilon_{ijt} \tag{2.20}$$

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 (4) and (5) of Tables 2.A.1 and 2.A.2 present results for both OLS methods. In the formal sector, the coefficients on both final goods tariffs (-0.06 and -0.08) and input tariffs (0.44 and 0.59) are somewhat attenuated relative to the baseline results, but remain highly significant. In Column (5), 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 on final goods tariffs (0.29 and 0.30) are slightly attenuated

[17] 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 $S^k = 1 - S^l - S^m$.

relative to the baseline results, while the coefficients on input tariffs (0.73 and 0.81) 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 (1.01), 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:

$$\begin{aligned} q_{ijt} &= \beta_1 \tau_{jt} + \beta_2 \tau^I_{jt} + \alpha_j + \alpha_t + \beta_l l_{ijt} + \beta_m m_{ijt} + \beta_k k_{ijt} + \omega_{ijt} + \eta_{ijt} \\ &= \beta_1 \tau_{jt} + \beta_2 \tau^I_{jt} + \alpha_j + \alpha_t + \beta_l l_{ijt} + \beta_m m_{ijt} + \beta_k k_{ijt} + h_t(\iota_{ijt}, k_{ijt}) + \eta_{ijt} \qquad (2.21) \end{aligned}$$

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 2.21 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 2.19 and 2.20. As in the two-stage OLS procedure, I allow β_l, β_m, and β_k to vary across industries.

Columns (6) and (7) of Table 2.A.1 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 5.5% in the baseline case). In Column (6), 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 did 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 (8) in Table 2.A.1, and Column (6) in Table 2.A.2, show the modified LP results for the formal and informal sectors, respectively. In the formal sector, the coefficients on final goods tariffs and input tariffs (-0.08 and 0.53, respectively) have the same sign as the baseline results and are similar in magnitude. In the informal sector, the LP coefficient on final goods tariffs (0.30) is similar to the baseline result, while the coefficient on input tariffs (0.68) is slightly larger than the baseline result and is statistically significant.

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 (2009) 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 (9) and (10) in Table 2.A.1, and Columns (7) and (8) in Table 2.A.2, show the results for the formal and informal sectors, respectively. For both values of σ, a fall in final goods tariffs decreases formal sector productivity and increases informal sector productivity.

Finally, I use labor productivity (the log of output per number of employees) as an alternate measure of productivity. While labor productivity is likely to overstate the productivity of larger, more capital-intensive firms, it allows me to avoid calculating capital inputs. Column (11) in Table 2.A.1 and Column (9) in Table 2.A.2 show a similar pattern as the TFP results, with a fall in final goods tariffs decreasing formal labor productivity by 10% 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 2.A.1: Alternate Total Factor Productivity Measures: Formal Sector

	(1) IN-1	(2) IN-2	(3) IN-3	(4) OLS-1	(5) OLS-2	(6) OP-1	(7) OP-2	(8) LP	(9) σ Low	(10) σ High	(11) Labor Prod.
Fall in FG Tariffs	-0.11***	-0.06***	-0.16***	-0.06***	-0.08***	-0.06***	-0.06***	-0.08***	-0.27***	-0.15***	-0.21***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.05)	(0.03)	(0.05)
Fall in Input Tariffs	0.65***	0.53***	0.84***	0.44***	0.59***	0.48***	0.46***	0.53***	1.20***	0.77***	0.73***
	(0.10)	(0.09)	(0.11)	(0.08)	(0.09)	(0.08)	(0.08)	(0.08)	(0.18)	(0.11)	(0.16)
log(Employment)					0.18***	0.15***		0.14***			
					(0.02)	(0.01)		(0.01)			
log(Materials)					0.84***	0.82***					
					(0.01)	(0.01)					
log(Capital)					0.02***						
					(0.00)						
Observations	96942	96942	96942	97118	97118	69080	97118	97118	96942	96942	97118
R^2	0.258	0.172	0.268	0.071	0.919	0.916	0.904	0.466	0.414	0.320	0.230

"FG" indicates final goods tariffs. "IN-1", "IN-2" and "IN-3" indicate that the dependent variable is total factor productivity (TFP), which is calculated using various versions of an index number method based on Aw et al. (2001). "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. "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 (2009). "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.

Table 2.A.2: Alternate Total Factor Productivity Measures: Informal Sector

	(1) IN-1	(2) IN-2	(3) IN-3	(4) OLS-1	(5) OLS-2	(6) LP	(7) σ Low	(8) σ High	(9) Labor Prod.
Fall in Final Goods Tariffs	0.32***	0.32***	0.35***	0.29***	0.30***	0.30***	0.58***	0.38***	0.43**
	(0.09)	(0.09)	(0.10)	(0.08)	(0.09)	(0.08)	(0.18)	(0.11)	(0.18)
Fall in Input Tariffs	0.59	0.60	0.61	0.73***	0.81***	0.68***	1.17	0.72	1.01
	(0.57)	(0.57)	(0.58)	(0.18)	(0.22)	(0.20)	(1.06)	(0.68)	(0.95)
log(Employment)					0.22***	0.18***			
					(0.02)	(0.02)			
log(Materials)					0.72***				
					(0.02)				
log(Capital)					0.07***				
					(0.01)				
Observations	183260	182275	183260	184378	184378	184378	183260	183260	184378
R^2	0.088	0.091	0.088	0.074	0.911	0.696	0.109	0.093	0.380

"IN-1", "IN-2" and "IN-3" indicate that the dependent variable is total factor productivity (TFP), which is calculated using various versions of an index number method based on Aw et al. (2001). "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. "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 (2009). "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 2.B: Other Industrial Policy Changes

As discussed in Section 2.2, 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 Tables 2.B.1 and 2.B.2. 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 (5) of Table 2.B.1 indicate that in this restricted set of industries, the effect of the fall in final goods tariffs on productivity is almost the same as the baseline in the formal sector, and is slightly smaller in magnitude than the baseline in the informal sector. Columns (2) and (6) suggest that NTB liberalization does magnify the effect of the fall in tariffs on firm productivity in both sectors.

Tables 2.B.1 and 2.B.2 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 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 et al. 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 2009). Using firm-level ASI data, Sivadasan (2009) 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.

Using data on the delicensing and FDI reforms from Aghion et al. (2008),[18] I find that the effects of the tariff cuts are robust to controlling for these policies (Tables 2.B.1 and 2.B.2). The coefficients on the fall in final goods tariffs are similar in magnitude to the baseline results. I also find that delicensing decreases average firm size in the formal sector, which is consistent with

[18] Since Aghion et al.'s (2008) data stop in 1997, I use the 1997 delicensing and FDI reform variables for the 1999-2000 survey round.

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). Somewhat surprisingly, I find a slightly negative correlation between FDI liberalization and formal sector productivity, and positive correlations between FDI liberalization and both informal sector productivity and firm size. Sivadasan (2009) finds that FDI liberalization increases average productivity among formal firms with more than five employees by 1994; however, it is possible that by 1999, FDI liberalization encourages entry into the formal sector by less productive firms, which would be consistent with the overall negative correlation I find.

Table 2.B.1: Other Industrial Policies: Total Factor Productivity

Dependent Variable: Log of Total Factor Productivity

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Formal	Formal	Formal	Formal	Informal	Informal	Informal	Informal
Fall in Final Goods Tariffs	-0.11***	-0.11***	-0.11***	-0.11***	0.25***	0.27***	0.24***	0.23***
	(0.024)	(0.024)	(0.024)	(0.024)	(0.073)	(0.077)	(0.074)	(0.068)
Fall in Final Goods Tariffs x NTB		-0.013				0.19*		
		(0.030)				(0.11)		
Delicense			-0.025*				0.024	
			(0.014)				(0.044)	
FDI				-0.023*				0.081**
				(0.014)				(0.040)
Fall in Input Tariffs	0.64***	0.65***	0.68***	0.63***	0.99***	0.75**	0.96***	1.07***
	(0.097)	(0.11)	(0.093)	(0.096)	(0.31)	(0.34)	(0.31)	(0.32)
Observations	94491	94491	94491	94491	173550	173550	173550	173550
R^2	0.248	0.248	0.248	0.248	0.087	0.087	0.087	0.087

"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). "Delicense" 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.

Table 2.B.2: Other Industrial Policies: Firm Size (Output)

Dependent Variable: Log of Firm Size (Output)								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Formal	Formal	Formal	Formal	Informal	Informal	Informal	Informal
Fall in Final Goods Tariffs	-0.32***	-0.33***	-0.33***	-0.32***	0.44***	0.43***	0.42**	0.37**
	(0.062)	(0.063)	(0.062)	(0.062)	(0.17)	(0.16)	(0.17)	(0.15)
Fall in Final Goods Tariffs x NTB		0.059				-0.12		
		(0.072)				(0.21)		
Delicense			-0.098**				0.054	
			(0.043)				(0.080)	
FDI				0.032				0.23**
				(0.045)				(0.093)
Fall in Input Tariffs	1.10***	1.06***	1.23***	1.10***	1.70**	1.85**	1.63**	1.92***
	(0.21)	(0.21)	(0.22)	(0.21)	(0.68)	(0.77)	(0.69)	(0.68)
Observations	94667	94667	94667	94667	174668	174668	174668	174668
R^2	0.196	0.196	0.196	0.196	0.405	0.405	0.405	0.406

"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). "Delicense" 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.

