Industrial De-Licensing, Trade Liberalization, and Skill Upgrading in India

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Abstract

We investigate the relationship between industrial de-licensing, trade liberalization, and skill upgrading during the 1980s and 1990s among Indian plants. We use a unique dataset on India's industrial licensing regime to test whether industrial de-licensing during the 1980s and 1990s played a role in generating demand for skilled labor, as measured by the employment and wagebill shares of white-collar workers. In addition, we assess the relative contribution of industrial de-licensing and trade liberalization to skill upgrading. We identify two main channels through which industrial de-licensing affects the relative demand for skilled labor: capital- and output-skill complementarities. Our analysis finds three important results. First, capital- and output-skill complementarities exist for plants in both licensed and de-licensed industries but were stronger in de-licensed industries during the 1980s, prior to India's massive trade liberalization reforms in 1991. Together, capital- and output-skill complementarities contributed 97% (70%) and 51% (40%), respectively, of the growth in the employment and wagebill shares of white-collar workers in de-licensed (licensed) industries during the 1980s. This suggests that industrial de-licensing increased the relative demand for skilled labor via capital- and output-skill complementarities during the 1980s, the decade before India liberalized trade. Second, capital-skill complementarities are stronger for plants that were de-licensed during the 1980s compared to those that were not, once trade was liberalized during the early 1990s. Thus, freedom from licensing requirements enabled plants in de-licensed industries to utilize more efficient inputs such as skill-biased capital, which together with trade reforms resulted in skill upgrading. Even though output-skill complementarities are stronger for plants that were de-licensed during the 1980s compared to those that were not, this difference was not magnified by trade liberalization. The ability of plants in de-licensed industries to take advantage of economies of scale thus appears to have benefited skilled labor regardless of trade liberalization. Third, regardless of de-licensing, capital- and output-skill complementarities are weaker for plants in industries where trade was liberalized during the early 1990s, a result that supports the predictions of the Stolper-Samuelson theorem.

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1 Introduction

During the 1980s and 1990s, the Indian labor market experienced two dramatic changes. First, there was a large increase in the employment of skilled labor. As shown in Figure 1, there was a steady increase in the share of white-collar workers employed by plants as well as in the share of the wagebill going to white-collar workers.[1] After 1991, the wagebill and employment shares of white-collar workers rose sharply. The second change that occurred in the Indian labor market during this period relates to the skill wage gap, as shown in Figure 2. The skill premium, which is defined as the ratio of the average white- and blue-collar wage rates, declined during the early 1980s, remained relatively stable from the mid-1980s until the late 1980s, and rose considerably after 1991.

An increase in the employment of skilled relative to unskilled labor together with stable relative wages suggests that increases in the relative demand for skilled labor were matched by increases in their relative supply during the 1980s. On the other hand, an increase in the employment of skilled relative to unskilled labor along with rising relative wages indicates increases in the relative demand for skilled labor dominated increases in their relative supply during the first half of the 1990s.[2]

The 1980s and 1990s also mark a period of widespread economic reforms in India, which consisted of industrial de-licensing from the mid-1980s onwards as well as trade and investment liberalization from 1991 onwards. Since the beginning of industrial de-licensing in 1984-85 coincides with a rising relative employment of skilled labor as well as a relatively constant skill premium, it is reasonable to expect that de-licensing may have increased the relative demand for skilled labor. Moreover, the sharp rise in the relative employment of skilled labor, together with a rising skill premium from 1991 onwards suggests that trade liberalization may have generated greater relative

[1] Plant-level data from the Annual Survey of Industries (ASI) is used for all figures and tables. A plant is defined as a production entity whereas a firm is a financial entity. Since the ASI consists of plants and industrial de-licensing pertained to production rather than financial units, we use the term plant throughout this paper. The survey covers all factories registered under the Factories Act of 1948 and only covers the formal sector in Indian manufacturing. White- and blue-collar workers are defined as skilled and unskilled workers, respectively.

[2] Even though our dataset ends in 1994-95, a continuation of the rising trend in the employment and wages of skilled labor relative to unskilled labor has been documented in the literature (Berman et al. 2005, Chamarbagwala 2006).

demand for skilled labor as well. In this paper, we therefore investigate whether or not industrial de-licensing and trade liberalization contributed to skill upgrading between 1980-81 and 1994-95 in India.

Industrial de-licensing meant freedom from constraints on output, inputs, technology, and location as well as free entry into de-licensed industries.[3] Freedom from these constraints allowed plants to take advantage of economies of scale, more efficient input combinations, and new technology. Further, greater domestic competition as a result of free entry into de-licensed industries provided plants with incentives to innovate, increase productivity, and improve product quality. Thus, in the presence of output-, capital-, and technology-skill complementarities, skill upgrading may be a result of industrial de-licensing, ceteris paribus. Moreover, if relative demand increases dominated relative supply increases, wage inequality may also increase. Besides industrial de-licensing, trade liberalization may have a similar effect on skilled labor. By increasing foreign competition for domestic plants and providing them with additional incentives to innovate, increase productivity, and improve product quality, there may be skill upgrading as well as greater wage inequality in the presence of output-, capital-, and technology-skill complementarities. On the other hand, the predictions of the Stolper-Samuelson theorem suggest that trade liberalization would lower the relative demand for and returns to skill in an unskilled labor-intensive country where the most protected sectors were skill-intensive. Given the chronology of Indian reforms – i.e. industrial de-licensing during the 1980s and trade liberalization and de-licensing from 1991 onwards – as well as trends in the relative demand for and returns to skilled labor during the 1980s and 1990s, it is unclear how these reforms contributed to the relative demand for skilled labor.

A large body of literature has established a link between external sector reforms, skill upgrading, and wage inequality in India and other developing countries (Attanasio et al. 2004, Cragg & Epelbaum 1996, Feenstra & Hanson 1996, 1997, 2003, Goldberg & Pavcnik 2004, Gorg & Strobl 2002, Hanson 2003, Harrison & Hanson 1999, Pavcnik 2003, Verhoogen 2004). For the case of India, Berman et al. (2005), Chamarbagwala (2006), Kumar & Mishra (2005), Dutta (2005) all examine the relationship between trade liberalization, skill upgrading, and wage inequality during the 1980s

[3]See Sharma (2006*a*) and Sharma (2006*b*) for a detailed description of industrial de-licensing in India.

and 1990s. While these studies provide valuable insights into the relationship between external sector reforms, skill upgrading, and wage inequality, they don't allow for a relationship between domestic sector reforms, such as industrial de-licensing, and the demand for and returns to skilled labor. Berman et al. (2005) use Indian industry-level data to examine the relationship between output, capital, trade, and skill, but do not allow for a link between industrial de-licensing and skill. Sharma (2006*b*) provides evidence that industrial de-licensing contributed to productivity gains among Indian plants, though it does not address the effect of domestic sector reforms on skill upgrading. Our work builds on Berman et al. (2005) and Sharma (2006*b*) by allowing for industrial de-licensing as well as trade liberalization to influence skill upgrading using plant-level data for India.

In this paper, we investigate the relationship between industrial de-licensing, trade liberalization, and skill upgrading in India. Incorporating industrial de-licensing in an analysis of skill upgrading is particularly important for the case of India and is the major contribution of this paper to the literature. Few of the previous studies on India's labor market control for the changes in the 1980s that were brought about by industrial de-licensing and hence may provide biased estimates of the impact of trade liberalization on skill upgrading. Moreover, by stifling industrial growth and the relative demand for and returns to skilled labor, the licensing regime may have contributed to India's comparative advantage in the service sector during the Internet boom in the 1990s. Thus, examining how industrial de-licensing affected skill upgrading during the 1980s may provide a deeper understanding of India's labor market changes post 1991.

Table 1 brings forward three important points that challenge the predictions of other studies on India. First, the chronology of reforms was such that industrial de-licensing began during the mid-1980s and therefore well before the external sector reforms were implemented in July 1991. Thus, industrial de-licensing may have changed the domestic manufacturing environment during the 1980s and 1990s, which may have, in turn, affected the ability and incentives of Indian plants to respond to trade and investment liberalization after 1991. Second, the industrial de-licensing reforms of the 1980s were quite significant with respect to the percentage of manufacturing output that they affected. Cumulatively, 23% of output and almost 23% of employment had been de-

licensed by 1990. These two points suggest that ignoring pre-1991 changes in the licensing regime may provide misleading and biased estimates of the impact of the 1991 reforms. Third, de-licensing in 1991 was not "across the board" as is the common assumption in most studies. In fact, 16% of manufacturing output and 10% of employment were still under compulsory licensing post-1991. Some of these industries were gradually de-licensed in 1993 and 1994. Therefore, studies that ignore the actual chronology of industrial de-licensing post-1991 may overstate the impact of the 1991 reforms.

We identify two main channels through which industrial de-licensing affects the relative demand for skilled labor: capital- and output-skill complementarities. Our analysis finds three important results. First, capital- and output-skill complementarities exist for plants in both licensed and de-licensed industries but were stronger in de-licensed industries during the 1980s, prior to India's massive trade liberalization reforms in 1991. This suggests that industrial de-licensing increased the relative demand for skilled labor via capital- and output-skill complementarities during the 1980s, the decade before India liberalized trade. Second, capital-skill complementarities are stronger for plants that were de-licensed during the 1980s compared to those that were not, once trade was liberalized during the early 1990s. Thus, freedom from licensing requirements enabled plants in de-licensed industries to utilize more efficient inputs such as skill-biased capital, which together with trade reforms resulted in skill upgrading. Even though output-skill complementarities are stronger for plants that were de-licensed during the 1980s compared to those that were not, this difference was not magnified by trade liberalization. The ability of plants in de-licensed industries to take advantage of economies of scale thus appears to have benefited skilled labor regardless of trade liberalization. Third, regardless of de-licensing, capital- and output-skill complementarities are weaker for plants in industries where trade was liberalized during the early 1990s, a result that supports the predictions of the Stolper-Samuelson theorem.

This paper is organized as follows. Section 2 describes the domestic and external sector reforms during the 1980s and 1990s in India. Section 3 summarizes the mechanisms through which skill upgrading and wage inequality may be affected by domestic and external sector reforms. Section 4 describes our data, estimation, and identification strategy. We discuss our results in Section 5 and

conclude in Section 6.

2 Domestic and External Sector Reforms

Even though India's mixed economy framework mandated a role for private enterprise, the government believed it was necessary to provide incentives to private establishments to invest in desirable industries and locations. Industrial licensing therefore evolved as a method for the Indian government to control private enterprise in India.[4] A license was a document that permitted a plant to begin or continue production in an industry and was issued by the Ministry of Industry in New Delhi.

The licensing regime controlled entry into an industry and hence the amount of competition faced by a plant. The most important concern for the licensing committee while debating a particular case was the "demand-supply situation" of the good – if it was felt that there was enough existing capacity to satisfy projected demand then the application was rejected, irrespective of the quality of the proposed good and the nature and productivity of the technology that it proposed to use. Another important facet was the type of the good. There was a disdain for variety among policy-makers of the time and competition was thought to be wasteful. Import and foreign exchange requirements were also important considerations and a large number of applications were rejected because they required "too much" foreign exchange. Thus, new projects were not assessed on the merit of their efficiency, productivity, or quality (Das 2000, Marathe 1989).

A license also specified the amount of output that a plant could produce. This was conditional on the proposed location of the project and permission was required to change the location of production. The exact nature of the product was also specified and either permission or a new license was needed to change the product mix. A plant's inputs and technology, though not specified on the license, were also restricted. This is because the most crucial raw materials – steel, cement, coal, fuel, and furnace oil – as well as licenses to import inputs – including machinery and equipment – were controlled by the government with plants receiving annual allotments of these inputs for production. In fact, licensing requirements were implemented primarily through the restricted

[4]See Sharma (2006*a*) and Sharma (2006*b*) for a detailed description of industrial licensing in India.

allocation of these inputs to the plant. Based on the specified output limit on its license, every plant was allotted a fixed amount of these inputs annually. Thus, it was difficult if not impossible for an entrepreneur to produce over the specified output limit on his license.

Policy makers began realizing the crippling effect of the licensing regime on the Indian economy during the 1960s and 1970s and several ad hoc measures were implemented during this period.[5] However, it was only during the 1980s that the government took substantial steps in relaxing the licensing regime by "de-licensing" certain industries. Table 1 shows the percentage of manufacturing output and employment that was de-licensed during the 1980s and 1990s. While this piece-meal approach to reforming industrial policy continued through the 1980s, the Indian economy faced a severe balance of payments crisis in July 1991 and was forced to take loans from international organizations. It was at this time that the biggest de-licensing episode occurred, under pressure from these organizations. Almost all industrial licensing was removed, other than for 16% of manufacturing output.

