Effects of Licensing Reform on Firm Innovation: Evidence from India

Seker, Murat and Ulu, Mehmet Fatih

26 July 2017

Effects of Licensing Reform on Firm Innovation: Evidence from India

Murat Şeker* Mehmet Fatih Ulu†

July 26, 2017

Abstract

The regulatory environment in a country is an important factor affecting firm performance. This study investigates the impact of a particular regulation, namely license requirements for certain firm activities, on the innovation performance of Indian firms. Using a firm level panel data set, it shows that removal of license requirements led to roughly eight percentage points faster innovation rates within two years following the reform where innovation is measured as introduction of new product varieties that had not existed in the market. When the residual increase in sales revenues even after controlling for the product innovation is called as process innovation, substantial improvements in process innovation are also observed. The results are robust to inclusion of controls for the other policy reforms that occurred during the period of licensing reform, and persist in different subcategories of firms.

JEL classification: L11; L52; O14; O31; O38.

Keywords: Innovation, research and development, regulatory environment, regulations, industrial policy, India.

We would like to thank to Mark Dutz at World Bank, participants of Finance and Private Sector Development Academy Talks in the World Bank, participants of 10^{th} International Industrial Organization Conference, and members of the Research Department at Bureau of US Census.

*Turkish Airlines, , Bakırköy, Istanbul, Turkey 34450, phone: +90-212, e-mail: muradseker@gmail.com.

†Central Bank of the Republic of Turkey, Kadikoy, Istanbul, Turkey, phone: +90-216-542-3135, e-mail: fatih.ulu@tcmb.gov.tr.

1. Introduction

Since the seminal works of Grossman and Helpman (1993) and Aghion and Howitt (1992), many studies have found technological innovation to be the main determinant of growth. There are structural factors like human and physical capital levels that affect innovation performances of firms. The regulatory environment and investment climate in a country also play important roles for the success of technology adoption strategies and innovative efforts. This study provides an empirical analysis of how regulatory environment affects innovation. It focuses on a particular product market regulation that was reformed in India in mid 1980s and then again in early 1990s and shows how this reform affected introduction of new product varieties and process improvements in formal manufacturing sector.

There are a number of papers that investigate the relationship between different aspects of regulatory environment, investment climate, and innovation. Aghion, Blundell, Griffith, Howitt, and Prantl (2009) focus on liberalization of foreign firm entry to U.K. market and find that technologically advanced entry by foreign firms has a positive effect on innovation in sectors that are initially close to technological frontier. In another study Aghion, Bloom, Blundell, Griffith, and Howitt (2005) use a sequence of competition policy reforms to investigate how product market competition level affects innovation performances. They find that an inverted U-shape relationship between product market competition and innovation outcomes. (Chamarbagwala and Sharma, 2011) revealed that the delicensing in 1980s in India raised the relative demand for skilled workers, and emphasized the role of capital- and output-skill complementarities in this transition. Goldberg, Khandelwal, Pavcnik, and Topalova (2010a) relate international trade to innovation. They show that liberalization of tariff rates which led to imports of new intermediate goods that were not available in the market before increased the rate at which firms introduce new products to the market.

Following this literature, we analyze the effects of India's licensing reform on firms' innovation performances. Before the reform all firms were required to obtain a license to establish a new factory, significantly expand capacity, start a new product line, or change location. Licensing reform meant freedom from constraints on output, inputs, technology usage, and location choice as well as easier entry into delicensed industries. Freedom from these constraints allowed firms to take advantage of economies of scale, more efficient input combinations, and newer technologies. Furthermore, greater domestic competition as a result of free entry into delicensed industries provided firms with incentives to innovate, increase productivity, and improve product quality.