Chapter 3

The "Missing Middle" in Indian Manufacturing

A number of developing countries exhibit a "missing middle" in the employment size distribution. This phenomenon refers to the fact that a large share of employment is found in small firms and large firms, with less employment in mid-sized firms than is typically found in developed countries (Tybout 2000). Figure 3.1 shows the employment size distribution in the Indian and US manufacturing industries in the 1990's. As in the previous chapter, the Indian data include both informal and formal firms, but are confined to firms that use material inputs to produce physical products. Panel (a) shows that in the US, the largest share of employment (20%) is found in the 100-249 employee category. In contrast, less than 10% of Indian employment is found in firms with 100-249 employees. Instead, approximately 50% of Indian employment is found in firms with fewer than five employees, and the share of employment declines as employment size increases. Panel (b) shows that the employment size categories in which India is "missing" the most employment, relative to the US, are in the middle of the size distribution.

Figure 3.2 shows the same comparison for US firms and formal Indian firms, both with 10 or more employees. In this case, the difference between the two distributions is less stark. However, the missing middle pattern remains: India has a higher share of employment in small firms (less than 50 employees) and large firms (more than 500 employees) than the US, and a lower share of employment in mid-sized firms (50-500 employees). Two recent papers (Alfaro, Charlton and Kanczuk 2009, Hsieh and Klenow 2009) argue that changing the firm size distribution by reallocating resources across firms could increase productivity significantly in the Indian manufacturing industry.

A number of explanations have been proposed for the missing middle. For example, Rauch (1991) formalizes the theory that if costs are higher when firms grow above a certain size (for instance, if minimum wage laws are not enforced for small firms), then the least productive firms will choose to stay small in order to avoid the higher costs, while the most productive firms will pay the higher costs in order to achieve optimal size. There will be a size range, just above the cutoff at which the costs increase, where no firms will choose to locate, because the higher costs outweigh the size advantage. In the Indian context, labor regulations provide an example of such costs. Under India's Industrial Disputes Act (IDA), firms with 100 or more workers have to obtain government permission in order to shut down or lay off workers, while firms with 50 or more employees must pay severance wages to workers who are laid off.

Other potential explanations for the missing middle include lack of access to credit for small and mid-sized firms and poor infrastructure quality. Sleuwaegen and Goedhuys (2002) find that a higher share of mid-sized firms in Cote d'Ivoire report facing a number of barriers to growth, including financial and infrastructure constraints, relative to small and large firms. Angelini and Generale (2008) show that the distribution of firms that report being financially-constrained is left-shifted compared to the distribution of other firms. In India, small firms are much less likely to take out loans than large firms (see Chapter 1). Mazumdar and Sarkar (2008) point out that although India has programs that attempt to allocate credit to small firms, these policies may in fact exacerbate the missing middle because mid-sized firms may be too large to qualify for these programs but too small to receive credit through standard channels.

As discussed in Chapter 1, several commentators and politicians have also argued that India's liberalization increased the share of small and informal firms (Hensman 2001, Jhabvala and Sinha 2002, Vajpayee 2003, among others), but there is little quantitative evidence to support this claim. The evidence in Chapter 1 suggested that the employment size distribution in the formal sector shifted to the left (towards more small firms) over time, while the (nominal) output size distribution shifted to the right. In Chapter 2, I found that by 1999, industries that received higher tariff cuts had more mid-sized firms and fewer small and large firms, in terms of (real) output. Other reforms that took place during the 1980's and 1990's could also have affected the employment size distribution. For example, the removal of licensing requirements for firms with 50 or more employees and a certain amount of capital may have encouraged more firms to grow, as might the allowance of foreign direct investment (FDI) into certain industries.

In this chapter, I conduct a quantitative study of how a variety of Indian policies affect the employment size distribution of manufacturing firms. I consider several policies: (1) the share of credit allocated by state banks to small-scale industries (SSI); (2) the estimated surplus (deficit) of electricity in each state; (3) the liberalization of final goods and input tariffs; (4) the liberalization of FDI inflows; and (5) the removal of licensing requirements for firms with 50 or more employees and a certain amount of capital ("delicensing"). I employ quantile regression techniques to estimate the effect of each policy on various percentiles of the employment size distribution, and I also simulate what the distribution would look like under various policy scenarios.

I restrict my analysis to formal manufacturing firms for two reasons. First, the vast majority of informal firms have fewer than five employees, while the missing middle generally refers to mid-sized firms. Second, preliminary results indicated that the policies under consideration had very little impact on the employment size distribution in the informal sector. As in Chapter 2, I also restrict my analysis to formal firms that use material inputs to produce physical products, and to those industries for which I have data on the above-mentioned policies.

I would ideally measure the impact of Indian labor regulations on the employment size distribution, but the measures of labor regulations I use (from Besley and Burgess (2004) and Ahsan and Pages (2007)) do not vary significantly during the 1990s. However, since labor regulations may play an important role in India's missing middle, I consider whether each of the policies discussed above has a different impact on the employment size distribution in states designated as "pro-worker," "pro-employer," or "neutral" based on Besley and Burgess's (2004) classification system.

I find that improving India's poor electricity supplies from the 25th to the 75th percentile of state-level electricity surpluses (-10% to 4%) is associated with a shift in the employment size distribution away from firms with 5-50 employees and towards firms with 50-1,000 employees, thus mitigating the missing middle. Furthermore, the effects of improving electricity supplies would be greater in pro-employer states than in pro-worker states. A similar increase in the share of credit allocated to SSIs is correlated with shifting density away from firms with 10-50 employees and towards firms with 5-10 and 50-500 employees; however, the quantile regression results for the increase in credit to SSIs are not statistically significant.

India's reforms of the 1990's had varying impacts on the employment size distribution. If we consider only final goods tariff liberalization, the missing middle was exacerbated, as the density of employment size shifted away from firms with 10-100 employees and towards firms with fewer than 10 employees. However, the overall effect of the trade liberalization, considering both final goods and input tariffs, was to mitigate the missing middle by shifting the density of employment size away from firms with 1-10 employees and towards firms with 10-100 employees. The FDI liberalization also shifted density away from relatively small firms (with fewer than 20 employees) and towards larger firms (with 20-500 employees), while delicensing increased the density of employment size for firms with 10 to approximately 60 employees while shifting density away from relatively small (5-10 employee) and large (60-1,000 employee) firms. The FDI liberalization clearly moderated the missing middle, while the effect of the delicensing reforms may reflect the fact that more firms began to operate just above the 50-employee mark. The effects of the FDI liberalization were also somewhat larger in pro-employer states, while the effects of delicensing were larger in pro-worker states.

The remainder of this chapter is organized as follows: Section 3.1 provides an overview of the policies I will consider, Section 3.2 discusses the empirical strategy, Section 3.3 presents results, and Section 3.4 concludes.

3.1 Brief Overview of Policies

As discussed above, one potential cause of the missing middle is the lack of credit available to small firms. In India, 40% of the credit granted by banks must go to "priority sectors," one of which consists of SSIs (Banerjee and Duflo 2008). A firm can register as an SSI if the value of its fixed assets is below a certain limit.[1] Individual banks have some discretion as to how they allocate the 40% among the various priority sectors; using various annual reports of the Reserve Bank of India, I measure the availability of credit for SSIs as the fraction of total outstanding credit allocated to SSIs in each state.