Along with this, there were massive external sector reforms in 1991, which consisted of trade and investment liberalization. The trade policy reforms aimed at liberalizing and promoting both exports and imports. As a result of lower tariffs, elimination of quotas and import license requirements, and liberalization of technology imports, total exports and imports increased dramatically during the 1990s. Exports were liberalized via the abolition of export subsidies and controls while the liberalization of imports was implemented via a rapid reduction in tariff rates and the abolition of licensing and quantitative restrictions on most imports except consumer goods. The average ad valorem tariff rate fell from 125% in 1990 to 40% in 1999. Besides lower tariffs, non-tariff barriers were reduced by eliminating quantitative restrictions - quotas and import licensing requirements - particularly on capital and intermediate goods. In addition, technology imports were liberalized by eliminating technology license requirements. Foreign direct investment (FDI) was liberalized to a limited extent, resulting in an increase of FDI from $233 million to $3.3 billion during the 1990s. Besides these reforms, the rupee was devalued by 22% (from Rs. 21.20 to Rs. 25.80 per

[5]The first "de-licensing" of plants occurred in 1966 and by 1969, 41 industries were de-licensed. However in 1973, these industries were licensed again and it was only in 1975 that the second phase of de-licensing began, when 21 industries accounting for 3% of manufacturing output were de-licensed.

U.S. dollar). The sheer scale and scope of the reforms were so large that this reform episode has been the one that has caught the attention of policy-makers and researchers alike.

The licensing regime affected plant-level productivity and costs through its control on both the plant's ability and incentives to innovate, reduce costs, use efficient input combinations, adopt new technology, and exploit economies of scale. Direct controls on outputs and inputs affected plants' abilities whereas indirect control of entry affected plants' incentives. Even if direct controls were not fully implemented due to corruption, the effect of indirect controls on incentives was substantial. Licensing restricted entry into most sectors and created artificial monopolies and oligopolies. The average four-firm concentration ratio in Indian manufacturing in 1981 was 54% compared to 32% for the US in 1977. Even among developing countries, India's concentration ratio was closer to Poland's (65% in 1988) rather than Brazil's (32% in 1988).

3 Mechanisms of Skill Upgrading and Increased Wage Inequality

Given the extent of India's licensing regime, it is reasonable to expect that industrial de-licensing during the 1980s and 1990s may have played a role in raising the demand for and returns to skill in the country. We explore several hypotheses which explain the mechanisms through which domestic and external sector reforms may affect skills in less developed countries (LDCs). Hypotheses I and II relate both domestic and external sector reforms to the demand for and returns to skill in LDCs. Hypotheses III and IV concern only external sector reforms – that is, trade and investment liberalization.

The first hypothesis (Hypothesis I) relates skill-biased change to increased demand for skilled labor and a rising skill premium. According to this hypothesis, domestic and external sector reforms increase the degree of competition faced by firms as a result of entry of domestic firms as well as from foreign firms. Increased competition provides incentives for firms to become more productive – that is, exploit economies of scale, utilize more efficient input combinations, and adopt new technology. If these changes are *complementary* to skilled labor, economic liberalization should result in skill upgrading and increased wage inequality. In other words, in the presence of output-, capital-, and

technology-skill complementarities, we should observe skill upgrading and a widening skill-wage-gap after economic reforms. The existing literature focuses solely on trade liberalization and not on domestic sector reforms. Wood (1995) argues that trade liberalization results in "defensive innovation" – that is, greater competition from foreign firms may induce domestic firms in LDCs to either engage in R&D or to adopt new and advanced technologies in order to secure their market share in the domestic and international markets. Because of technology-skill complementarities, adoption of modern technologies raises the demand for and returns to skilled labor. Acemoglu (2003) describes how, as the result of trade liberalization in LDCs, increased capital goods imports can lead to greater demand for skilled workers as a result of capital-skill complementarities, thus increasing the skill-premium. Empirical support for this hypothesis is found by Attanasio et al. (2004) for Colombia and by Harrison & Hanson (1999) for the case of Mexico. Gorg & Strobl (2002) find an increase in the relative wages of skilled labor in Ghana, brought about by skill-biased technological change induced through imports of technology-intensive capital goods or export activity. However, Pavcnik (2003) rejects this hypothesis for Chilean plants. Berman et al. (2005) find evidence of output- and capital-skill complementarities in Indian industries during the 1990s, though they exclude any potential effect of industrial de-licensing on skill upgrading.

Quality-upgrading by firms, as a result of greater competition, is the second hypothesis (Hypothesis II). The basic argument is that domestic and external sector liberalization may induce quality upgrading by firms, where quality refers to either firm productivity or product quality. Quality upgrading may be complementary to skilled labor, thereby increasing the relative demand for and returns to skill. Verhoogen (2004) finds strong support for this hypothesis for the case of Mexico where greater exports as a result of the peso crisis resulted in better quality products being produced by exporters. Because higher quality products require a higher proportion of skilled workers, the relative demand for and returns to skilled labor increased. For India, Sharma (2006*b*) finds that plants that were de-licensed also experienced higher productivity both before and after the country's external sector reforms of 1991 but does not examine the relationship between reforms and skills. If productivity is complementary to skilled labor, we would expect that there would also be skill upgrading among Indian plants.

The third hypothesis (Hypothesis III) is based on the Stolper-Samuelson theorem in the Heckscher-Ohlin-Samuelson model and relates solely to external sector reforms in trade. The Stolper-Samuelson theorem predicts that trade liberalization will raise the demand for and returns to the abundant factor of production – that is, unskilled labor in most LDCs. Even though at first glance this theorem predicts a decrease in the wage gap between skilled and unskilled labor in LDCs, on closer inspection it shows that as protective import tariffs, quotas, and licenses are removed, the price of formerly protected goods will fall. By the Stolper-Samuelson, a decrease in the relative price of a good will decrease the relative price of the factor used intensively in the production of that good and increase the relative price of other factors. Since in many LDCs – namely Colombia, Mexico, Brazil, and Morocco – the most protected sectors were those that were intensive in unskilled labor, the Stolper-Samuelson theorem predicts that trade liberalization in these countries should lower unskilled wages. Thus, an increased demand for skilled labor and a widening skill-wage-gap support the predictions of the Stolper-Samuelson theorem in these countries. India, on the other hand, had its highest protection levels – both, tariff and non-tariff barriers – in human- and physical-capital-intensive sectors, making the Stolper-Samuelson theorem predict a decreased demand for skilled labor and a narrowing of the skill-wage-gap. The rising relative demand for and returns to skilled labor after 1991 therefore contradict the predictions of the Stolper-Samuelson theorem for India.

Global production sharing or outsourcing, which relates solely to external sector reforms in investment, is the fourth hypothesis (Hypothesis IV) that has been provided to explain the rising skill premium and demand for skilled labor in LDCs. Feenstra & Hanson (1996) and Feenstra & Hanson (2003) argue that trade and investment liberalization on the part of LDCs allows developed countries (DCs) to transfer the production of intermediate goods and services to LDCs. For LDCs these activities are skill-intensive, which results in a greater demand for and returns to skilled labor. Therefore, external sector reforms that promote trade in manufactures and services and those that attract foreign direct investment can benefit skilled workers in LDCs. Feenstra & Hanson (1997) find empirical support for this hypothesis for the case of Mexico. Since our analysis does not include a measure of outsourcing, we cannot evaluate Hypothesis IV in this study.

Our empirical analysis provides evidence that capital- and output-skill complementarities exist

for plants in both licensed and de-licensed industries but were stronger in de-licensed industries during the 1980s, prior to India's massive trade liberalization reforms in 1991. These results support Hypotheses I and II with respect to domestic sector reforms and indicate that industrial de-licensing played an important role in skill upgrading before the 1991 trade liberalization reforms. The lifting of microeconomic constraints for plants in de-licensed industries appears to have brought about greater competition and therefore more incentives to increase productivity and improve product quality. We also find support for the predictions of the Stolper-Samuelson theorem (Hypothesis III) until the mid-1990s in India. Regardless of de-licensing, capital- and output-skill complementarities are weaker for plants in industries where trade was liberalized during the early 1990s. Skilled labor in protected industries benefited more than those in unprotected ones whether they were in de-licensed industries or not. On the other hand, capital-skill complementarities are stronger for plants that were de-licensed during the 1980s compared to those that were not, once trade was liberalized during the early 1990s. Thus, despite evidence in support of the Stolper-Samuelson theorem, skilled labor in de-licensed industries benefited more than those in licensed ones, a result that once again supports Hypotheses I and II with respect to domestic sector reforms. That we find stronger output-skill complementarities among plants that were de-licensed in the 1980s compared to those that were not, regardless of trade liberalization, also supports Hypotheses I and II with respect to domestic sector reforms.

4 Data and Estimation

4.1 Data

Our data comes from three sources. In order to measure the extent of industrial de-licensing faced by a plant, we have collected a unique and detailed dataset of industrial policy in India from the 1970s onwards. Using this data, we can identify which four-digit industry underwent reform – that is, freedom from licensing requirements – in each year in the 1970s, 1980s, and 1990s. The main source of this data was internal government publications and notifications issued to administrative ministries. Various issues of "Guidelines for Industry", which is a publication by the Ministry of Industry, were used to collect this data. This publication consists of various government orders,

notifications, and memos that were compiled for entrepreneurs as well as government officials to use and was obtained from various government and ministry libraries. Some commonly available publications like the Economic Survey were also used to collect and check the de-licensing data. Common publications, however, do not reveal the level of detail about the conditions under which plants were eligible to avail of certain policies, for example, size-based exemption from licensing. Study of government notifications and memos provided insight into the ideology of policy-makers and provided rich detail that we exploit in our identification strategy. Table 2 presents information on the number of industries that were de-licensed in each year from 1980-81 until 1994-95. De-licensing began only in 1984-85 and there was no de-licensing between 1988 and 1991. The biggest de-licensing episode occurred in 1991-92 along with external sector reforms in trade and investment. After 1991-92, a few more industries were de-licensed and by 1994-95 only 100 four-digit industries remained under licensing.

Data on trade liberalization consists of tariffs in three-digit NIC industries for three sub-periods 1980-84, 1985-90 and 1991-95, obtained from Das (2003). We find that tariffs for an average 3-digit industry declined by 22 percentage points between 1985-90 and 1991-95. An industry is defined as trade liberalized if its tariff fell by more than 22 percentage points between these two periods. Table 3 shows the number of industries where trade was liberalized between 1985-90 and 1991-95.

The third source of data is plant-level data for the years 1980-81 until 1994-95 from the Annual Survey of Industries (ASI), conducted by the Central Statistical Organization (CSO), a department in the Indian Government's Ministry of Statistics and Program Implementation. The survey covers all plants registered under the Factories Act of 1948 and only covers the formal sector in Indian manufacturing. The ASI frame can be classified into two sectors – the census sector and the sample sector. Units employing more than 100 workers constitute the census sector. Units in the census sector are covered with a sampling probability of 1 while units in the sample sector are covered with probabilities one-half (until 1987-88) or one-third (after 1987-88). The ASI data consists of a time-series of cross-sections of plants and is not a panel.

The ASI collects data from plants employing more than 20 workers for plants not using electricity and 10 workers if the plant used electricity. However, a plant only came under the purview of the

licensing regime if it was defined as a factory, as per the Industries Development & Regulation Act of 1951 (IDRA). According to the IDRA, a factory is defined as a unit that employs 100 or more workers without power or 50 or more workers with power. For our analysis, we use data on all establishments surveyed by the ASI and include an indicator for "factories" as defined by the IDRA since only these plants were the ones that came under the ambit of industrial licensing. In all our analyses, we weight observations using the multiplier or the inverse sampling probability to adjust for sampling frequency.

Production units with assets in plant, machinery, land, and building below a certain defined threshold were free or "exempt" from industrial licensing requirements. This was part of the government's strategy to promote the growth of smaller plants that would then be the main generation of employment in the manufacturing sector. Moreover, by limiting the number of establishments that fell under the licensing requirement, the administrative burden of the licensing regime was controlled. By granting exemptions to some plants, the volume of applications required for processing by the licensing authority was diminished. As long as exempt plants remained under the threshold asset level, they could enter into and operate in any industry without restrictions on output, inputs, or investment.

The criterion for exemption was based on the original rupee value of plant, machinery, land, and building owned (or proposed to be owned) by the plant and was the same for all industries. From 1980-81 to 1982-83, units with assets in plant, machinery, land, and building worth less than or equal to Rs. 30 million were defined as "small" plants and therefore exempt from licensing requirements. Between 1983-84 and 1989-90, this threshold rose to Rs. 50 million and after 1990-91 to Rs. 150 million.[6]

De-licensing data was merged with plant-level data from the ASI at the four-digit NIC level. Table 4 presents plant characteristics in licensed and de-licensed industries that are used in the empirical analysis. The number of four-digit NIC industries that were de-licensed and under licensing requirements is cumulative and include those in the ASI dataset in each year. Plant characteristics include average values of the employment and wagebill shares of white-collar workers, the

[6]Inflation did not change a plant's exemption status since the threshold was based on the original or book value rather than the current value of a plant's assets.

capital-output ratio, and real output in each year from 1980-81 until 1994-95. The ASI includes information on an occupational rather than a skill or education measure of employment. The occupational measure differentiates between non-production and production workers, which we define as white- and blue-collar workers, respectively. The employment share of white-collar workers is the number of white-collar workers divided by the total number of workers hired by a plant. The wagebill share of white-collar workers is total wages paid to white-collar workers divided by total wages paid to all workers. The skill premium is defined as the ratio of the average white- and blue-collar wage rates. Capital is defined as "the average of the opening and closing book value of assets in plant, machinery, land, and building". This definition does not take account of inflation or the economic value of capital owned by the plant and is similar to the asset level that determined whether or not a plant was exempt from de-licensing or under licensing restrictions. Real output is in 1993-94 Rupees.