Most of the existing studies on innovation use patenting activity/citations, total factor productivity (TFP), and data from innovation surveys.[1] The main innovation measure we use in this paper is introduction of new products to the market. This information is available for a large number of firms over a six year period. The use of such direct measure of innovation activities differentiates this study from most of the existing work with firm-level datasets. TFP measures have the well known problem that they are biased in the presence of imperfectly competitive product markets. Moreover there is a general problem with interpreting TFP findings as they usually use revenue data which makes it difficult to identify the effects of policy reforms on physical efficiency separately from its the effects on firm markups, product quality, and in the case of multiproduct firms the range of products produced by the firm (see Foster, Haltiwanger, and Syverson (2008) and Katayama, Lu, and Tybout (2009)). The patent data provides a better measure of innovation compared to TFP or innovation survey data but it usually has low data coverage. Moreover in developing countries the patenting mechanism usually does not work efficiently and thus provide a very limited picture of overall innovation activities.

There are several studies that analyze the effects of licensing reform in Indian economy. In one of these studies Aghion, Burgess, Redding, and Zilibotti (2008) analyze how the effects of this reform on industrial output varies across states with differing restrictiveness of labor regulations. Our analysis differs from their work in two main aspects. We use a firm level panel dataset whereas their data is at industry level. Hence the policy question we investigate is how the reform affects firm dynamics rather than industry dynamics. Their focus is on the complementarity between the delicensing reform and other labor market regulations whereas ours is directly on innovation and growth. In another study Chari (2010) focuses on the effects of the licensing reform on total factor productivity. Using the same dataset as Aghion et al.

[1] An example of these surveys is Community Innovation Surveys (CIS) which is developed by European Commission for member countries of European Union.

(2008) he concentrates on the licensing reform in 1985. Lack of a panel dataset prevents to perform a firm-level productivity analysis using a production function estimation method. It also prevents to observe the heterogeneity in firms' responses to the policy change. Using the same dataset as Aghion et al. (2008), Chamarbagwala and Sharma (2011) analyze the effect of licensing reform on skill upgrading where they measure skill upgrading as employment and wage bill shares of white-collar workers. None of these studies can analyze growth at firm level as the data they use is a repeated cross-section of firms. Our use of firm-level panel data gives us the advantage of controlling for firm-specific unobservables while quantifying the impact.

Removal of the distortive regulations can have significant contribution to firm performance. The analysis of Hsieh and Klenow (2009) on within-industry dispersion in factor productivities in China and India show that the removal of plant-level distortions could result in as much as a 30% improvement in aggregate productivity. Chari (2011) shows that the licensing reform in India improved productivity by 22%.

A further advantage of our empirical setting is that we can conduct a number of placebo and robustness tests. These tests have the ability to falsify any spurious link from delicensing to firms' innovative output. In particular, we use the year and two years before an actual reform as placebo reform years. We also restrict the sample by excluding firms that are heavily influenced from the concurrent reforms to confine only the impact of delicensing reform. Also, we narrow down the sample to include only a balanced firm sample to abstain from any specious inference that is caused by firm entry and exit in our sample.

In this study, we show that the licensing reform increased product innovation rate by around eight percentage points within the two years following the delicensing reforms. We find positive and significant impacts of delicensing on firm productivity and sales which can also proxy for process innovation. One channel for the observed increase in firm product scope can be the productivity boost caused by delicensing. For identifying this channel we instrument the contemporaneous firm productivity with lagged reform variables and find a significant impact on firm product scope through firm productivity. We attribute the remaining impact on sales revenue even after controlling for product innovation is due to the unobserved process innovations and quality upgrades of products.

The rest of the paper is structured as follows. In the next section we explain the data and the various policy reforms that were implemented in India. In section 3, we present descriptive analysis of the licensing reform, the empirical model, and discuss the estimation results. We finish with some concluding remarks.