Another potential contributor to the missing middle is the lack of infrastructure. Poor infrastructure, and in particular the poor provision of electricity, has been identified as a barrier to development (UNCTAD 2006). The evidence presented in Chapter 1 suggests that most small, informal firms use labor-intensive processes and do not use electricity; in contrast, nearly all mid-sized and

[1] The limit on fixed assets was Rs. 3.5 million from 1985 to 1989; Rs. 6 million from 1989 to 1991; Rs. 30 million from 1991 to 1997; and Rs. 10 million from 1997 onwards (DCMSME Last checked March 16, 2010). Banerjee and Duflo (2008) use these changes to provide evidence that firms affected by these changing limits are credit constrained.

large firms use electricity. Sleuwaegen and Goedhuys (2002) find that mid-sized firms in Cote d'Ivoire are more likely than small and large firms to consider poor infrastructure a barrier to growth. In the Indian context, anecdotal evidence indicates that many large firms use their own generators to provide an uninterrupted supply of electricity; however, mid-sized firms may use capital-intensive production processes that depend on electricity, but may be unable to produce a sufficient quantity of electricity in-house. As a measure of the adequacy of electricity supply, I use estimates of electricity supply and demand from the Centre for Monitoring Indian Economy (CMIE). The CMIE estimates the expected annual electricity demand in every state, as well as the electricity supply based on in-state production and transfers (CMIE 1999-2000). Based on their estimates, I calculate the fraction of electricity surplus/deficit (supply minus demand, divided by demand), to serve as a proxy for electricity availability.[2]

Chapter 2 discussed the three other policies that I will consider. First, trade liberalization reduced the average tariff rate from 95% to 35% ad valorem between 1989 and 1999. Second, FDI inflows, which were previously capped at 40% for most industries, were allowed up to 51% in selected industries with "automatic" approval beginning in 1991 (Sivadasan 2009). Third, the "license raj," which required firms with more than 50 employees (100 employees without power) and a certain amount of assets to obtain an operating license, was dismantled during the 1980's and 1990's (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 et al. 2008). Data on the tariff reforms are from the Government of India's Customs Tariff Working Schedules and the Trade Analysis and Information System (TRAINS) database maintained by the United Nations Conference on Trade and Development (UNCTAD); details on how measures of final goods tariffs and input tariffs are calculated for each industry were provided in Chapter 2. Data on the FDI and delicensing reforms are from Aghion et al. (2008).[3] The FDI reform variable measures the fraction of product lines within an industry that were liberalized. The delicensing variable is a dummy that takes on a value of one if all or part of the industry was delicensed, zero otherwise.

Finally, as discussed above, I cannot estimate the impact of labor regulations on the employment size distribution since the measure of labor regulations that I use does not change during the course of the 1990's. India's IDA lays out labor regulations at a national level, but states may make amendments to the IDA. Besley and Burgess (2004) classify each amendment as "pro-worker" or "pro-employer," with pro-worker amendments rated +1 and pro-employer amendments rated -1. Each state is then assigned an overall value of +1 if the sum of the ratings for amendments passed is positive in a particular year, -1 if the sum of the ratings for amendments passed is negative in a particular year. The measure of labor regulations is then the cumulative sum of the state's yearly amendments. In 1989, the cumulative measures range from -2 to 4. I use these cumulative measures from 1989 to test whether the effects of the above-mentioned policies on the employment size distribution vary across pro-worker, pro-employer, and "neutral" states (those with a cumulative measure of zero).

Table 3.1 provides summary statistics for the policy measures discussed above. I combine these

[2] The CMIE data on electricity end in 1996; therefore, I assign the 1996 values to the 1999 firm-level data in my dataset.

[3] Since their data stop in 1997, I use the 1997 delicensing and FDI reform variables for the 1999-2000 survey round.

data on policy measures with firm-level data from the formal sector in 1989, 1994, and 1999. The firm-level dataset was discussed in detail in Chapters 1 and 2. I restrict my analysis to formal manufacturing firms that use material inputs to produce physical products. By necessity, I also restrict my analysis to those industries and states for which I have data on the policies discussed above, which leaves me with a somewhat smaller sample of formal firms than the one used in Chapter 2.

3.2 Empirical Strategy

I employ quantile regression techniques to identify the effects of the policies discussed in Section 3.1 on the employment size distribution. I begin by estimating the following equation for employment at firm i in state s and industry j at time t:

$$\begin{aligned} l_{ijst} \; = \; & \beta_1 CreditShare_{st} + \beta_2 ElecSurplus_{st} + \beta_3 \tau_{jt} + \beta_4 \tau^I_{jt} + \beta_5 Delic_{jt} + \beta_6 FDI_{jt} ... \\ & ... + \gamma_1 CreditShare_{st} * BB_s + \gamma_2 ElecSurplus_{st} * BB_s + \gamma_3 \tau_{jt} * BB_s + ... \\ & ... \gamma_4 \tau^I_{jt} * BB_s + \gamma_5 Delic_{jt} * BB_s + \gamma_6 FDI_{jt} * BB_s + \alpha_j + \alpha_s + \alpha_t + \varepsilon_{ijst} \end{aligned} \quad (3.1)$$

$CreditShare_{st}$ is the share of total outstanding credit allocated to SSIs by state banks. $ElecSurplus_{st}$ is the state's electricity surplus (estimated supply minus demand, divided by demand). τ_{jt} and τ^I_{jt} are ad valorem final goods and input tariffs, as negative fractions; in other words, the coefficients on these variables can be interpreted as the results of tariff liberalizations. $Delic_{jt}$ is a dummy variable equal to one if the industry (or part of the industry) is delicensed, zero otherwise. FDI_{jt} is the share of products within an industry in which FDI up to 51% is allowed without case-by-case authorization. The credit and electricity surplus measures vary by state and time, while the tariff, delicensing, and FDI liberalization measures vary by industry and time. BB_s is a measure of how pro-worker or pro-employer a state's labor regulations were in 1989, based on Besley and Burgess (2004), with -2 being the most pro-employer state and 4 being the most pro-worker state. The measure of labor regulations does not vary over time.

Data sources for the policy variables were discussed in Section 3.1, while the data source for the employment variable was discussed in Chapter 2. All regressions include industry and state dummy variables, to control for any time-invariant, industry- or state-specific characteristics, as well as time dummy variables, to control for any macroeconomic shocks that affected all industries/states in the same way at the same time.

I conduct quantile regressions for employment size at every 5th percentile of the distribution. All regressions use inverse sampling multipliers to re-weight firm-level observations, so the results should be representative of the population of formal manufacturing firms. As discussed in Chapter 2, the parameters are identified using the methodology developed by Koenker and Bassett (1978). I then use a modified version of the technique from Machado and Mata (2005), also described in Chapter 2, to simulate counterfactual employment size distributions under a variety of policy scenarios.

3.3 Results

The quantile regression results are presented graphically in Figures 3.3 through 3.5. In each of these figures, the solid line indicates the quantile regression coefficient at each of 19 percentiles (5th, 10th, etc.) while the dotted lines indicate the 90% confidence intervals from a block bootstrap that is clustered at the state-by-industry level.

The counterfactual simulation results are presented in Figures 3.6 through 3.11. The specific counterfactual scenarios considered for each policy reform are discussed below.

3.3.1 Credit and Electricity

Panel (a) of Figure 3.3 presents the quantile regression coefficients for the share of credit allocated to SSIs. Allocating a greater fraction of credit to SSIs is associated with smaller employment sizes in the lower quantiles of the distribution, but larger employment sizes in the upper quantiles; however, the results are not statistically significant.

Panel (a) of Figure 3.6 illustrates the change in employment size distribution that would be expected if a state moved from the 25th percentile of credit share allocated to SSIs (15%) to the 75th percentile (20%). It suggests that increasing the share of credit allocated to SSIs from 15% to 20% would decrease the density of the employment size distribution in the 1-5 and 10-50 employee ranges and increase it in the 5-10 employee and 50-500 employee ranges.

Furthermore, Figure 3.9 indicates that the effects of allocating credit to SSIs depend on state labor regulations. In this figure, I simulate the changes in the employment size distribution associated with increasing the credit share allocated to SSIs from 15% to 20% under three different scenarios: (1) setting BB_s to zero in Equation 3.1, which implies a neutral state with respect to labor regulations; (2) setting BB_s to +1, which implies a pro-worker state; and (3) setting BB_s to -1, which implies a pro-employer state. Figure 3.9 suggests that the results discussed above are greater in pro-worker states than in neutral states; that is, in pro-worker states, increasing the allocation of credit to SSIs is associated with a greater decrease in the density of the employment size distribution in the 10-50 employee range and a greater in increase in the 5-10 employee and 50-500 employee ranges. However, in pro-employer states, allocating more credit to SSIs increases the density of employment size in the 10-100 employee range and decreases it in the 100-500 employee range.

Panel (b) of Figure 3.3 shows that increasing the electricity surplus (reducing the deficit) increases firm size across nearly all quantiles of the distribution, though the effects are only statistically significant for the upper quantiles. Panel (b) of Figure 3.6 indicates that moving from the 25th percentile of electricity surplus (-10%) to the 75th percentile (+4%) mitigates the missing middle, by decreasing the prevalence of firms with 5-50 employees and increasing the prevalence of firms with 50 to nearly 1,000 employees.

I conduct a similar exercise as described above to examine whether the effect of increasing the electricity surplus varies with labor regulations. Panel (b) of Figure 3.9 suggests that increasing the electricity surplus diminishes the missing middle in neutral, pro-worker, and pro-employer states, though the effect is slightly more pronounced in pro-employer states and less pronounced in pro-worker states.

3.3.2 Trade and Industrial Reforms

Figure 3.4 shows the effects of the trade liberalization - the falls in final goods and input tariffs - on various quantiles of the employment size distribution. The final goods tariff liberalization decreases employment size across all quantiles of the distribution, though the effects are only statistically significant in the lower quantiles. The fall in input tariffs increases employment size in the lower quantiles, but may decrease it in the upper quantiles; the effects are only statistically significant in the lower quantiles.