As shown in Table 4, the employment and wagebill shares of white-collar workers are slightly higher in de-licensed than in licensed industries until 1991-92, after which the pattern reverses. de-licensed industries also have higher capital-output ratios compared to licensed ones. Real output is slightly higher in de-licensed industries until 1991-92 onwards, when real output in licensed industries is almost double that in de-licensed ones.[7]

4.2 Empirical Analysis

4.2.1 Industrial de-licensing and Skill Upgrading: 1980-81 to 1990-91

We begin by investigating the relationship between industrial de-licensing and skill upgrading prior to the 1991 external sector reforms. To focus on the pre-1991 relationship between industrial de-licensing and skills, we restrict our sample to only include the period *before* the external sector reforms of July 1991. Thus, we only include plants during the period 1980-81 to 1990-91 and estimate the following equation.

$$Y_{ijts} = \alpha + \beta_1 DL_{jt} + \epsilon_{ijts} \tag{1}$$

[7]The rise in output in licensed industries from 1991-92 onwards is primarily due to the dramatic decline in the number of plants in licensed industries from 1991-92 onwards. The dramatic decline in the number of observations makes the distribution less skewed, which raises the average output.

Here Y_{ijts} is a measure of the relative demand for skilled labor for plant i producing in industry j located in state s in year t. We use two alternate measures of the relative demand for skilled labor – that is, the proportion of white-collar workers employed by the plant and the plant's wagebill share of white-collar workers. White- and blue-collar workers are non-production and production workers respectively. The employment share of white-collar workers is defined as $\frac{White-CollarWorkers_{ijts}}{TotalWorkers_{ijts}}$ whereas the wagebill share of white-collar workers is defined as $\frac{White-CollarWages_{ijts}}{TotalWages_{ijts}}$. DL_{jt} is an indicator that takes a value of 1 if industry j was de-licensed in year t and 0 otherwise.

There are two potential sources of endogeneity of industry de-licensing which may provide biased and inconsistent estimates of β_1 in Equation 1. The first potential source of endogeneity is unobserved heterogeneity or omitted variable bias at the industry level. Our main explanatory variable, DL_{jt}, varies at the four-digit industry-level of the National Industrial Classification (NIC). Political economy factors, like political affiliation and lobbying power, also vary at the industry-level and may determine whether or not industry j gets de-licensed in any given year t. If political power is also concentrated among highly skilled industries, then there may be a spurious correlation between industrial de-licensing and the relative demand for skilled labor, which would bias our estimate of β_1. In order to control for unobservable heterogeneity at the industry-level, we include four-digit industry fixed effects, δ_j. We also include year (γ_t) and state (λ_s) fixed effects to control for year- and state-specific unobservables that may influence labor market conditions, such as labor laws. Equation 2 includes industry, year, and state fixed effects.

$$Y_{ijts} = \alpha + \beta_1 DL_{jt} + \delta_j + \gamma_t + \lambda_s + \epsilon_{ijts} \tag{2}$$

The nature of industrial de-licensing in India provides yet another potential source of bias of β_1: there may be a reverse causation between skill upgrading and industrial de-licensing. The reforms of the 1980s have been characterized by some as "reforms by stealth". There was no consensus for economic reforms in the 1980s. More importantly, it is clear from policy documents that the government was eager to portray the changes of the 1980s as a continuation of the existing system even though these reforms introduced dramatic changes that veered away from the high-regulation, socialist paradigm that had been operating since the 1950s. Under these circumstances, it is possible that the Indian government chose industries for de-licensing based on certain industry-specific

characteristics that either raised the chances of success of the reforms or that minimized social costs in case of failure. For example, the government may have chosen to de-license more skill-intensive industries if government officials expected skill-intensity to enhance the success of the reforms or to minimize the employment effects of de-licensing. In this case, β_1 will not measure the effect of industrial de-licensing on skills. Rather, it will capture the *selection* of skill-intensive industries into de-licensing. While industry fixed effects control for some industry-specific characteristics that may have determined selection into de-licensing, we need plant-level variation in our de-licensing measure in order to get reliable estimates.

Our identification strategy coincides closely with an important institutional feature of the licensing regime in India. As discussed in Section 4.1, there was an important size-based difference in the application of licensing provisions. In particular, units that had assets in plant, machinery, land, and building less than a threshold value were exempt from industrial licensing requirements. It is reasonable to expect that all plants in an industry – i.e. both exempt and non-exempt plants – will be affected once the industry is de-licensed since they all face free entry, greater competition, and incentives to innovate and improve product quality. However, the greatest impact of de-licensing will most likely be observed among plants that were non-exempt from licensing requirements since these plants will experience freedom from output, input, and technology constraints after de-licensing. In order to identify the effect of industrial de-licensing on skill upgrading, we therefore include an indicator for a plant's non-exemption status (NE_{ijts}) and interact this indicator with the de-licensing dummy ($DL_{jt} * NE_{ijts}$) in Equation 3.

$$Y_{ijts} = \alpha + \beta_1 DL_{jt} + \beta_2 NE_{ijts} + \beta_3 DL_{jt} * NE_{ijts} + \delta_j + \gamma_t + \lambda_s + \epsilon_{ijts} \tag{3}$$

The specification in Equation 3 is a difference-in-differences estimation where NE_{ijts} is an indicator that takes the value of 1 if plant i in industry j and state s was non-exempt from licensing requirements in year t – i.e. if the plant's assets in plant, machinery, land, and building were equal to or more than a certain threshold – and 0 otherwise. Assets in plant, machinery, land, and building are the plant's fixed capital in a given year.[8] The difference-in-differences specification in Equation 3

[8]Fixed capital is defined as the "book value of assets in plant, machinery, land, and building". This definition does not take account of inflation or the economic value of capital owned by the plant.

captures whether or not the difference in skill upgrading between non-exempt (large) and exempt (small) plants was different for plants in industries that were de-licensed compared to those that remained under licensing requirements.[9]

One potential concern with the identification strategy in Equation 3 is that de-licensing may result in a change in the size distribution of plants in an industry, which could affect the results. For example, after the removal of licensing requirements, plants that previously limited their size in order to remain exempt from licensing may have expanded production. Sharma (2006*a*) investigates this claim in great detail and finds no evidence of any major change in the size distribution of plants after de-licensing. Sharma (2006*a*) finds that in industries that were de-licensed between 1984-85 and 1990-91, the proportion of exempt plants was 0.95 during 1980-81 to 1983-84 – i.e. the period before de-licensing. Once these industries were de-licensed, the proportion of exempt plants fell to 0.93.[10] This pattern was identical to that in industries that were not de-licensed during the 1980s, where the proportion of exempt plants fell from 0.97 to 0.95 from the pre-reform period (1980-81 to 1983-84) to the de-licensing period (1984-85 to 1990-91). Thus, there was no sudden inexplicable decline in the proportion of exempt plants post-reform. Similarly, the average annual rate of growth of the number of exempt plants also maintained its pattern across licensed and de-licensed industries between 1980-81 and 1983-84 and between 1984-85 and 1990-91. It rose from 1.6% to 2.4% in de-licensed industries and from -1.5% to 0.5% in industries that remained under licensing requirements. Sharma (2006*a*) also finds no sudden or major shift in the size distribution of small plants in de-licensed industries when compared to small plants in licensed industries.

Hypothesis I in Section 3 discusses two important mechanisms through which domestic reforms, such as industrial de-licensing, are expected to affect skill upgrading – i.e. capital- and output-skill complementarities. In order to investigate this hypothesis, we replace the indicator for a plant's non-exemption status (NE_{ijts}) with the natural log of a plant's capital-output ratio ($ln\left(\frac{K_{ijts}}{O_{ijts}}\right)$)

[9]Note that exempt plants are not the control in Equation 3 since the definition of a control group would imply that exempt plants are identical to non-exempt plants, except for the de-licensing experiment. There are large differences between exempt and non-exempt plants, based simply on size.

[10]See Chapter 3, Section 3.5.3 and Appendix B.2 in Sharma (2006*a*).

and the natural log of a plant's output level ($ln\left(O_{ijts}\right)$) in Equation 4.

$$Y_{ijts} = \alpha + \beta_1 DL_{jt} + \beta_2 ln\left(\frac{K_{ijts}}{O_{ijts}}\right) + \beta_3 ln\left(O_{ijts}\right) + \beta_4 DL_{ijts} * ln\left(\frac{K_{ijts}}{O_{ijts}}\right) + \beta_5 DL_{jt} * ln\left(O_{ijts}\right) + \delta_j + \gamma_t + \lambda_s + \epsilon_{ijts} \tag{4}$$

K_{ijts} is measured as the plant's assets in plant, machinery, land, and building in year t and is identical to the measure used to calculate a plant's non-exemption status. Output is measured as plant j's real output in year t, which is calculated using industry-specific deflators.

The rationale for including the capital-output ratio and output level of a plant rather than it's non-exemption status is the following. First, as mentioned above, capital- and output-skill complementarities are two important mechanisms through which industrial de-licensing is expected to affect skill upgrading. Second, the capital-output ratio and output level of a plant is highly correlated with it's non-exemption status, as is evident in Table 5, which presents summary statistics of our key variables for plants that were not exempt from industrial licensing (columns (2) and (3)) and for plants that were exempt from licensing requirements (columns (4) and (5)) for three periods.[11] In all three periods, plants that were not exempt from licensing had approximately twice the average natural log of the capital-output ratio and roughly 1.5 times the average natural log of output compared to plants that were exempt from licensing. Third, the specification in Equation 4 allows us to examine whether or not *all* plants in an industry – i.e. both exempt and non-exempt ones – are affected by de-licensing, based on continuous measures of their capital-output ratio and output level rather than simply comparing plants above and below the threshold asset level.[12]

The size-based exemption from licensing requirements, however, suggests a regression-discontinuity design which compares capital- and output-skill complementarities among firms that are near the cutoff asset limit after de-licensing. Equation 4 does not take this regression-discontinuity into account. Estimating a fully interacted model with a plant's capital-output ratio, output level, and

[11] The period 1980-81 to 1983-84 is pre-reform with no industrial de-licensing or external sector policy changes. During 1984-85 and 1990-91 there was only industrial de-licensing and the 1991-92 to 1994-95 period was characterized by both industrial de-licensing and external sector reforms.

[12] An equation that uses changes in the share of skilled labor as the dependent variable and changes in the capital-output ratio and output level of a firm as explanatory variables can be derived from a translog cost function of a firm that uses capital as well as skilled and unskilled labor as inputs. This has been used by Berman et al. (1993) and Berman et al. (2005). Since the ASI dataset is not a panel of plants, we cannot estimate such an equation at the plant level.

non-exemption and de-licensing status would make the analysis overly complicated and intractable. We therefore estimate Equation 4 at various points around the threshold for exemption and discuss this in Section 5.3.1.

All regressions are weighted with plant-level multipliers or the inverse sampling probability to adjust for sampling frequency and winsorized at the 1% level. In all regressions we include an indicator for whether the plant is a factory or not, as defined by the IDRA.[13] We also include indicators for the type of ownership and organization of a plant. For ownership structure, we include two indicators – one for a joint sector plant and the other for a plant in the private sector. The omitted group consists of plants in the public sector. We include two indicators to capture overall differences in organization structure – one for a public or private limited company and the other for a co-operative society. The omitted group consists of plants that are individual proprietorships or partnerships.[14] In all regressions, we estimate robust standard errors, clustered at the four-digit NIC industry-year level.

Even though we include four-digit industry, state, and year fixed effects, in addition to indicators for the type of ownership and organization of a plant, the existence of plant-level unobserved heterogeneity may still provide biased estimates of capital- and output-skill complementarities in licensed and de-licensed industries. This may happen if, for example, plant-level productivity is correlated with a plant's size, capital-output ratio, output level, as well as it's relative demand for skilled labor. While the inclusion of plant-level fixed effects would solve this problem, the ASI data does not include a panel of plants. Therefore, we cannot include plant fixed effects in any of our regressions and this should be considered in evaluating the results.

[13] A factory is a plant that employs 50 or more workers and uses power in the production process or one that employs 100 or more workers without using power in the production process.

[14] The four major choices for organizing a business in India are individual proprietorships, partnerships, companies (private or public limited), and co-operative societies. The individual proprietorship form consists of entrepreneurs who have sole ownership of the establishment. Establishments with multiple owners or shareholders may be partnerships, companies, or co-operative societies. See Chapter 3 of Ramani et al. (2004) for a detailed discussion of alternative business forms.