2. I. Data and Policy Reforms in India

2.1. Data Description

Firm level data used in the analysis is obtained from Prowess Database which is constructed by Centre for Monitoring the Indian Economy (CMIE) in India. This dataset has advantages over the Annual Survey of Industries (ASI) which is the India's manufacturing census. ASI is constructed from a repeated cross section of firms whereas Prowess database includes a panel of firms. The panel feature allows us to tract firms over time. It is also among the few databases that records annual information on firms' product mix. Hence product creation and destruction can be tracked at firm level. This unique feature of the data allows us to evaluate the relationship between firms' adjustment of their product lines and policy changes. There are several innovation strategies that firms can follow. They can introduce process innovation by significantly improving their production processes or they can introduce product innovation by introducing a new product variety that they did not produce before. Studies like Bertschek (1995), Parisi, Schiantarelli, and Sembenelli (2006), and Fritsch and Meschede (2001) highlight the differences between these two innovation strategies. The data from Prowess are appropriate for analyzing product innovation strategy which will be measured by the change in product mix of firms.[2] Sales revenue and measured productivity numbers from (Topalova and Khandelwal, 2011) also help indirectly identify the impact on process innovation. The database contains information from income statements and balance sheets of publicly listed (relatively large sized) Indian firms from 1989 to 1995. This dataset is well suited for the particular purpose of the study as large firms contribute more to aggre-

[2] The partial model to be introduced in the following section can be easily expanded to include process innovation by adding a quality attribute to the products innovated and firms can be allowed to invest in both quality improvement and product innovation. An older version of (Şeker, 2012a) which is available upon request provides such a setup.

gate product creation compared to small firms. As discussed in Goldberg et al. (2010a) the dataset is not well suited to analyze entry and exit dynamics because firms are not obliged to report to the data collecting agency. Goldberg et al. (2010a) uses data from 1989 to 2003 and present that prowess database accounts for 60% to 70% of the economic activity in the organized industrial sector and account for 75% of corporate taxes. The panel in this study is unbalanced and the number of firms included in the data increases from 752 in 1989 to 2,293 in 1995. Only manufacturing firms are included in the analysis.

In the data product level information is available for around 85% of the firms in manufacturing sector. Products are defined according to CMIE's internal product classification. Goldberg, Khandelwal, Pavcnik, and Topalova (2010b) present a detailed description of the data, product classification, and product mix change. They identify 1,886 products linked to 108 four digit 1998 version of National Industrial Classification (NIC) industries in manufacturing sector and they find that products that can be mapped to four or five digit NIC codes account for 99 percent of total output. They also show that the number of products classified in India is quite comparable to the number found in Bernard, Redding, and Schott (2010) for US manufacturing sector.

[Table 1 about here.]

The Prowess database has been used in a series of papers by Goldberg et al. (2010a,b), Chari and Gupta (2008), and Krishna and Mitra (1998) among many others. From this database we use the number of products produced by a firm, and total sales. Descriptive statistics for these variables are presented in Table 1. An average firm of the regression sample has 1.95 products and average product growth rate in the economy is 6%. The data shows that average product addition is more frequent than product dropping. A discussion of this high product creation is presented in Goldberg et al. (2010b). The table also shows the overall variation, over time variation for each firm (within), and variation between firms (between) for each variable. Between firm variation is higher than within firm variation for the left hand side variables of the empirical analysis -number of products,and sales -, which is expected due to short time period.

[Table 2 about here.]

Multi-product firms make around 45% of the firm population in the data. An average multi-product firm produces around 3 products and these firms make around 80% of total sales. A descriptive analysis of evolution of multi-product and single product firms is presented in Table 2. The table shows the percentage of firms that showed various product evolution patterns annually, over three and five year periods for 1989-1995 period. The results presented in Table 2 are quite similar to those found in Goldberg et al. (2010b) who constructs the same table for 1989-2003 period. Percentage of firms that change their product mix increases over longer time periods. Over five year period around 40% of firms add or drop a product. Adding new products is much more common among Indian firms than dropping existing products and it is more common among multi-product firms than single-product firms.