Figure 3.7 shows the simulated changes in the density of employment size associated with the trade liberalization. I consider the effects of the final goods tariff liberalization alone (Panel (a)), the intermediate input tariff liberalization alone (Panel (b)), and the final goods and input tariff liberalizations together (Panel (c)). Each simulation shows the change between the density of employment size with tariffs as they were distributed in 1999, minus the density with tariffs as they were distributed in 1989, all else equal.

Panel (a) indicates that the final goods tariff liberalization exacerbated the missing middle by increasing the density of employment in the 1-10 employee range and decreasing it in the 10-100 employee range. However, Panel (b) shows that the input tariff liberalization had the opposite effect. Panel (c), which combines the final goods and input tariff liberalizations, indicates that the overall effect of the trade reforms was to mitigate the missing middle by shifting density away from the 1-10 employee category and towards the 10-100 employee category. The effects of the trade liberalization do not appear to vary across states with different labor regulations (Figure 3.10).

If we compare the effects of the trade liberalization on employment size to the effects on output size (see Chapter 2), there are notable parallels. In both cases, the final goods tariff liberalization led to a fall in formal firm size (in terms of output and employment), while the input tariff liberalization led to an increase in formal firm size.

Finally, Figure 3.5 shows the quantile regression coefficients for the two other industrial policy reforms that took place during the 1990's: FDI reform and delicensing. Panel (a) indicates that FDI liberalization is associated with increased employment size across most quantiles of the distribution; the results are statistically significant for most quantiles. Moving from having 0% of product lines FDI-liberalized to having 100% of product lines FDI-liberalized shifts density away from firms with 5-20 employees and towards firms with 20-500 employees, thus decreasing the missing middle phenomenon (Panel (a) of Figure 3.8). Similar to the results for electricity, Panel (a) of Figure 3.11 shows that this effect is more pronounced for states with pro-employer regulations.

Panel (b) of Figure 3.5 suggests that delicensing increases employment size in the lower quantiles of the distribution but decreases it in the upper quantiles; the results are only statistically significant in the upper quantiles. Consistent with this pattern, Panel (b) of Figure 3.8 indicates that when an industry is delicensed, firms with 10-60 employees become more prevalent, while firms with 5-10 employees and 60-1,000 employees become less prevalent. In contrast with the FDI liberalization results, Panel (b) of Figure 3.11 suggests that the effect is slightly more pronounced in pro-worker states.

3.4 Conclusion

The results indicate that a number of different policies play a role in India's missing middle. In particular, the poor provision of electricity seems to be an important driver of the missing middle; improving electricity surplus from the 25th to the 75th percentile (-10% to 4%) is associated with shifting density away from formal firms with 5-50 employees and towards firms with 50-1,000 employees. The allocation of credit to SSIs also seems to be correlated with employment size to some extent; although the quantile regression results are not statistically significant, they suggest that increasing credit to SSIs may shift the employment size density towards firms with 5-10 and 50-500 employees.

The liberalization measures that India undertook during the 1990's - trade reform, FDI liberalization, and delicensing - had mixed impacts on the employment size distribution. The final goods tariff liberalization exacerbated the missing middle, while the input tariff liberalization mitigated it. Overall, the impact of the trade liberalization was to shift employment size density away from firms with fewer than 10 employees and towards firms with 10-100 employees.

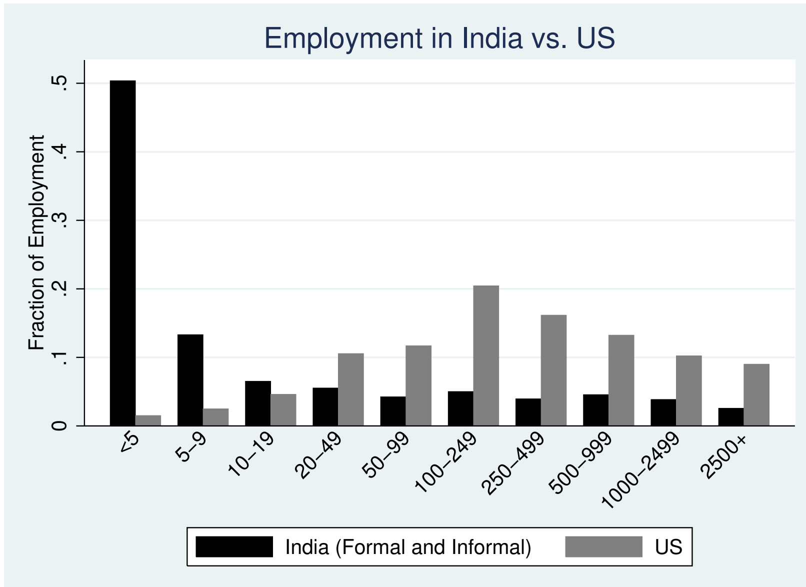
The FDI liberalization is associated with a smaller missing middle, as the density of employment size shifted away from firms with fewer than 20 employees and towards firms with 20-500 employees. Delicensing had a more ambiguous impact on the missing middle, as the density of employment size shifted away from firms with 5-10 and more than 60 employees and towards firms with 10-60 employees. It is somewhat surprising that the delicensing reforms may have moved employment share away from relatively large firms (those with more than 60 employees) and towards relatively small firms (10-60 employees). However, since these reforms presumably made it easier for firms to have more than 50 employees, the shift in density may reflect more firms operating just above the 50-employee mark.

It is important to interpret some of the results presented here with caution. As discussed in Chapter 2, the trade liberalization was initiated as part of a reforms package required by the IMF, and evidence suggests that the tariff liberalization measures were not driven by, or otherwise correlated with, pre-reform industry characteristics. It would thus be reasonable to interpret these results as the causal impact of the trade liberalization on the employment size distribution. The FDI liberalization and delicensing reforms were also largely imposed as part of the 1991 reforms package. However, the allocation of credit to SSIs and the electricity surplus are driven by state policy. While all of the analyses conducted in this chapter include state dummy variables to account for time-invariant, state-specific characteristics, it is possible that changes in state credit and electricity policies are correlated with time-varying state characteristics.

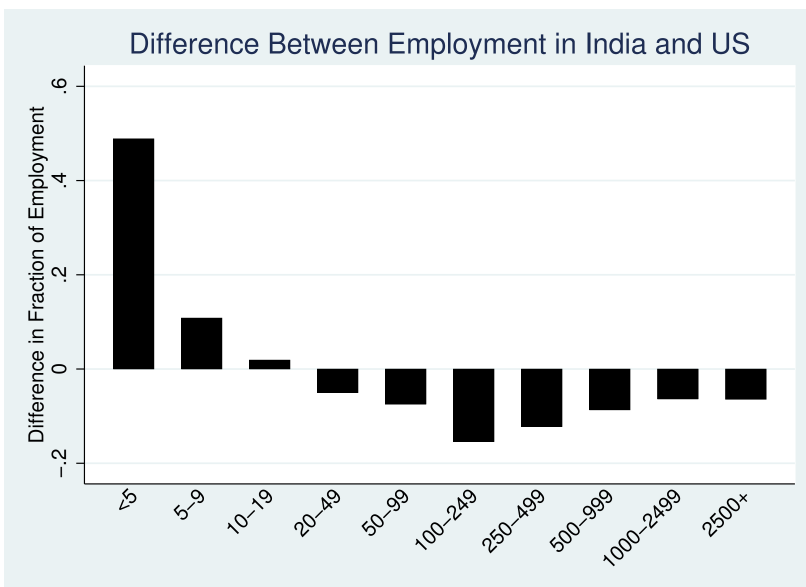
The results also suggest that state labor regulations may have important effects on the way in which these policies affect the missing middle. The effects of improving electricity supplies and liberalizing FDI are larger in pro-employer states, while the effects of providing credit to SSIs and delicensing are larger in pro-worker states. In addition, theory suggests that labor regulations are likely to have a direct effect on the missing middle. Developing a more detailed measure of labor regulations, including an assessment of whether and how those regulations changed during the 1990's, is an important area for future research.