4.2.2 Industrial de-licensing, Trade Liberalization, and Skill Upgrading: 1980-81 to 1994-95

Using data for the entire period, 1980-81 to 1994-95, we next examine how industrial de-licensing during the 1980s and trade liberalization from 1991 onwards affected the relative demand for skills. Given the chronology of reforms, the main objective of this analysis is to understand how plants that were de-licensed during the 1980s performed with respect to skill upgrading after the trade reforms from 1991 onwards. Using data on tariffs in three-digit NIC industries from Das (2003) for three sub-periods 1980-84, 1985-90 and 1991-95, we find that tariffs for an average 3-digit industry declined by 22 percentage points between 1985-90 and 1991-95. We therefore define an indicator for whether industry j underwent trade liberalization between 1985-90 and 1991-95, TL_{jt}, which is 1 from 1991-92 onwards if the tariff in industry j fell by more than 22 percentage points between 1985-90 and 1991-95 and 0 otherwise. We estimate Equations 5 and 6 using data for the period 1980-81 to 1994-95.

$$\begin{aligned} Y_{ijts} = {} & \alpha + \beta_1 DE80_{jt} + \beta_2 TL_{jt} + \beta_3 NE_{ijts} + \beta_4 DE80_{jt} * TL_{jt} \\ & + \beta_5 DE80_{jt} * NE_{ijts} + \beta_7 TL_{jt} * NE_{ijts} + \beta_8 DE80_{jt} * TL_{jt} * NE_{ijts} \\ & + \delta_j + \gamma_t + \lambda_s + \epsilon_{ijts} \end{aligned} \tag{5}$$

$$\begin{aligned} Y_{ijts} = {} & \alpha + \beta_1 DE80_{jt} + \beta_2 TL_{jt} + \beta_3 ln\left(\frac{K_{ijts}}{O_{ijts}}\right) + \beta_4 ln\left(O_{ijts}\right) + \beta_5 DE80_{jt} * TL_{jt} \\ & + \beta_6 DE80_{jt} * ln\left(\frac{K_{ijts}}{O_{ijts}}\right) + \beta_7 DE80_{jt} * ln\left(O_{ijts}\right) + \beta_8 TL_{jt} * ln\left(\frac{K_{ijts}}{O_{ijts}}\right) \\ & + \beta_9 TL_{jt} * ln\left(O_{ijts}\right) + \beta_{10} DE80_{jt} * TL_{jt} * ln\left(\frac{K_{ijts}}{O_{ijts}}\right) \\ & + \beta_{11} DE80_{jt} * TL_{jt} * ln\left(O_{ijts}\right) + \delta_j + \gamma_t + \lambda_s + \epsilon_{ijts} \end{aligned} \tag{6}$$

In Equations 5 and 6 we use a different measure of industrial de-licensing that only incorporates de-licensing during the 1980s. $DE80_{jt}$ is an indicator that takes a value of 1 if industry j was de-licensed in year t and 0 otherwise, provided it was de-licensed during the 1980s. Thus, if industry a was de-licensed in 1984-85, $DE80_{at}$ will be 1 from 1984-85 until 1994-95 for all plants in industry a and 0 from 1980-81 until 1983-84. On the other hand, if industry b was only de-licensed in 1991-92, $DE80_{bt}$ will be 0 from 1980-81 until 1994-95. We use this alternate measure of industrial

de-licensing in order to isolate the impact of de-licensing during the 1980s from the effects of the 1991 reforms. As described in Section 2, the 1991 reforms consisted of industrial de-licensing as well as trade and investment liberalization and Table 2 shows that the largest de-licensing episode occurred in 1991, along with trade and investment liberalization. Equation 5 therefore allows us to examine the effect of pre-1991 industrial de-licensing on skill upgrading with and without trade liberalization.

5 Results

5.1 Industrial De-Licensing and Skill Upgrading: 1980-81 to 1990-91

We present results of estimating Equation 3 in Table 7. The bottom panel presents coefficients and F-test statistics for the relationship between a plant's non-exemption status and skill upgrading in licensed and de-licensed industries. In licensed industries, the employment share of white-collar workers is 4.1 percentage points (pp) higher among large plants (i.e. those with an asset value equal to or above the threshold) compared to small plants (i.e. those with as asset value below the threshold). In de-licensed industries, the employment share of white-collar workers is 6.7 p.p. higher in large compared to small plants. A similar relationship is found for the wagebill share of white-collar workers, which is 3.4 pp and 5.2 pp higher in large than in small plants in licensed and de-licensed industries, respectively.

In Table 8, results of Equation 4 are presented. In order to compare plants in licensed and de-licensed industries, Table 9 presents coefficients and F-test statistics in Panel A.[15] In Panel B, elasticities are calculated using the coefficient estimates in Panel A and the average employment and wagebill shares of white-collar workers from Table 6 (0.19 and 0.26 respectively).[16] The elasticity of the employment share of white-collar workers with respect to the capital-output ratio is larger in de-licensed industries (0.079) than in licensed ones (0.058). A similar pattern is found for the elasticity of the wagebill share of white-collar workers with respect to the capital-output ratio,

[15]The coefficients in Panel A are obtained by taking the derivative of the employment and wagebill shares of white-collar workers with respect to $(ln\left(\frac{K_{ijts}}{O_{ijts}}\right))$ and $(ln\left(O_{ijts}\right))$, respectively, separately for plants in licensed and de-licensed industries.

[16]Elasticities are calculated as the coefficient (in Panel A) divided by the average employment and wagebill shares of white-collar workers in the period 1980-81 to 1990-91.

which is 0.085 in de-licensed industries and 0.065 in licensed ones. Elasticities of the employment and wagebill shares of white-collar workers with respect to the output level are almost double those with respect to the capital-output ratio and are larger in de-licensed than in licensed industries.

Panel C summarizes the degree of capital- and output-skill complementarities in terms of elasticities based the rate of growth of the capital-output ratio (80.58%) and output level (49.83%) for the average plant during the period 1980-81 to 1990-91. Panel C shows that an increase of 80.58% in the capital-output ratio for the average plant between 1980-81 and 1990-91 is associated with a 4.67% and 6.36% rise in the employment share of white-collar workers for plants in licensed and de-licensed industries, respectively. For the wagebill share of white-collar workers, these figures are 5.27% and 6.82% for plants in licensed and de-licensed industries, respectively. Even though these changes are small, we find that industrial de-licensing strengthened capital-skill complementarities with respect to the employment and wagebill shares of white-collar workers during the 1980s in India.

With respect to output-skill complementarities, an increase of 49.83% in the output level for the average plant between 1980-81 and 1990-91 is associated with a 5.51% and 7.87% rise in the employment share of white-collar workers for plants in licensed and de-licensed industries, respectively. For the wagebill share of white-collar workers, there is a 6.32% and 8.05% increase for plants in licensed and de-licensed industries, respectively. Thus, industrial de-licensing during the 1980s *strengthened* output-skill complementarities with respect to the relative demand for skilled labor. Our results are qualitatively similar to Berman et al. (2005), who find that output-skill complementarities are substantially larger than capital-skill complementarities in Indian industries.

Overall, industrial de-licensing appears to have increased the relative demand for skilled workers via both capital- and output-skill complementarities during the 1980s in India.

5.2 Industrial De-Licensing, Trade Liberalization, and Skill Upgrading: 1980-81 to 1994-95

We next turn to examining how plants that were de-licensed during the 1980s performed in terms of skill upgrading after trade liberalization from 1991 onwards. Results of estimating Equation 5 are presented in Table 10, the bottom panel of which shows the relationship between a plant's

non-exemption status and skill upgrading in licensed and de-licensed industries for two groups – industries that did not undergo trade liberalization during the early 1990s and those that did. For both groups – i.e. industries without and with trade liberalization – the results are qualitatively similar to those presented in Table 7. In industries without trade liberalization, the employment share of white-collar workers is 4.7 pp and 6.2 pp higher in large compared to small plants in licensed and de-licensed industries, respectively. Corresponding figures for the wagebill share of white-collar workers are 4.3 pp and 4.9 pp. Thus, skill upgrading is higher in de-licensed than in licensed industries. In industries with trade liberalization, a similar pattern is found. However, the difference between de-licensed and licensed industries is much stronger for this group with respect to both the employment share (7.9 pp versus 4.4 pp) and wagebill share (8.5 pp versus 4.5 pp) of white-collar workers. Thus, de-licensing together with trade liberalization appears to have benefited skilled labor among large plants more than just de-licensing alone.

Results of estimating Equation 6 are presented in Table 11. In order to compare plants in licensed and de-licensed industries, Table 12 presents coefficients and F-test statistics in Panel A, elasticities in Panel B, and capital- and output-skill complementarities in Panel C. Results for plants in industries that did not undergo trade liberalization are presented in the left panel whereas results for trade liberalized industries are presented in the right panel. Three observations are striking in comparing capital- and output-skill complementarities in panel C by licensing and trade liberalization status.

First, there is no difference in capital-skill complementarities between plants in licensed and de-licensed industries for industries that did not undergo trade liberalization during the early 1990s. An increase of 122.07% in the capital-output ratio for the average plant in industries without trade liberalization between 1980-81 and 1994-95 is associated with a 5.49% and 5.88% rise in the employment and wagebill shares of white-collar workers for plants in both licensed and de-licensed industries. On the other hand, capital-skill complementarities are stronger in de-licensed than in licensed industries for industries where trade was liberalized from 1991 onwards. An increase of 148.54% in the capital-output ratio for the average plant in industries with trade liberalization between 1980-81 and 1994-95 generated an increase of 2.23% and 3.71% in the employment share of

white-collar workers in licensed and de-licensed industries, respectively. The corresponding figures for the wagebill share of white-collar workers – 2.75% and 6.05% – show an even wider gap in capital-skill complementarities in licensed and de-licensed industries. This result indicates that freedom from licensing requirements during the 1980s enabled plants in de-licensed industries to utilize more efficient inputs such as skill-biased capital, which only together with trade reforms resulted in greater skill upgrading in de-licensed than in licensed industries.

Second, output-skill complementarities are stronger in de-licensed than in licensed industries. However, this is true for both groups of industries – i.e. protected as well as trade liberalized ones. An increase of 55.44% in the output level for the average plant in industries without trade liberalization between 1980-81 and 1994-95 generated an increase of 6.10% (6.37%) and 7.76% (7.19%) in the employment (wagebill) share of white-collar workers in licensed and de-licensed industries, respectively. For industries with trade liberalization, these figures are respectively 6.00% (6.55%) and 6.63% (6.78%), given an increase of 63.15% in the output level for the average plant between 1980-81 and 1994-95 in liberalized industries. Since trade liberalization did not magnify the difference in output-skill complementarities between de-licensed and licensed industries, the ability of plants in de-licensed industries to take advantage of economies of scale appears to have benefited skilled labor regardless of trade liberalization.

The third interesting result in Table 12 is that regardless of de-licensing, capital- and output-skill complementarities were weaker for plants in industries where trade was liberalized during the early 1990s. That capital- and output-skill complementarities in liberalized industries (right panel) are lower than those in protected industries (left panel) in both licensed and de-licensed industries indicates that trade liberalization lowered the relative demand for skilled labor via capital and output, despite the incentives faced by plants in de-licensed industries to upgrade skills. This result therefore supports the predictions of the Stolper-Samuelson theorem – the lowering of tariffs in previously protected industries weakened capital- and output-skill complementarities.

5.3 Robustness Checks

5.3.1 Locally Weighted Regressions

A potential concern with estimates of Equation 4 is that there is no explicit control for the exemption status of plant.[17] That is, we would like to allow exempt (small) plants to have different capital- and output-skill complementarities levels as compared to non-exempt (large) plants. Going a step further, we would also like to see whether distance from the threshold matters – i.e. do firms closer to the threshold behave differently, in terms of skill upgrading, from firms further away from the threshold? Ideally, we would like to incorporate a plant's exemption status into Equation 4. However, this is not possible for several reasons. First, a plant's exemption status is highly correlated with it's capital-output ratio and output level, leading to multi-collinearity. Second, a fully interacted model makes the analysis complicated and intractable.

We solve this problem by estimating the coefficients of Equation 4 at various distances from the exemption threshold which gives us a set of map-able parameter estimates. These are locally weighted regressions where the weights are calculated using a Gaussian weighting scheme. According to this weighting scheme, the weight or influence of other data on point i decreases with increased distance from point i and the decreasing weight follows a Gaussian curve. This method allows us to use all observations to calculate regression coefficients for 150 distances from the exemption threshold.

Figure 3 plots the coefficients that capture the relationship between a plant's capital-output ratio and it's employment and wagebill shares of white-collar workers in a de-licensed industry – i.e. $\beta_2 + \beta_4$ – by it's asset level relative to the threshold asset level for exemption. The 100% point on the horizontal axis represents plants with assets exactly equal to the threshold for exemption. Similarly, Figure 4 plots the coefficients that capture the relationship between a plant's output level and it's employment and wagebill shares of white-collar workers in a de-licensed industry – i.e. $\beta_3 + \beta_5$ – by it's asset level relative to the threshold asset level for exemption.[18]

[17] This concern also holds for Equation 6. We restrict this robustness check to the 1980s data – i.e. estimating Equation 4. Results for Equation 6 are similar and can be provided by the authors upon requenst.

[18] Locally weighted regressions of Equation 4 with a Gaussian kernel bandwith of 0.1 over 150 grid points are estimated. Bootstrapped 95% confidence intervals from 50 repetitions are shown in both figures. Standard errors are clustered at the 4-digit-industry-year level. All regressions include industry, state, and year unweighted fixed

These figures show that there is no abrupt jump in complementarities around the threshold for exemption. That is, Equation 4 seems to be correctly specified and provides reliable estimates of capital- and output-skill complementarities. Secondly, the graphs also show that our results of greater capital-skill complementarities for plants in de-licensed industries are not driven by extremely large or extremely small plants. If anything, very large plants seem to have lower regression coefficient estimates. Thirdly, the graphs for output-skill complementarities show more variability than those for capital-skill complementarities. This makes sense since output was one of the target variables of licensing and there were explicit limits that were placed on non-exempt plants. Exempt (small) plants had indirect limits on their output since their capital (plant, machinery, land, and building) was restricted – i.e. increasing their value of plant, machinery, land, and building to the threshold level would move these plants from the exempt to the non-exempt category. It is interesting to note that smaller plants seem to have larger output-skill complementarities. This may be the case if smaller plants were more output constrained and so had more scope for economies of scale to kick in.