Figure 3.1: Employment Size Distribution, India versus US

(a) Employment Shares by Number of Employees



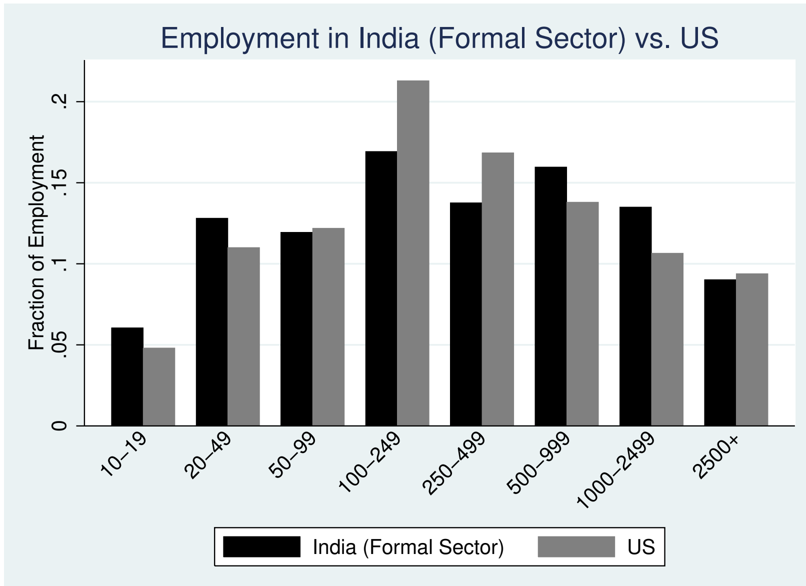
(b) Difference in Employment Shares



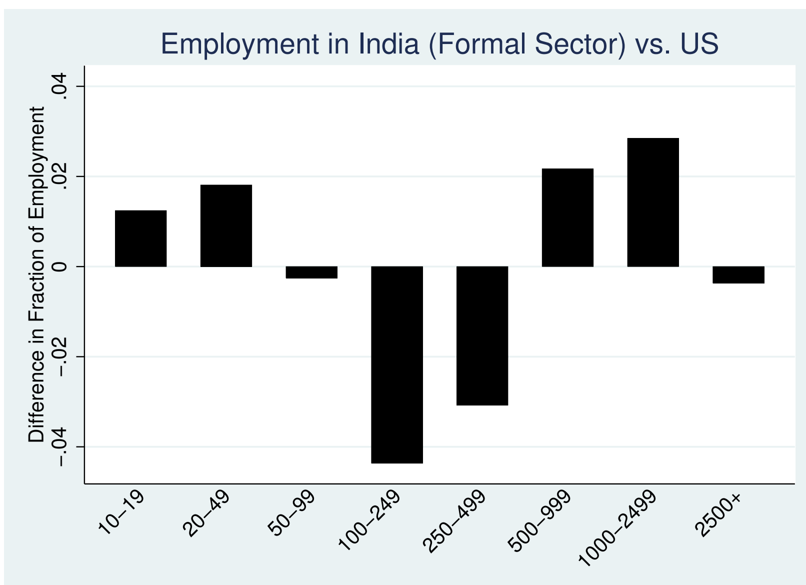
Panel (a) shows the share of manufacturing employment, by employment size, in India and the US. Panel (b) shows the difference between the share of manufacturing employment in India and the share of manufacturing employment in the US (India minus US), by employment size. Indian data include both formal and informal manufacturing firms. Source: Author's calculations based on US Census of Manufactures, 1997; Annual Survey of Industries, 1994; Unorganized Manufacture Survey, 1994.

Figure 3.2: Employment Size Distribution, India (Formal Sector) versus US

(a) Employment Shares by Number of Employees



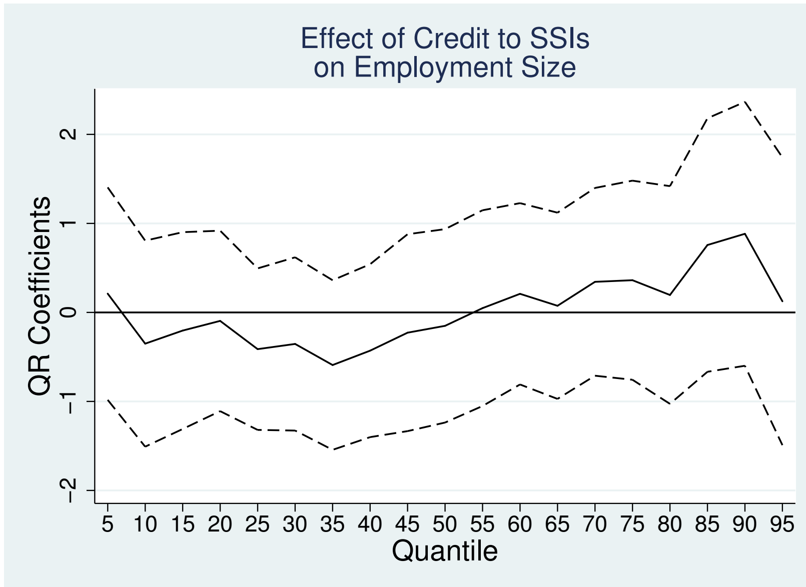
(b) Difference in Employment Shares



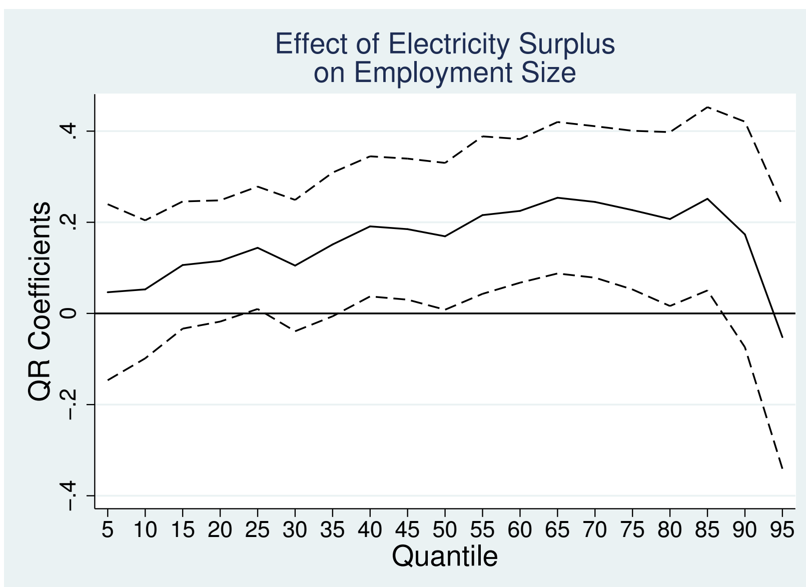
Panel (a) shows the share of manufacturing employment, by employment size, in India and the US, for firms with 10 or more employees. Panel (b) shows the difference between the share of manufacturing employment in India and the share of manufacturing employment in the US (India minus US), by employment size. Indian data include formal manufacturing firms. Source: Author's calculations based on US Census of Manufactures (1997) and Annual Survey of Industries (1994).

Figure 3.3: Quantile Regression Results - Credit and Electricity

(a) Credit to SSIs



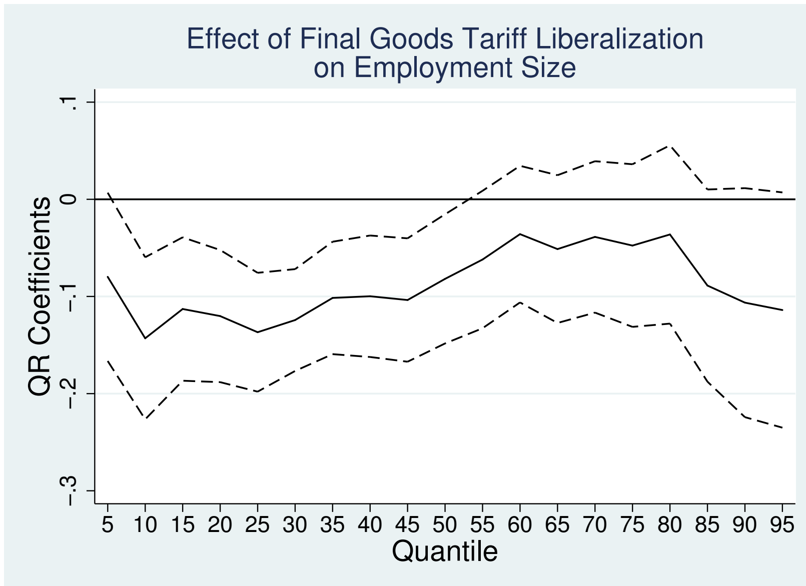
(b) Electricity Surplus



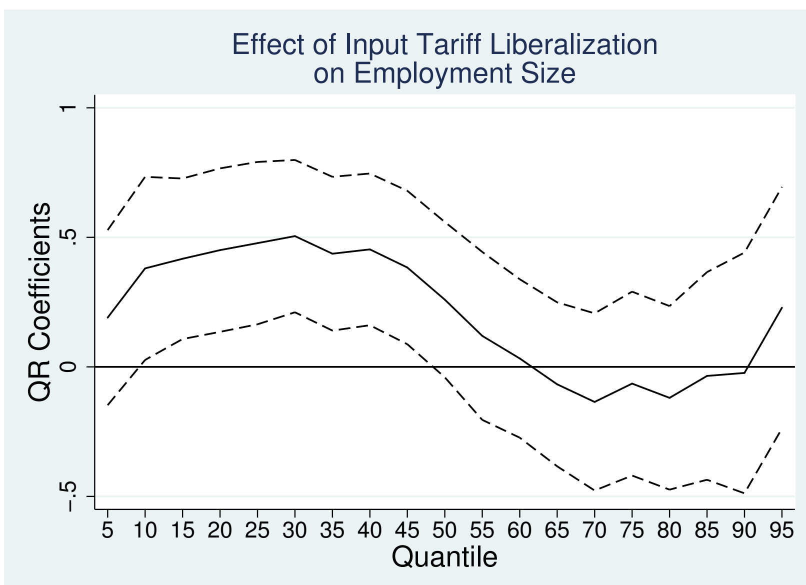
Panels (a) and (b) show the effects of credit given to small-scale industries (SSI) and electricity surpluses, respectively, on various quantiles of the firm size (employment) distributions in the formal sector. Dependent variable is log of employment. Solid lines show quantile regression (QR) coefficients 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 3.4: Quantile Regression Results - Trade Liberalization

(a) Final Goods Tariffs



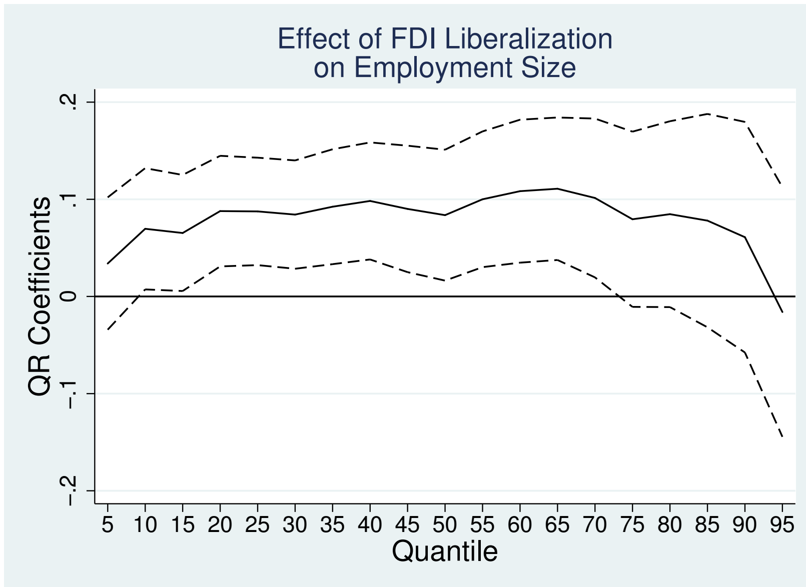
(b) Input Tariffs



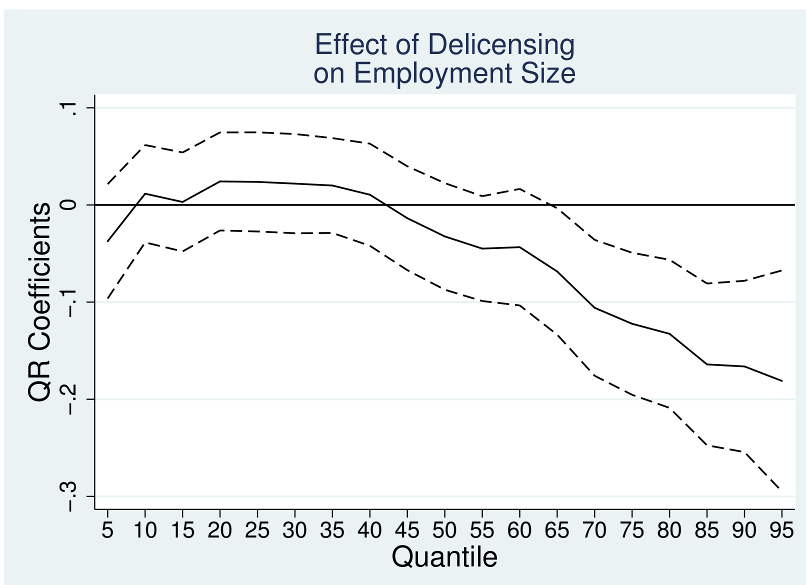
Panels (a) and (b) show the effects of a fall in final goods and input tariffs, respectively, on various quantiles of the firm size (employment) distributions in the formal sector. Dependent variable is log of employment. Solid lines show quantile regression (QR) coefficients at each of 19 quantiles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

Figure 3.5: Quantile Regression Results - Other Industrial Policy Reforms

(a) FDI Liberalization



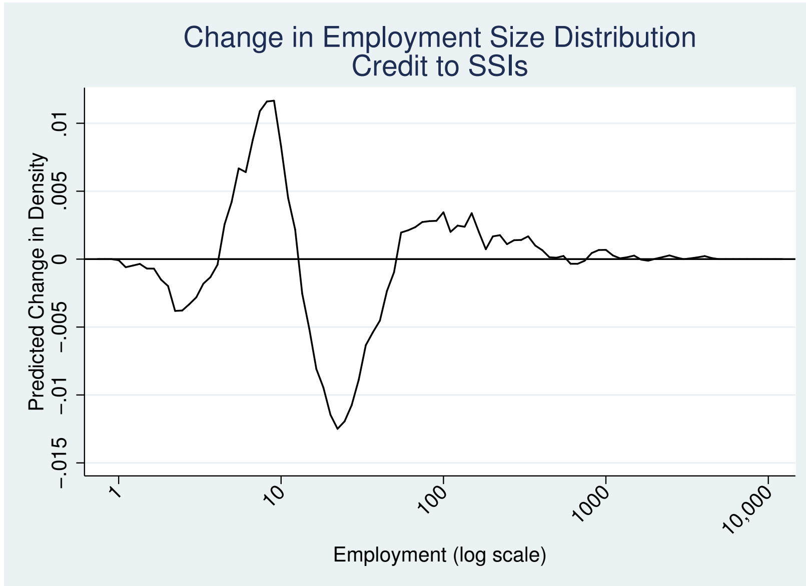
(b) Delicensing



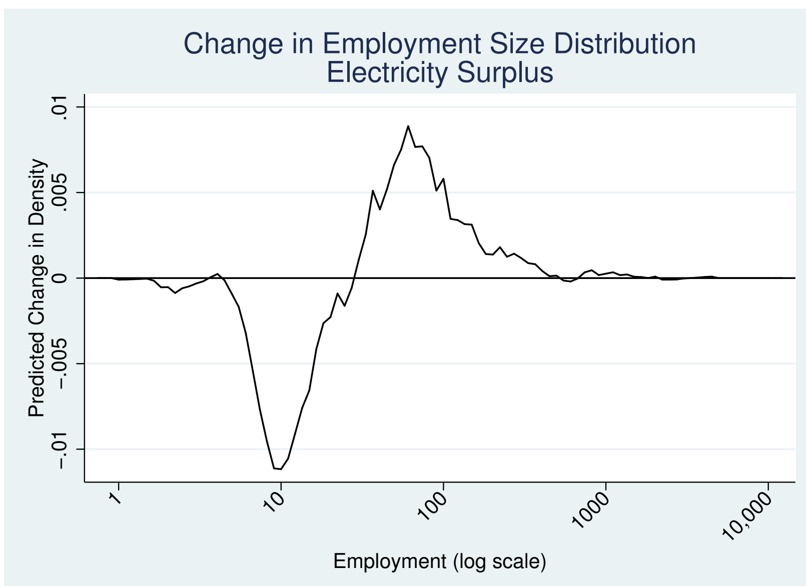
Panels (a) and (b) show the effects of FDI liberalization and delicensing, respectively, on various quantiles of the firm size (employment) distributions in the formal sector. Dependent variable is log of employment. Solid lines show quantile regression (QR) coefficients at each of 19 quantiles (5th, 10th,...,95th) of the firm size distribution. Dashed lines indicate 90% confidence intervals, based on a block bootstrap.

Figure 3.6: Changes in the Employment Size Distribution - Credit and Electricity

(a) Credit to SSIs



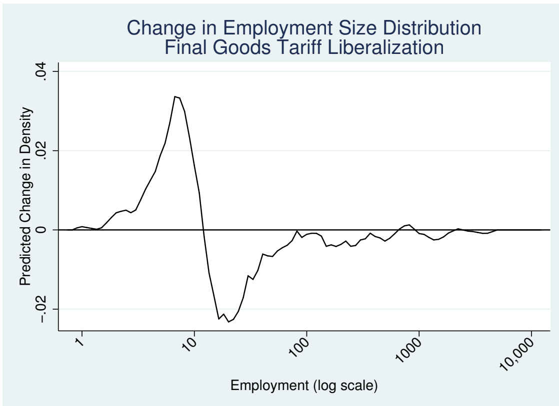
(b) Electricity Surplus



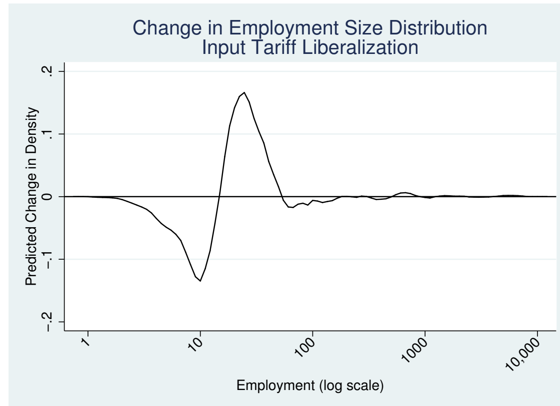
Panels (a) and (b) show the simulated changes in the employment size distribution associated with moving from the 25th percentile to the 75th percentile of credit share given to small-scale industries (SSI) and electricity surpluses, respectively. Simulated densities were developed using a modified version of the procedure from Machado and Mata (2005). Changes in density were calculated by estimating the densities associated with the 25th and 75th percentiles at the same points and subtracting the 25th percentile value from the 75th percentile value.