5.3.2 De-Licensing During the 1980s and 1990s

As shown in Table 2, the most dramatic reduction in licensing occurred in 1991-92, together with trade liberalization. Since there was a considerable overlap in the industries that were de-licensed and those with a larger than average reduction in tariffs (Table 3), the trade liberalization measure (TL_{jt}) may be capturing not only trade liberalization but also industrial de-licensing in 1991-92. To isolate the effect of trade liberalization and de-licensing in 1991-92 on skill upgrading, we estimate Equation 7 where $DE91_{jt}$ is 1 if industry j was de-licensed in or after 1991-92 and 0 otherwise.

effects.

$$
\begin{aligned}
Y_{ijts} = {} & \alpha + \beta_1 DE80_{jt} + \beta_2 DE91_{jt} + \beta_3 TL_{jt} + \beta_4 ln\left(\frac{K_{ijts}}{O_{ijts}}\right) + \beta_5 ln\left(O_{ijts}\right) \\
& + \beta_6 DE80_{jt} * TL_{jt} + \beta_7 DE91_{jt} * TL_{jt} + \beta_8 DE80_{jt} * ln\left(\frac{K_{ijts}}{O_{ijts}}\right) + \beta_9 DE91_{jt} * ln\left(\frac{K_{ijts}}{O_{ijts}}\right) \\
& + \beta_{10} DE80_{jt} * ln\left(O_{ijts}\right) + \beta_{11} DE91_{jt} * ln\left(O_{ijts}\right) + \beta_{12} TL_{jt} * ln\left(\frac{K_{ijts}}{O_{ijts}}\right) \\
& + \beta_{13} TL_{jt} * ln\left(O_{ijts}\right) + \beta_{14} DE80_{jt} * TL_{jt} * ln\left(\frac{K_{ijts}}{O_{ijts}}\right) + \beta_{15} DE91_{jt} * TL_{jt} * ln\left(\frac{K_{ijts}}{O_{ijts}}\right) \\
& + \beta_{16} DE80_{jt} * TL_{jt} * ln\left(O_{ijts}\right) + \beta_{17} DE91_{jt} * TL_{jt} * ln\left(O_{ijts}\right) + \delta_j + \gamma_t + \lambda_s + \epsilon_{ijts}
\end{aligned}
\tag{7}
$$

Tables 13 and 14 present results of estimating Equation 7. Comparing plants in industries that were de-licensed during the 1980s to licensed ones, the degree of capital- and output-skill complementarities in Table 14 are similar to those in Table 12. Capital-skill complementarities are stronger among plants in industries that were de-licensed during the 1980s compared to licensed ones, but only in industries that underwent trade liberalization during the early 1990s. Output-skill complementarities are stronger among plants in industries that were de-licensed during the 1980s than in licensed industries in both protected and liberalized industries. Moreover, weaker capital- and output-skill complementarities in industries with trade liberalization provides support for the Stolper-Samuelson theorem. The only difference in Table 14 is that for those industries that did not experience trade liberalization, capital-skill complementarities are slightly weaker among plants in industries that were de-licensed during the 1980s compared to licensed ones.

For plants in industries that were de-licensed during the 1990s, capital-skill complementarities are either the same or weaker than those in both licensed as well as 1980s de-licensed industries. This is true for industries with and without trade liberalization. Thus, de-licensing during the early 1990s did not benefit skilled labor, regardless of trade liberalization. Among plants in industries without trade liberalization, output-skill complementarities are weaker in 1990s de-licensed industries compared to licensed and 1980s de-licensed industries. However, for plants in industries that did experience trade liberalization during the early 1990s, output-skill complementarities are stronger in 1990s de-licensed industries compared to licensed ones and only slightly lower than

those in 1980s de-licensed industries. Thus, jointly, de-licensing and trade liberalization in 1991 onwards appears to have benefited skilled labor via output-skill complementarities.

This analysis indicates that it was primarily the 1980s de-licensing that benefited skilled labor via capital- and output-skill complementarities. Thus, skill upgrading was greater among plants that had time to adjust to de-licensing prior to trade liberalization. de-licensing during the 1990s did, however, benefit skilled labor in trade liberalized industries with respect to output-skill complementarities.

6 Conclusion

In this paper we use disaggregated data on plant-level characteristics, industrial de-licensing, and tariffs to examine how industrial de-licensing and trade liberalization affected the relative demand for skilled labor in India. The chronology of Indian reforms, with piece-meal industrial de-licensing in the 1980s and external sector reforms in the 1990s, allows us to separate the effects of domestic and external reforms.

We find that during the 1980s, capital- and output-skill complementarities exist for plants in all industries but are stronger in industries that were de-licensed. Thus, freedom from output, input, and technology constraints as well as increased entry and competition in de-licensed industries appears to have increased the relative demand for skilled labor before India liberalized trade from 1991 onwards. Using data for the 1980s and early 1990s, we find that increased use of capital by plants in de-licensed industries generated greater demand for skilled labor compared to those in licensed industries, but only in industries that experienced greater than average reductions in their tariffs during the early 1990s. Therefore, only together with trade liberalization did de-licensing benefit skilled labor via capital-skill complementarities. With respect to output-skill complementarities, relative demand for skilled labor was greater among plants in de-licensed than in licensed industries. This was true both for industries with and without trade liberalization during the early 1990s. These results all support Hypotheses I and II described in Section 3.

We also find support for the predictions of the Stolper-Samuelson theorem as explained in Hypothesis III. Despite greater relative demand for skilled labor among plants in de-licensed industries,

capital- and output-skill complementarities are weaker for plants in industries where trade was liberalized during the early 1990s. Thus, the expansion of the unskilled-labor-intensive sector after trade liberalization appears to have dampened skill upgrading in both licensed and de-licensed industries, showing a move towards the country's comparative advantage in unskilled-labor-intensive industries.

Robustness checks provide two important results. First, locally weighted regressions show that there is little discontinuity around the threshold asset level, indicating that Equation 4 may be correctly specified. Second, it was de-licensing during the 1980s that mostly resulted in skill upgrading via capital- and output-skill complementarities. Thus, plants that had time to adjust to de-licensing before trade was liberalized in their industry experienced greater skill upgrading than those whose industries were de-licensed and trade liberalized simultaneously.

Our regression results as well as simple diagrammatic analysis confirm that an increasing trend in the relative demand for skilled workers preceded the external sector reforms of 1991 and that industrial de-licensing in India played a role in this. Together, capital- and output-skill complementarities contributed 97% and 51%, respectively, of the growth in the employment and wagebill shares of white-collar workers in de-licensed industries during the 1980s. In licensed industries capital- and output-skill complementarities contributed much less – 70% and 40%, respectively.[19] Similar evidence is found for industries where trade remained protected as well as for trade liberalized industries – i.e. together, capital- and output-skill complementarities contributed 32% (26%) and 18% (13%) of the growth in the employment and wagebill shares of white-collar workers in de-licensed (licensed) industries where trade was liberalized during the early 1990s. For protected industries, the corresponding figures are 41% (36%) and 18% (17%) in de-licensed (licensed) industries.[20]

[19]From Table 9, the predicted growth rate in the employment share of skilled labor in de-licensed industries is 14.23% (6.36 + 7.87), which is 97% of the actual growth rate of 14.62% in the employment share of white-collar workers during the 1980s. For the wagebill share of white-collar workers, the predicted growth rate due to capital- and output-skill complementarities is 14.87% (6.82 + 8.05), which is 51% of the actual growth rate of 29.32% during the 1980s. In licensed industries, the predicted growth rates are 10.18% (4.67 + 5.51) and 11.59% (5.27 + 6.32) in the employment and wagebill shares of white-collar workers, which are 70% and 40% of the actual growth rates of 14.62% and 29.32%, respectively.

[20]The predicted growth rates are obtained from Table 12. The actual growth rates of the employment and wagebill shares of white-collar workers between 1980-81 and 1994-95 are 32.07% and 72.81%, respectively.

Our results support Hypotheses I and II, described in Section 3. Once microeconomic constraints were lifted from plants, they could invest in more capital as well as produce more output and take advantage of economies of scale. Thus, it is not surprising that both capital and output play important roles in skill upgrading. Increased competition, brought about by industrial de-licensing during the 1980s, appears to have provided plants with greater incentives to increase productivity and product quality, thereby benefiting skilled workers in India.

The results of this paper underscore the importance of incorporating domestic industrial policy changes in economic research since these changes may lead to distortions in optimal resource use. We find that capital- and output-skill complementarities generated greater skill upgrading among plants in de-licensed than in licensed industries. Including external sector reforms in such analyses is also important since trade reforms may reduce these distortions. In both licensed and de-licensed industries, skill upgrading due to capital- and output-skill complementarities is weaker in industries where trade was liberalized – a result which supports the Stolper-Samuelson theorem for an unskilled-labor-intensive country such as India. This paper also provides some evidence that there may have been some unexpected consequences of India's industrial policy distortions. By keeping the relative demand for and returns to skilled labor low, the licensing regime may have contributed to the success of the Indian software industry as well as to the growth of business process outsourcing activities from the 1990s onwards.

References

Acemoglu, D. (2003), 'Patterns of skill premia', *Review of Economic Studies* **70**, 199–230.

Attanasio, O., Goldberg, P. & Pavcnik, N. (2004), 'Trade reforms and wage inequality in Colombia', *Journal of Development Economics* **74**, 331–366.

Berman, E., Bound, J. & Griliches, Z. (1993), Changes in the demand for skilled labor within U.S. manufacturing: Evidence from the annual survey of manufactures. NBER, Working Paper No. 4255.

Berman, E., Somanathan, R. & Tan, H. W. (2005), Is skill-biased technological change here yet?

Evidence from Indian manufacturing in the 1990s. The World Bank, Policy Research Working Paper Series: 3761.

Chamarbagwala, R. (2006), 'Economic liberalization and wage inequality in India', *World Development* **34**(12), 1997–2015.

Cragg, M. & Epelbaum, M. (1996), 'Why has wage dispersion grown in Mexico? Is it the incidence of reforms or the growing demand for skills?', *Journal of Development Economics* **51**, 99–116.

Das, D. (2003), Quantifying trade barriers: Has protection declined substantially in Indian manufacturing? ICRIER Working Paper No. 105.

Das, G. (2000), *India unbound. From independence to the global information age*, Profile books Limited.

Dutta, P. V. (2005), Accounting for wage inequality in India. Poverty Research Unit at Sussex, University of Sussex, PRUS Working Paper No. 29.

Feenstra, A. D. & Hanson, G. H. (1996), Foreign investment, outsourcing and relative wages, *in* R. e. a. Feenstra, ed., 'Political Economy of Trade Policy: Essays in Honor of Jagdish Bhagwati', MIT Press, Cambridge, MA, USA, pp. 89–127.

Feenstra, A. D. & Hanson, G. H. (1997), 'Foreign direct investment and relative wages: evidence from Mexicos maquiladoras', *Journal of International Economics* **42**, 371–393.

Feenstra, A. D. & Hanson, G. H. (2003), Global production sharing and rising inequality: a survey of trade and wages, *in* E. Choi & J. Harrigan, eds, 'Handbook of International Trade', Blackwell: Malden, MA, USA, pp. 146–185.

Goldberg, P. K. & Pavcnik, N. (2004), Trade, inequality, and poverty: what do we know? Evidence from recent trade liberalization episodes in developing countries, *in* S. M. Collins & D. Rodrik, eds, 'Brookings Trade Forum 2004: Globalization, Inequality, and Poverty', Brookings Institutions Press, Washington, DC, USA.

Gorg, H. & Strobl, G. (2002), Relative wages, openness, and skill-biased technological change in Ghana. Unpublished paper.

Hanson, G. H. (2003), What has happened to wages in Mexico since NAFTA? Implications for hemispheric free trade. NBER Working Paper No. 9563.

Harrison, A. & Hanson, G. (1999), 'Who gains from trade reform? Some remaining puzzles', *Journal of Development Economics* **59**, 125–154.

Kumar, U. & Mishra, P. (2005), Trade liberalization and wage inequality: evidence for India. International Monetary Fund Working Paper.

Marathe, S. (1989), *Regulation and development: India's policy experience of controls over industry*, Sage Publications.

Pavcnik, N. (2003), 'What explains skill upgrading in less developed countries?', *Journal of Development Economics* **71**, 311–328.

Ramani, K., Jain, N., Ramani, S. K., Lakshmi-Narayanan, K. & Mehta, P. (2004), *Doing business in India*, Chamber of Income Tax Consultants.

Sharma, G. (2006*a*), Competing or collaborating siblings? An investigation of the relationship between industrial and trade policies. Ph.D. thesis, University of Maryland, College Park.

Sharma, G. (2006*b*), Competing or collaborating siblings? Industrial and trade policies in India. Dept. of Economics Working Paper 06-10, University of Missouri, Columbia.

Verhoogen, E. (2004), Trade, quality upgrading and wage inequality in the Mexican manufacturing sector: theory and evidence from an exchange-rate shock. University of California, Berkeley, mimeo.