Figure 3.7: Changes in the Employment Size Distribution - Trade Liberalization

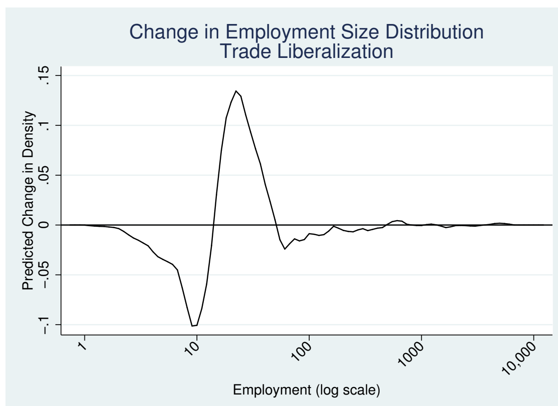
(a) Final Goods Tariffs



(b) Input Tariffs



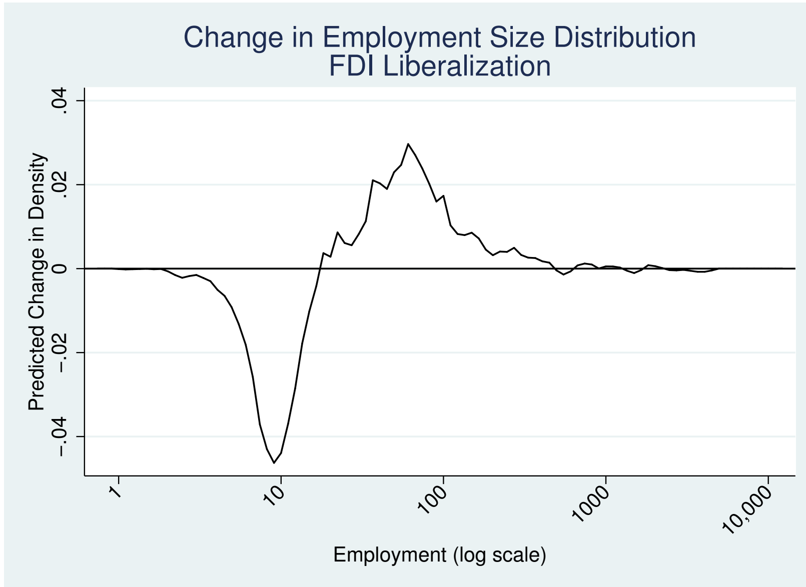
(c) Overall Trade Liberalization



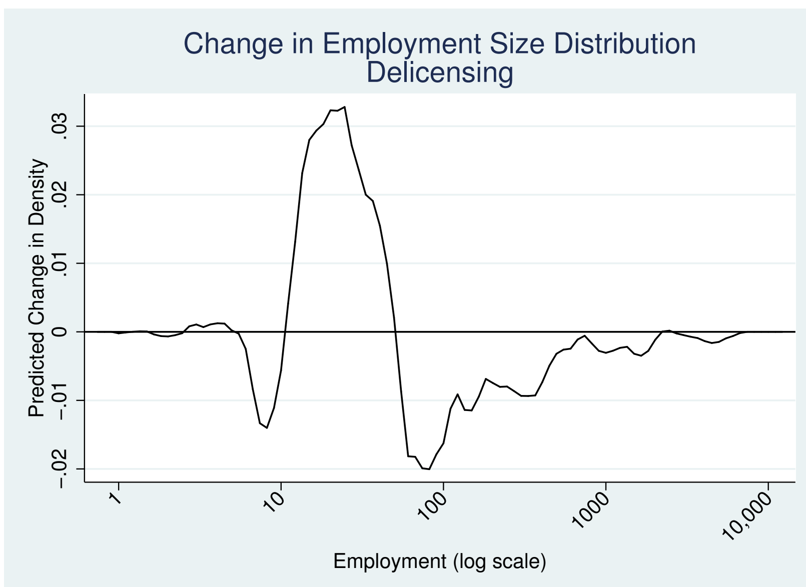
Panels (a), (b), and (c) show the simulated changes in the employment size distribution associated with the fall in final goods tariffs, input tariffs, and overall trade liberalization (a fall in both final goods and input tariffs), respectively, between 1989 and 1999. Simulated densities were developed using a modified version of the procedure from Machado and Mata (2005). Changes in density were calculated by estimating the 1989 and 1999 densities at the same points and subtracting the 1989 values from the 1999 values.

Figure 3.8: Changes in the Employment Size Distribution - Other Industrial Policy Reforms

(a) FDI Liberalization



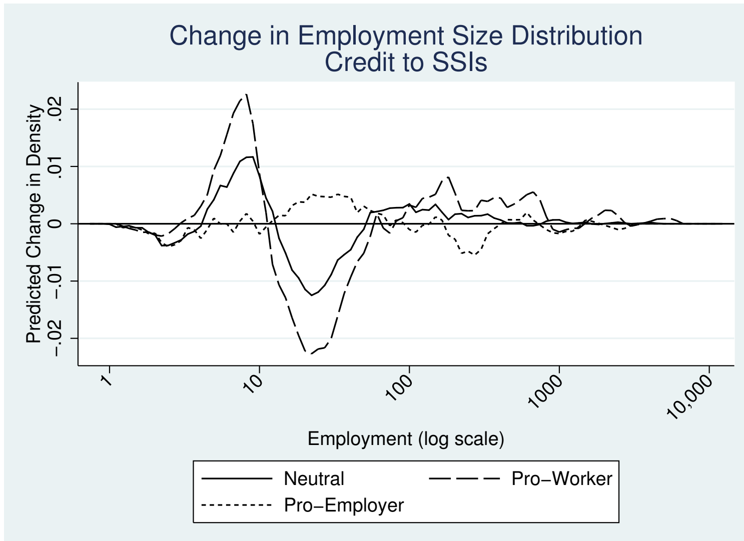
(b) Delicensing



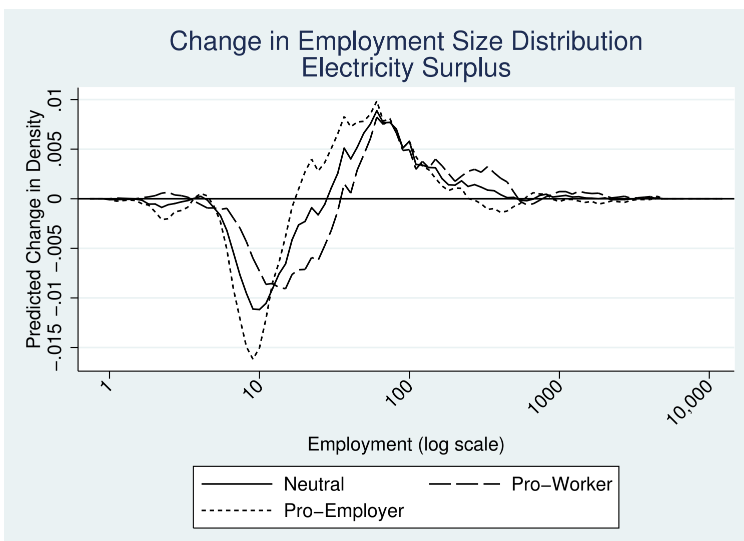
Panels (a) and (b) show the simulated changes in the employment size distribution associated with FDI liberalization and delicensing, respectively. Simulated densities were developed using a modified version of the procedure from Machado and Mata (2005). Changes in density were calculated by estimating the densities with and without FDI liberalization (delicensing) at the same points, and subtracting the values without FDI liberalization (delicensing) from the values with FDI liberalization (delicensing).