Wood, A. (1995), 'How trade hurt unskilled workers', *Journal of Economic Perspectives* **9**(3), 57–80.

Figure 1: Trends in the Wagebill and Employment Shares of White-Collar Workers: India, 1980-81 to 1994-95

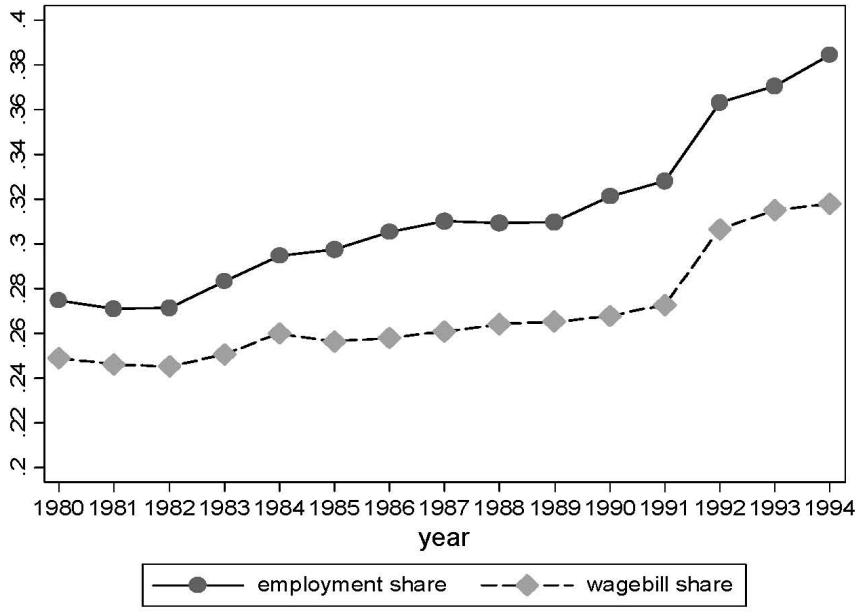

Figure 2: Trends in the Skill Premium: India, 1980-81 to 1994-95

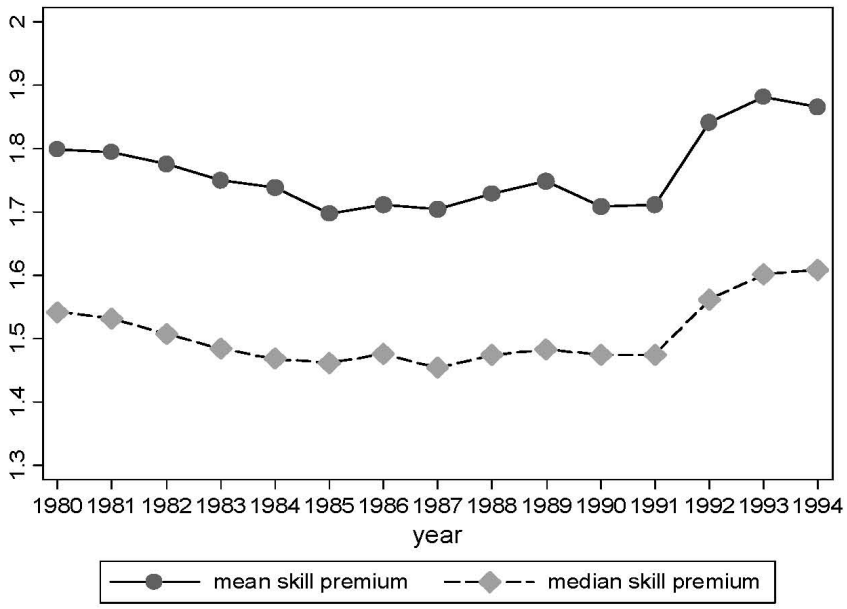

Figure 3: Total Effect of $ln\left(\frac{K}{O}\right)$ on Employment and Wagebill Shares of Skilled Labor: 1980-81 to 1990-91

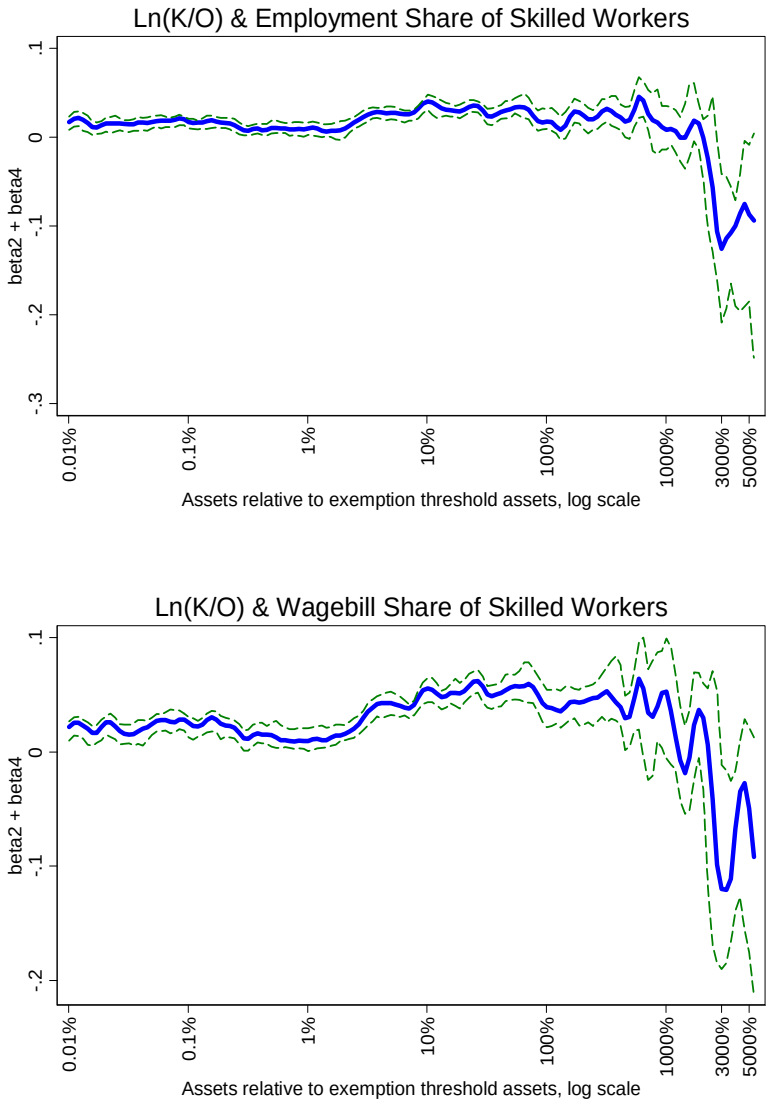

Figure 4: Total Effect of $ln\,(O)$ on Employment and Wagebill Shares of Skilled Labor: 1980-81 to 1990-91

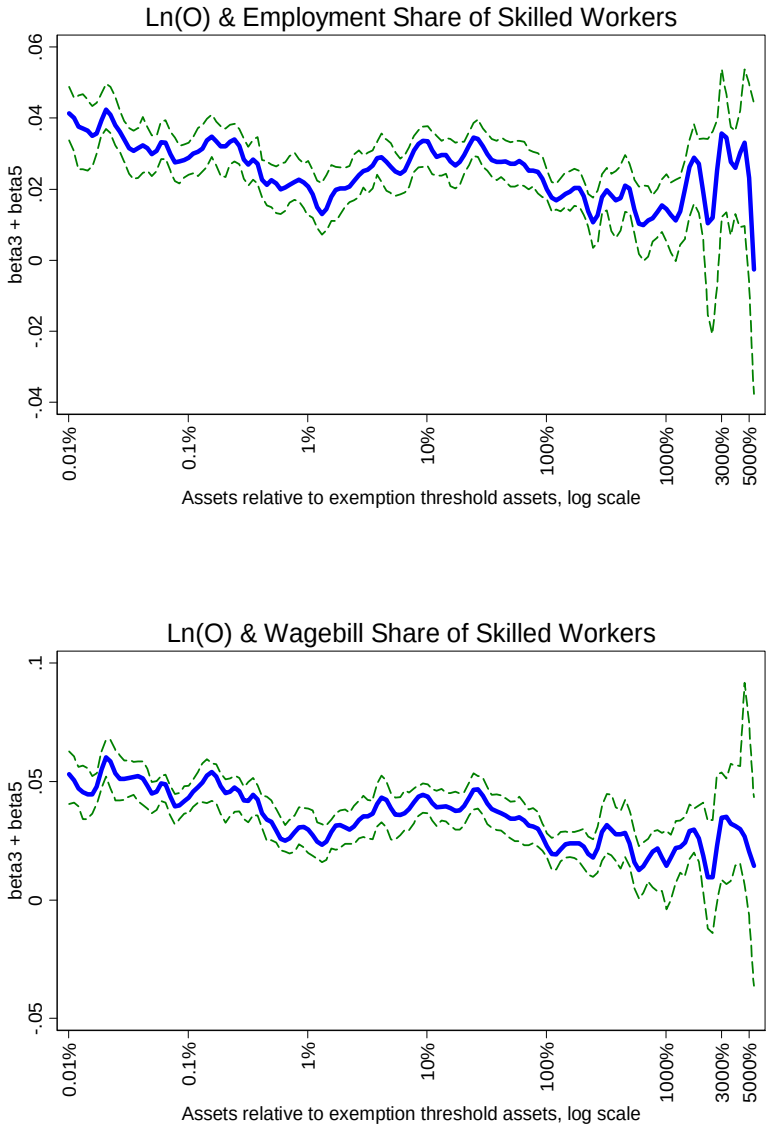

Table 1: Percentage of Cumulative Output and Employment in De-Licensed Industries

Year	**% Output**	**% Employment**
1980-81	0.000	0.000
1981-82	0.000	0.000
1982-83	0.000	0.000
1983-84	0.000	0.000
1984-85	6.807	7.627
1985-86	13.933	15.040
1986-87	19.994	17.885
1987-88	24.957	23.477
1988-89	25.028	23.395
1989-90	22.774	22.378
1990-91	23.174	22.820
1991-92	84.123	89.972
1992-93	83.612	90.198
1993-94	84.765	90.881
1994-95	84.412	91.078

To compute these figures we use de-licensing and plant-level data at the four-digit level of the National Industrial Classification (NIC).

Table 2: Industrial De-Licensing By Industry and Year

Two-Digit NIC Industries	**Industry**	**No. of Four-Digit NIC Industries**	**Number of Four-Digit NIC Industries de-licensed in:**								
			1984	1985	1986	1987	1991	1992	1993	1994	All Years
20	Food products	20	2	1	1	0	9	0	0	1	14
21	Food products	22	0	0	0	1	9	0	0	2	12
22	Beverages, tobacco, and related products	17	0	0	0	0	10	0	0	1	11
23	Cotton textiles	7	0	0	0	0	7	0	0	0	7
24	Wool, silk, and man-made fibre textiles	15	0	0	0	0	12	0	0	0	12
25	Jute and other vegetable fibre textiles	9	0	0	0	0	8	1	0	0	9
26	Textile products and wearing apparel	30	0	0	0	0	23	1	0	3	27
27	Wood, wood products, furniture, and fixtures	11	0	0	0	0	8	0	0	0	8
28	Paper, printing, publishing, and allied industries	24	2	0	0	14	3	0	0	2	21
29	Leather, fur, and leather products	10	3	0	0	1	0	0	0	0	4
30	Chemicals and chemical products	53	1	1	5	0	30	0	0	1	38
31	Rubber, plastic, petroleum, and coal products	18	1	0	0	0	12	0	0	4	17
32	Non-metallic mineral products	41	10	1	1	0	19	0	0	1	32
33	Basic metals and alloy industries	14	0	0	0	0	11	0	0	1	12
34	Metal products and parts	26	4	1	1	0	12	1	0	3	22
35	Machinery and equipment	55	6	8	0	17	18	0	0	1	50
36	Machinery and equipment	43	5	5	1	4	18	0	0	1	34
37	Transport equipment and parts	18	1	3	0	0	9	0	1	0	14
38	Other manufacturing industries	30	4	1	1	2	10	0	0	0	18
All		463	39	21	10	39	228	3	1	21	362

To compute these figures we use de-licensing data at the two- and four-digit levels of the National Industrial Classification (NIC).

Table 3: Trade Liberalization By Industry Between 1985-90 and 1991-95

Two-Digit NIC Industries	**Industry**	**No. of Four-Digit NIC Industries**	**No. of Four-Digit NIC Industries Trade Liberalized Between 1985-90 and 1991-95**
20	Food products	20	4
21	Food products	22	3
22	Beverages, tobacco, and related products	17	0
23	Cotton textiles	7	7
24	Wool, silk, and man-made fibre textiles	15	3
25	Jute and other vegetable fibre textiles	9	4
26	Textile products and wearing apparel	30	21
27	Wood, wood products, furniture, and fixtures	11	1
28	Paper, printing, publishing, and allied industries	24	2
29	Leather, fur, and leather products	10	5
30	Chemicals and chemical products	53	11
31	Rubber, plastic, petroleum, and coal products	18	6
32	Non-metallic mineral products	41	8
33	Basic metals and alloy industries	14	4
34	Metal products and parts	26	6
35	Machinery and equipment	55	10
36	Machinery and equipment	43	23
37	Transport equipment and parts	18	3
38	Other manufacturing industries	30	3
All		463	124

Source: Das (2003). An industry is defined as trade liberalized if its tariff fell by more than 22 percentage points (the average tariff decline) between 1985-90 and 1991-95.