Figure 3.9: Changes in the Employment Size Distribution - Credit, Electricity, and Labor Regulations

(a) Credit to SSIs



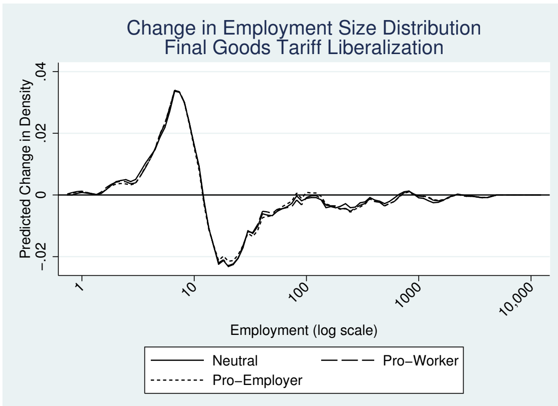
(b) Electricity Surplus



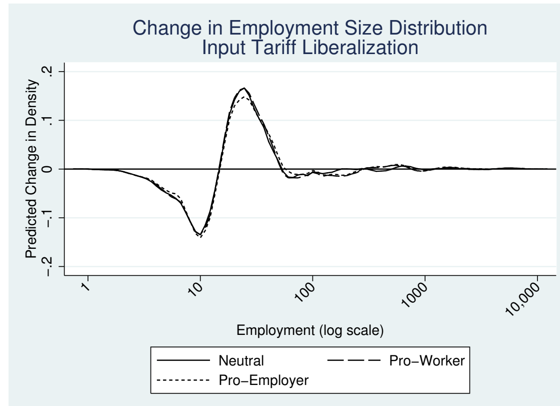
Panels (a) and (b) show the simulated changes in the employment size distribution associated with moving from the 25th percentile to the 75th percentile of credit share given to small-scale industries (SSI) and electricity surpluses, respectively. Simulated distributions were developed using a modified version of the procedure from Machado and Mata (2005). Changes in density were calculated by estimating the densities associated with the 25th and 75th percentiles at the same points and subtracting the 25th percentile value from the 75th percentile value. Distributions were estimated for states with different pre-reform (1989) labor regulations, based on classifications from Besley and Burgess (2004): "Neutral" indicates a classification of zero, "Pro-Worker" indicates a classification of one; and "Pro-Employer" indicates a classification of negative one.

Figure 3.10: Changes in the Employment Size Distribution - Trade Liberalization and Labor Regulations

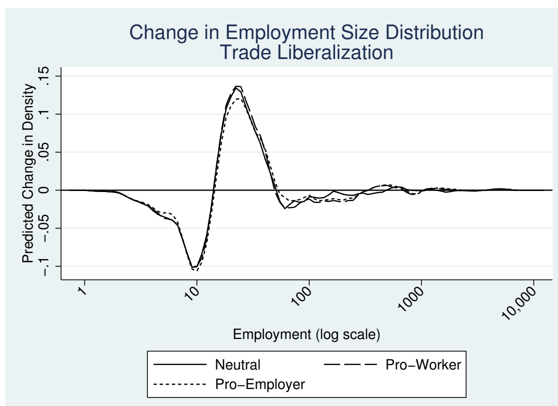
(a) Final Goods Tariffs



(b) Input Tariffs



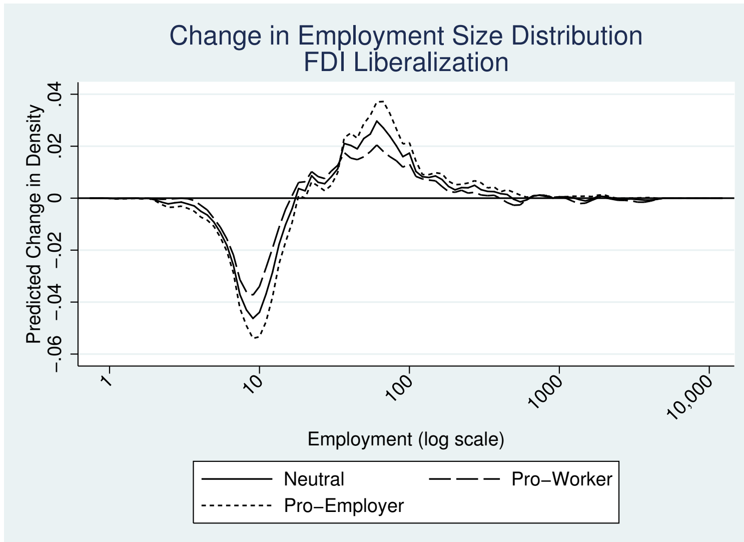
(c) Overall Trade Liberalization



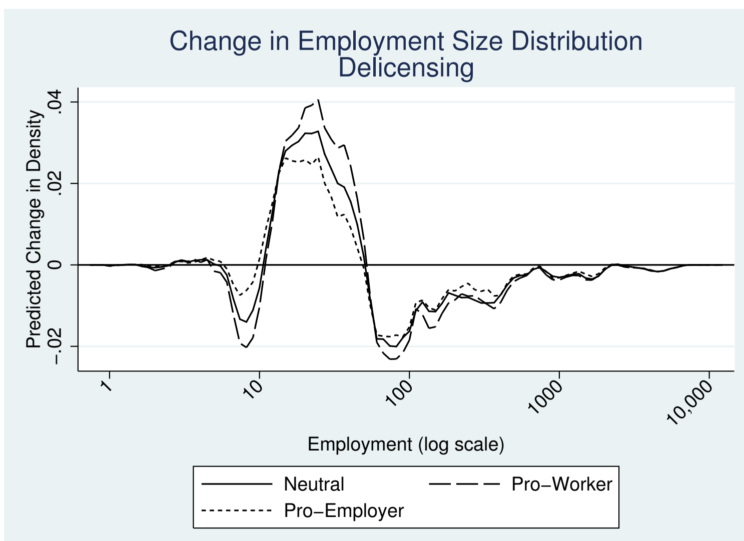
Panels (a), (b), and (c) show the simulated changes in the employment size distribution associated with the fall in final goods tariffs, input tariffs, and overall trade liberalization (a fall in both final goods and input tariffs), respectively, between 1989 and 1999. Simulated distributions were developed using a modified version of the procedure from Machado and Mata (2005). Changes in density were calculated by estimating the 1989 and 1999 densities at the same points and subtracting the 1989 values from the 1999 values. Distributions were estimated for states with different pre-reform (1989) labor regulations, based on classifications from Besley and Burgess (2004): “Neutral” indicates a classification of zero, “Pro-Worker” indicates a classification of one; and “Pro-Employer” indicates a classification of negative one.

Figure 3.11: Changes in the Employment Size Distribution - Other Industrial Policy Reforms and Labor Regulations

(a) FDI Liberalization



(b) Delicensing



Panels (a) and (b) show the simulated changes in the employment size distribution associated with FDI liberalization and delicensing, respectively. Simulated distributions were developed using a modified version of the procedure from Machado and Mata (2005). Changes in density were calculated by estimating the densities with and without FDI liberalization (delicensing) at the same points, and subtracting the values without FDI liberalization (delicensing) from the values with FDI liberalization (delicensing). Distributions were estimated for states with different pre-reform (1989) labor regulations, based on classifications from Besley and Burgess (2004): "Neutral" indicates a classification of zero, "Pro-Worker" indicates a classification of one; and "Pro-Employer" indicates a classification of negative one.

Table 3.1: Policy Variables

Panel A: Summary Statistics, 1989

	Mean	**Std. Dev.**	**Min**	**Max**
% Credit Share to SSIs	18.6	4.7	14.4	30.2
% Electricity Surplus	-0.4	22.7	-23.4	50.1
Final Goods Tariffs (% ad valorem)	96.4	44.4	0	355
Input Tariffs (% ad valorem)	99.9	9.4	74.7	133.6
FDI Liberalized	0.0	0.0	0	0
Delicensed	0.4	0.5	0	1

Panel B: Summary Statistics, 1994

	Mean	**Std. Dev.**	**Min**	**Max**
% Credit Share to SSIs	15.2	3.5	10.9	23.2
% Electricity Surplus	-3.5	10.3	-18.8	25.2
Final Goods Tariffs (% ad valorem)	63.8	34.1	28.2	400
Input Tariffs (% ad valorem)	60.5	5.3	33.6	74.1
FDI Liberalized	0.3	0.4	0	1
Delicensed	0.9	0.3	0	1

Panel C: Summary Statistics, 1999

	Mean	**Std. Dev.**	**Min**	**Max**
% Credit Share to SSIs	15.7	5.1	11.1	29.7
% Electricity Surplus	-6.0	16.3	-24.8	40.3
Final Goods Tariffs (% ad valorem)	35.8	15.8	12.5	158.3
Input Tariffs (% ad valorem)	34.5	2.6	25	42.3
FDI Liberalized	0.4	0.4	0	1
Delicensed	0.9	0.3	0	1

Summary statistics for the policy variables in 1989, 1994, and 1999. Final goods and input tariffs are ad valorem values (%) and vary by industry. “Delicensed” is a dummy variable equal to zero if an industry required operating licenses, one otherwise. “FDI Reform” is the fraction of product lines within an industry that do not require case-by-case approval of FDI up to 51%. “% Electricity Surplus” is the estimated surplus of electricity available in the state. “% Credit Share to SSIs” is the estimated share of total credit extended by state banks that was given to small-scale industries (SSI). Source: Credit data are based on various publications of the Reserve Bank of India. Estimates of electricity surplus are based on CMIE (1999-2000). Final goods tariff data are based on customs tariff publications of the Government of India and the Trade Analysis and Information System (TRAINS) database maintained by the United Nations Conference on Trade and Development (UNCTAD). Input tariffs are calculated by using final goods tariff data and India’s Input-Output Transactions Table. FDI liberalization and delicensing data are from Aghion et al. (2008).

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