Table 4: Characteristics of Plants in De-Licensed and Licensed Industries: Average Values

De-Licensed Industries

Year	No. of Four-Digit NIC Industries	No. of Observations	Employment Share	Wagebill Share	Capital-Output Ratio	Real Output
1980-81	0	0	0	0	0	0
1981-82	0	0	0	0	0	0
1982-83	0	0	0	0	0	0
1983-84	0	0	0	0	0	0
1984-85	39	6,156	0.21	0.27	20.26	168,579
1985-86	62	11,072	0.22	0.29	22.09	183,766
1986-87	65	13,181	0.24	0.32	24.18	233,597
1987-88	129	17,886	0.23	0.31	25.64	245,203
1988-89	88	18,107	0.23	0.31	25.69	257,600
1989-90	121	20,782	0.23	0.31	25.94	256,668
1990-91	120	21,259	0.24	0.31	27.16	271,596
1991-92	349	79,406	0.21	0.28	28.14	243,913
1992-93	355	82,646	0.23	0.31	31.96	246,192
1993-94	351	84,474	0.23	0.32	34.95	258,213
1994-95	415	87,566	0.23	0.32	38.11	274,361

Licensed Industries

Year	No. of Four-Digit NIC Industries	No. of Observations	Employment Share	Wagebill Share	Capital-Output Ratio	Real Output
1980-81	316	66,115	0.18	0.25	14.06	140,401
1981-82	317	70,012	0.18	0.25	14.62	142,960
1982-83	314	71,904	0.18	0.25	15.60	173,753
1983-84	331	74,586	0.19	0.25	21.19	173,285
1984-85	289	63,413	0.19	0.26	21.38	193,105
1985-86	276	63,690	0.19	0.25	21.91	195,469
1986-87	256	60,264	0.19	0.25	21.86	197,818
1987-88	302	55,011	0.19	0.25	23.94	218,565
1988-89	206	56,669	0.19	0.25	24.93	230,794
1989-90	262	60,516	0.19	0.25	23.00	249,061
1990-91	263	62,651	0.19	0.26	24.44	250,907
1991-92	31	6,157	0.22	0.29	22.61	467,145
1992-93	31	6,511	0.24	0.33	28.37	461,221
1993-94	33	6,503	0.25	0.34	30.99	469,239
1994-95	39	6,747	0.25	0.34	35.76	487,758

To compute these figures we use de-licensing and plant-level data at the four-digit level of the National Industrial Classification (NIC). The number of four-digit NIC industries that were de-licensed and under licensing requirements is cumulative and include those in the ASI dataset in each year. The number of observations are the number of plants surveyed in each year of the ASI data. All variables are weighted with plant-level multipliers and winsorized at the 1% level. Real output is in 1993-94 Rupees.

Table 5: Summary Statistics for Non-Exempt and Exempt Plants

Variable	**Non-Exempt plants**		**Exempt plants**	
	Mean	**Std. Dev.**	**Mean**	**Std. Dev.**
(1)	(2)	(3)	(4)	(5)
1980-81 to 1983-84				
Employment Share	0.29	0.13	0.18	0.16
Wagebill Share	0.39	0.15	0.25	0.21
Ln Skill Premium	0.47	0.36	0.43	0.53
Ln Capital-Output Ratio	3.00	1.12	1.37	2.11
Ln Real Output	15.32	1.31	10.04	1.87
Number of Observations	2542		206062	
1984-85 to 1990-91				
Employment Share	0.30	0.14	0.19	0.16
Wagebill Share	0.41	0.17	0.26	0.21
Ln Skill Premium	0.52	0.43	0.40	0.53
Ln Capital-Output Ratio	3.47	1.11	1.95	1.87
Ln Real Output	15.35	1.36	10.38	1.83
Number of Observations	6339		317892	
1991-92 to 1994-95				
Employment Share	0.32	0.14	0.22	0.17
Wagebill Share	0.44	0.17	0.30	0.22
Ln Skill Premium	0.56	0.46	0.46	0.53
Ln Capital-Output Ratio	4.14	1.12	2.39	1.83
Ln Real Output	15.68	1.34	10.56	1.89
Number of Observations	3638		187119	

Source: Annual Survey of Industries (1980-81 to 1994-95) and industrial de-licensing data collected by the authors. The number of observations are the number of plants surveyed in each of the three time periods in the ASI data. All variables are weighted with plant-level multipliers and winsorized at the 1% level. Real output is in 1993-94 Rupees.

Table 6: Summary Statistics

Variable	**Mean**	**Std. Dev.**
(1)	(2)	(3)
1980-81 to 1983-84		
Employment Share	0.18	0.16
Wagebill Share	0.25	0.21
Ln Skill Premium	0.43	0.53
Ln Capital-Output Ratio	1.38	2.11
Ln Real Output	10.08	1.92
Number of Observations	194056	
1984-85 to 1990-91		
Employment Share	0.20	0.16
Wagebill Share	0.26	0.21
Ln Skill Premium	0.40	0.53
Ln Capital-Output Ratio	1.97	1.87
Ln Real Output	10.44	1.90
Number of Observations	321814	
1991-92 to 1994-95		
Employment Share	0.22	0.17
Wagebill Share	0.30	0.22
Ln Skill Premium	0.46	0.53
Ln Capital-Output Ratio	2.41	1.83
Ln Real Output	10.61	1.95
Number of Observations	189851	
1980-81 to 1990-91		
Employment Share	0.19	0.16
Wagebill Share	0.26	0.21
Ln Skill Premium	0.41	0.53
Ln Capital-Output Ratio	1.77	1.98
Ln Real Output	10.32	1.92
Number of Observations	515870	
1980-81 to 1994-95		
Employment Share	0.20	0.16
Wagebill Share	0.27	0.21
Ln Skill Premium	0.43	0.53
Ln Capital-Output Ratio	1.96	1.96
Ln Real Output	10.40	1.93
Number of Observations	705721	

Source: Annual Survey of Industries (1980-81 to 1994-95) and industrial deregulation data collected by the authors. The number of observations are the number of plants surveyed in each of the three time periods in the ASI data. All variables are weighted with plant-level multipliers and winsorized at the 1% level. Real output is in 1993-94 Rupees.

Table 7: OLS Results of Equation 3: Industrial De-Licensing and Skill Upgrading, 1980-81 to 1990-91

Variable	**Coefficient**	**Employment Share of White-Collar Workers**	**Wagebill Share of White-Collar Workers**
(1)	(2)	(3)	(4)
DE	β_1	0.005***	0.003**
		[0.001]	[0.002]
NE	β_2	0.041***	0.034***
		[0.003]	[0.003]
$DE * NE$	β_3	0.026***	0.018***
		[0.006]	[0.007]
$Constant$	α	0.154***	0.202***
		[0.004]	[0.004]
Industry Fixed Effects		Yes	Yes
State Fixed Effects		Yes	Yes
Year Fixed Effects		Yes	Yes
No. of Observations		499500	499328
R-squared		0.24	0.28
Plants in Licensed Industries			
$H_0 : \beta_2 = 0$		0.041***	0.034***
		[231.77]	[117.84]
Plants in De-Licensed Industries			
$H_0 : \beta_2 + \beta_3 = 0$		0.067***	0.052***
		[191.49]	[71.30]

Source: Annual Survey of Industries (1980-81 to 1990-91) and industrial de-licensing data collected by the authors. The omitted year is 1980-81. Industry fixed effects are at the four-digit industry level. All regressions include indicators for whether or not the plant is a factory and for the type of ownership and organization. The omitted ownership structure is public sector plants and the omitted organization consists of individual proprietorship and partnership plants. Robust standard errors, clustered at the four-digit-industry-year level, are in parentheses. A *, **, and *** represent significance at the 10%, 5%, and 1% levels respectively. F-statistics are presented in parentheses in the bottom panel. The F-critical value with 1 restriction at the 1% level of significance is 6.63.

Table 8: OLS Results of Equation 4: Industrial De-Licensing and Skill Upgrading, 1980-81 to 1990-91

Variable	**Coefficient**	**Employment Share of White-Collar Workers**	**Wagebill Share of White-Collar Workers**
(1)	(2)	(3)	(4)
DE	β_1	-0.094***	-0.101***
		[0.024]	[0.031]
$ln(K/O)$	β_2	0.011***	0.017***
		[0.001]	[0.002]
$ln(O)$	β_3	0.021***	0.033***
		[0.002]	[0.003]
$DE * ln(K/O)$	β_4	0.004***	0.005**
		[0.001]	[0.002]
$DE * ln(O)$	β_5	0.009***	0.009***
		[0.002]	[0.003]
$Constant$	α	-0.069***	-0.131***
		[0.022]	[0.025]
Industry Fixed Effects		Yes	Yes
State Fixed Effects		Yes	Yes
Year Fixed Effects		Yes	Yes
No. of Observations		474976	475173
R-squared		0.23	0.27

Source: Annual Survey of Industries (1980-81 to 1990-91) and industrial de-licensing data collected by the authors. The omitted year is 1980-81. Industry fixed effects are at the four-digit industry level. All regressions include indicators for whether or not the plant is a factory and for the type of ownership and organization. The omitted ownership structure is public sector plants and the omitted organization consists of individual proprietorship and partnership plants. Robust standard errors, clustered at the four-digit-industry-year level, are in parentheses. A *, **, and *** represent significance at the 10%, 5%, and 1% levels respectively.

Table 9: Complementarities from Equation 4: 1980-81 to 1990-91

	Employment Share of White-Collar Workers	**Wagebill Share of White-Collar Workers**
Panel A: Coefficients and Test Statistics		
Plants in Licensed Industries		
$H_0 : \beta_2 = 0$	0.011***	0.017***
	[188.86]	[120.16]
$H_0 : \beta_3 = 0$	0.021***	0.033***
	[107.75]	[165.24]
Plants in De-Licensed Industries		
$H_0 : \beta_2 + \beta_4 = 0$	0.015***	0.022***
	[141.12]	[164.67]
$H_0 : \beta_3 + \beta_5 = 0$	0.030***	0.042***
	[380.74]	[524.70]
Panel B: Elasticities		
Plants in Licensed Industries		
Elasticity wrt capital-output ratio	0.058	0.065
Elasticity wrt output	0.111	0.127
Plants in De-Licensed Industries		
Elasticity wrt capital-output ratio	0.079	0.085
Elasticity wrt output	0.158	0.162
Panel C: Complementarities		
Plants in Licensed Industries		
Capital-skill complementarities	4.67	5.27
Output-skill complementarities	5.51	6.32
Plants in De-Licensed Industries		
Capital-skill complementarities	6.36	6.82
Output-skill complementarities	7.87	8.05

Source: Annual Survey of Industries (1980-81 to 1990-91) and industrial de-licensing data collected by the authors. F-statistics are presented in parentheses in Panel A. The F-critical value with 1 restriction at the 1% level of significance is 6.63. Average employment and wagebill shares of 0.19 and 0.26 are used to calculate elasticities in Panel B. An increase of 80.58% and 49.83% in the capital-output ratio and output level for the average plant between 1980-81 and 1990-91 are used to calculate complementarities in Panel C.

Table 10: OLS Results of Equation 5: Industrial De-Licensing, Trade Liberalization, and Skill Upgrading, 1980-81 to 1994-95

Variable	**Coefficient**	**Employment Share of White-Collar Workers**	**Wagebill Share of White-Collar Workers**
(1)	(2)	(3)	(4)
$DE80$	β_1	0.006***	0.005***
		[0.001]	[0.002]
TL	β_2	0.004*	0.004
		[0.002]	[0.003]
NE	β_3	0.047***	0.043***
		[0.002]	[0.003]
$DE80 * TL$	β_4	-0.010***	-0.017***
		[0.003]	[0.004]
$DE80 * NE$	β_5	0.015***	0.006
		[0.005]	[0.006]
$TL * NE$	β_6	-0.003	0.002
		[0.008]	[0.009]
$DE80 * TL * NE$	β_7	0.020	0.034
		[0.015]	[0.022]
$Constant$	α	0.167***	0.219***
		[0.003]	[0.004]
Industry Fixed Effects		Yes	Yes
State Fixed Effects		Yes	Yes
Year Fixed Effects		Yes	Yes
No. of Observations		704691	703987
R-squared		0.24	0.27
Industries Without Trade Liberalization			
Plants in Licensed Industries		0.047***	0.043***
$H_0 : \beta_3 = 0$		[374.46]	[225.21]
Plants in De-Licensed Industries		0.062***	0.049***
$H_0 : \beta_3 + \beta_5 = 0$		[227.74]	[97.15]
Industries With Trade Liberalization			
Plants in Licensed Industries		0.044***	0.045***
$H_0 : \beta_3 + \beta_6 = 0$		[35.29]	[29.05]
Plants in De-Licensed Industries		0.079***	0.085***
$H_0 : \beta_3 + \beta_5 + \beta_6 + \beta_7 = 0$		[43.61]	[19.03]

Source: Annual Survey of Industries (1980-81 to 1994-95) and industrial de-licensing data collected by the authors. The omitted year is 1980-81. Industry fixed effects are at the four-digit industry level. All regressions include indicators for whether or not the plant is a factory and for the type of ownership and organization. The omitted ownership structure is public sector plants and the omitted organization consists of individual proprietorship and partnership plants. Robust standard errors, clustered at the four-digit-industry-year level, are in parentheses. A *, **, and *** represent significance at the 10%, 5%, and 1% levels respectively.

Table 11: OLS Results of Equation 6: Industrial De-Licensing, Trade Liberalization, and Skill Upgrading, 1980-81 to 1994-95

Variable	**Coefficient**	**Employment Share of White-Collar Workers**	**Wagebill Share of White-Collar Workers**
(1)	(2)	(3)	(4)
$DE80$	β_1	-0.055***	-0.041***
		[0.008]	[0.010]
TL	β_2	0.047**	0.058**
		[0.018]	[0.025]
$ln(K/O)$	β_3	0.009***	0.013***
		[0.000]	[0.000]
$ln(O)$	β_4	0.022***	0.031***
		[0.001]	[0.001]
$DE80 * TL$	β_5	0.029	0.002
		[0.029]	[0.037]
$DE80 * ln(K/O)$	β_6	0.000	0.000
		[0.001]	[0.001]
$DE80 * ln(O)$	β_7	0.006***	0.004***
		[0.001]	[0.001]
$TL * ln(K/O)$	β_8	-0.006***	-0.008***
		[0.001]	[0.001]
$TL * ln(O)$	β_9	-0.003*	-0.003
		[0.002]	[0.002]
$DE80 * TL * Ln(K/O)$	β_{10}	0.002	0.006**
		[0.002]	[0.002]
$DE80 * TL * Ln(O)$	β_{11}	-0.004*	-0.003
		[0.002]	[0.003]
$Constant$	α	-0.041***	-0.080***
		[0.006]	[0.007]
Industry Fixed Effects		Yes	Yes
State Fixed Effects		Yes	Yes
Year Fixed Effects		Yes	Yes
No. of Observations		678384	677602
R-squared		0.27	0.31

Source: Annual Survey of Industries (1980-81 to 1994-95) and industrial de-licensing data collected by the authors. The omitted year is 1980-81. Industry fixed effects are at the four-digit industry level. All regressions include indicators for whether or not the plant is a factory and for the type of ownership and organization. The omitted ownership structure is public sector plants and the omitted organization consists of individual proprietorship and partnership plants. Robust standard errors, clustered at the four-digit-industry-year level, are in parentheses. A *, **, and *** represent significance at the 10%, 5%, and 1% levels respectively.

Table 12: Complementarities from Equation 6: 1980-81 to 1994-95

Industries Without Trade Liberalization	**Employment Share of White-Collar Workers**	**Wagebill Share of White-Collar Workers**	**Industries With Trade Liberalization**	**Employment Share of White-Collar Workers**	**Wagebill Share of White-Collar Workers**
Panel A: Coefficients and Test Statistics			**Panel A: Coefficients and Test Statistics**		
Plants in Licensed Industries			Plants in Licensed Industries		
$H_0 : \beta_3 = 0$	0.009***	0.013***	$H_0 : \beta_3 + \beta_8 = 0$	0.003***	0.005***
	[1419.03]	[1358.98]		[15.69]	[21.95]
$H_0 : \beta_4 = 0$	0.022***	0.031***	$H_0 : \beta_4 + \beta_9 = 0$	0.019***	0.028***
	[1502.83]	[2381.89]		[142.33]	[163.06]
Plants in De-Licensed Industries			Plants in De-Licensed Industries		
$H_0 : \beta_3 + \beta_6 = 0$	0.009***	0.013***	$H_0 : \beta_3 + \beta_6 + \beta_8 + \beta_{10} = 0$	0.005***	0.011***
	[276.33]	[348.52]		[12.86]	[31.10]
$H_0 : \beta_4 + \beta_7 = 0$	0.028***	0.035***	$H_0 : \beta_4 + \beta_7 + \beta_9 + \beta_{11} = 0$	0.021***	0.029***
	[2004.61]	[2495.43]		[134.90]	[179.90]
Panel B: Elasticities			**Panel B: Elasticities**		
Plants in Licensed Industries			Plants in Licensed Industries		
Elasticity wrt capital-output ratio	0.045	0.048	Elasticity wrt capital-output ratio	0.015	0.019
Elasticity wrt output	0.110	0.115	Elasticity wrt output	0.095	0.104
Plants in De-Licensed Industries			Plants in De-Licensed Industries		
Elasticity wrt capital-output ratio	0.045	0.048	Elasticity wrt capital-output ratio	0.025	0.041
Elasticity wrt output	0.140	0.130	Elasticity wrt output	0.105	0.107
Panel C: Complementarities			**Panel C: Complementarities**		
Plants in Licensed Industries			Plants in Licensed Industries		
Capital-skill complementarities	5.49	5.88	Capital-skill complementarities	2.23	2.75
Output-skill complementarities	6.10	6.37	Output-skill complementarities	6.00	6.55
Plants in De-Licensed Industries			Plants in De-Licensed Industries		
Capital-skill complementarities	5.49	5.88	Capital-skill complementarities	3.71	6.05
Output-skill complementarities	7.76	7.19	Output-skill complementarities	6.63	6.78

Source: Annual Survey of Industries (1980-81 to 1994-95) and industrial de-licensing data collected by the authors. F-statistics are presented in parentheses in Panel A. The F-critical value with 1 restriction at the 1% level of significance is 6.63. Average employment and wagebill shares of 0.20 and 0.27 are used to calculate elasticities in Panel B. An increase of 122.07% and 55.44% in the capital-output ratio and output level for the average plant between 1980-81 and 1994-95 are used to calculate complementarities in Panel C in industries without trade liberalization. An increase of 148.54% and 63.15% in the capital-output ratio and output level for the average plant between 1980-81 and 1994-95 are used to calculate complementarities in Panel C in industries with trade liberalization.

Table 13: OLS Results of Equation 7: Industrial De-Licensing, Trade Liberalization, and Skill Upgrading, 1980-81 to 1994-95

Variable	**Coefficient**	**Employment Share of White-Collar Workers**	**Wagebill Share of White-Collar Workers**
(1)	(2)	(3)	(4)
$DE80$	β_1	-0.051***	-0.036***
		[0.008]	[0.010]
$DE91$	β_2	0.017*	0.020*
		[0.010]	[0.012]
TL	β_3	0.185***	0.161***
		[0.029]	[0.025]
$ln(K/O)$	β_4	0.010***	0.014***
		[0.000]	[0.000]
$ln(O)$	β_5	0.022***	0.031***
		[0.001]	[0.001]
$DE80 * TL$	β_6	-0.111***	-0.106***
		[0.036]	[0.037]
$DE91 * TL$	β_7	-0.160***	-0.127***
		[0.035]	[0.037]
$DE80 * ln(K/O)$	β_8	-0.001	-0.002**
		[0.001]	[0.001]
$DE91 * ln(K/O)$	β_9	-0.003***	-0.006***
		[0.001]	[0.001]
$DE80 * ln(O)$	β_{10}	0.005***	0.004***
		[0.001]	[0.001]
$DE91 * ln(O)$	β_{11}	-0.001	-0.001
		[0.001]	[0.001]
$TL * ln(K/O)$	β_{12}	-0.006***	-0.006**
		[0.002]	[0.003]
$TL * ln(O)$	β_{13}	-0.015***	-0.013***
		[0.003]	[0.002]
$DE80 * TL * Ln(K/O)$	β_{14}	0.002	0.004
		[0.002]	[0.003]
$DE91 * TL * Ln(K/O)$	β_{15}	0.003	0.002
		[0.002]	[0.003]
$DE80 * TL * Ln(O)$	β_{16}	0.009***	0.007**
		[0.003]	[0.003]
$DE91 * TL * Ln(O)$	β_{17}	0.014***	0.011***
		[0.003]	[0.003]
$Constant$	α	-0.045***	-0.085***
		[0.007]	[0.007]
Industry Fixed Effects		Yes	Yes
State Fixed Effects		Yes	Yes
Year Fixed Effects		Yes	Yes
No. of Observations		678384	677602
R-squared		0.27	0.31

Source: Annual Survey of Industries (1980-81 to 1994-95) and industrial de-licensing data collected by the authors. The omitted year is 1980-81. Industry fixed effects are at the four-digit industry level. All regressions include indicators for whether or not the plant is a factory and for the type of ownership and organization. The omitted ownership structure is public sector plants and the omitted organization consists of individual proprietorship and partnership plants. Robust standard errors, clustered at the four-digit-industry-year level, are in parentheses. A *, **, and *** represent significance at the 10%, 5%, and 1% levels respectively.

Table 14: Complementarities from Equation 7: 1980-81 to 1994-95

Industries Without Trade Liberalization	Employment Share of White-Collar Workers	Wagebill Share of White-Collar Workers	Industries With Trade Liberalization	Employment Share of White-Collar Workers	Wagebill Share of White-Collar Workers
Panel A: Coefficients and Test Statistics			**Panel A: Coefficients and Test Statistics**		
Plants in Licensed Industries			Plants in Licensed Industries		
$H_0 : \beta_4 = 0$	0.010***	0.014***	$H_0 : \beta_4 + \beta_{12} = 0$	0.004*	0.008***
	[1376.89]	[1216.01]		[3.25]	[8.75]
$H_0 : \beta_5 = 0$	0.022***	0.031***	$H_0 : \beta_5 + \beta_{13} = 0$	0.007***	0.018***
	[1318.86]	[2017.69]		[6.86]	[67.54]
Plants in Industries De-Licensed in 1980s			Plants in Industries De-Licensed in 1980s		
$H_0 : \beta_4 + \beta_8 = 0$	0.009***	0.012***	$H_0 : \beta_4 + \beta_8 + \beta_{12} + \beta_{14} = 0$	0.005***	0.010***
	[264.96]	[332.30]		[12.78]	[30.91]
$H_0 : \beta_5 + \beta_{10} = 0$	0.027***	0.035***	$H_0 : \beta_5 + \beta_{10} + \beta_{13} + \beta_{16} = 0$	0.021***	0.029***
	[1996.73]	[2483.55]		[134.98]	[179.92]
Plants in Industries De-Licensed in 1990s			Plants in Industries De-Licensed in 1991		
$H_0 : \beta_4 + \beta_9 = 0$	0.007***	0.008***	$H_0 : \beta_4 + \beta_9 + \beta_{12} + \beta_{15} = 0$	0.004***	0.004***
	[175.33]	[159.94]		[13.82]	[19.13]
$H_0 : \beta_5 + \beta_{11} = 0$	0.021***	0.030***	$H_0 : \beta_5 + \beta_{11} + \beta_{13} + \beta_{17} = 0$	0.020***	0.028***
	[586.49]	[1012.35]		[143.93]	[157.60]
Panel B: Elasticities			**Panel B: Elasticities**		
Plants in Licensed Industries			Plants in Licensed Industries		
Elasticity wrt capital-output ratio	0.050	0.052	Elasticity wrt capital-output ratio	0.020	0.030
Elasticity wrt output	0.110	0.115	Elasticity wrt output	0.035	0.067
Plants in Industries De-Licensed in 1980s			Plants in Industries De-Licensed in 1980s		
Elasticity wrt capital-output ratio	0.045	0.044	Elasticity wrt capital-output ratio	0.025	0.037
Elasticity wrt output	0.135	0.130	Elasticity wrt output	0.105	0.107
Plants in Industries De-Licensed in 1990s			Plants in Industries De-Licensed in 1991		
Elasticity wrt capital-output ratio	0.035	0.030	Elasticity wrt capital-output ratio	0.020	0.015
Elasticity wrt output	0.105	0.111	Elasticity wrt output	0.100	0.104
Panel C: Complementarities			**Panel C: Complementarities**		
Plants in Licensed Industries			Plants in Licensed Industries		
Capital-skill complementarities	6.10	6.33	Capital-skill complementarities	2.97	4.40
Output-skill complementarities	6.10	6.37	Output-skill complementarities	2.21	4.21
Plants in Industries De-Licensed in 1980s			Plants in Industries De-Licensed in 1980s		
Capital-skill complementarities	5.49	5.43	Capital-skill complementarities	3.71	5.50
Output-skill complementarities	7.48	7.19	Output-skill complementarities	6.63	6.78
Plants in Industries De-Licensed in 1990s			Plants in Industries De-Licensed in 1991		
Capital-skill complementarities	4.27	3.62	Capital-skill complementarities	2.97	2.20
Output-skill complementarities	5.82	6.16	Output-skill complementarities	6.32	6.55

Source: Annual Survey of Industries (1980-81 to 1994-95) and industrial de-licensing data collected by the authors. F-statistics are presented in parentheses in Panel A. The F-critical value with 1 restriction at the 1% level of significance is 6.63. Average employment and wagebill shares of 0.20 and 0.27 are used to calculate elasticities in Panel B. An increase of 122.07% and 55.44% in the capital-output ratio and output level for the average plant between 1980-81 and 1994-95 are used to calculate complementarities in Panel C in industries without trade liberalization. An increase of 148.54% and 63.15% in the capital-output ratio and output level for the average plant between 1980-81 and 1994-95 are used to calculate complementarities in Panel C in industries with trade liberalization.