Figure 1(a) depicts the evolution of average number of products for the firms that have been delicensed within the sample time period (delicensed) and otherwise. 1(a)and (b) plot the time series for average firm product scope and real sales. As it is presented in Table 3 a big majority of delicensing took place towards the end of 1991 in our sample and the figure points that there is not a distinct trend difference before 1992. After 1992 an upward trend break occurs for average number of product and real sales revenue series for the delicensed firms sample. Panels (c) and (d) illustrates the residuals from regressing firms' number of products and real sales on firm and indsutry(NIC2)-year fixed effects, respectively, which are the default set of fixed effects that the analysis of the following section is going to control for. Since we use difference-in-differences methodology in our empirical analysis, although panels (c) and (d) do not present a perfect parallel trend in the pre-treatment era, the deviation from parallel trends may signal about a possible underestimation of the impact of delicensing on product scope an sales.

[Fig. 1 about here.]

2.2. Economic Reforms in India

We complement the data from Prowess with several other data sources to investigate whether the economic reforms that took place in India affected innovation. Starting from

1980s, India liberalized its economy by dismantling government controls over industries and also opened up to trade. One of these reforms is on product market regulations. Up until 1985, Industries Act of 1951 brought all key industries in the registered manufacturing sector under central government control through industrial licensing. Under this act firms were required to get a license to establish a new factory, significantly expand capacity, start a new product line, or change location. The granting of the licenses was subject to heavy bureaucracy. Moreover, firms were discouraged to pursue investment projects because each project would require multiple licenses. In 1985 after Rajiv Gandhi's rise to the power, a group of the industries were delicensed.

Later in 1991, as a part of the structural reforms pursuing the Balance of payments crisis, licenses were removed for another group of industries. A number of industries were retained from the licensing reform due to security and strategic concerns, social reasons, hazardous nature of the products, and to elitist consumption.[3,4]

Licensing reforms were mostly unanticipated.[5] In Table 3, we present the percentage of firms that belong to a 4-digit NIC industry that has been delicensed. In 1989 around 40% of the firms belonged to an industry that was delicensed on or before 1988. In 1992, the share of delicensed firms more than doubled. India had several other major market reforms in the same time period. One of these reforms was on international trade. Average tariff rates and non-tariff barriers were among the most restrictive in Asia towards the end of 1980s. There has been radical changes in economic policies during 1990s and Topalova and Khandelwal (2011) show that average tariff rates declined from 97% in 1989 to 46% in 1995. They also show that there were significant decreases in the share of products that are subject to quantitative restrictions which went down from 87% in 1987 to 45% in 1994.[6]

[Table 3 about here.]

Controlling for input tariff rates is particularly important because Goldberg et al. (2010b)

[3]There were few industries that were delicensed in other years than 1985 or 1991 such as manufacture of domestic appliances, n.e.c which was delicensed in 1993.

[4]Aghion et al. (2008) and Chari (2009) provide a detailed discussion of this reform and list the industries that were delicensed and when they were delicensed.

[5]Aghion et al. (2008) provide a discussion of this conclusion.

[6]Goldberg et al. (2010b) explain that the tariff liberalization up until 1997 was unanticipated, not targeted toward specific industries, and they were free of political economy pressures.

find that reduction of input tariff rates significantly increased innovation capacities of firms. Hence, the relationship between licensing reform and innovation can be biased if the effect of tariff reform is not controlled for. Indian government also reduced the barriers to foreign direct investment in a group of industries after the balance of payments crisis in 1991. The reform allowed majority ownership rights to foreign firms. The FDI variable takes a value of zero before 1991 in all industries when FDI was strictly controlled. After that year it shows the percentage of the industry that is opened to FDI. Foreign held companies are usually better at technology adoption and they are more innovative than domestic firms. They can get easier access to technology, capital resources, and R&D facilities of the parent company which facilitate innovation and growth.[7]

The trade liberalization and FDI reforms can affect innovation performances of firms. In the empirical analysis we test whether the licensing reform increased innovation capacities of firms controlling for all these changes as well as firm specific factors that affect their evolution.

3. Empirical Analysis

In theoretical models there are two margins of firm dynamics. The first one is the dynamics of incumbent firms and the second one is the entry/exit margin. Although entering and exiting firms contribute to reallocation of resources and aggregate innovation in an economy, Prowess database does not allow us to analyze their dynamics. Firms can exit and re-enter the database. Since it is not possible to identify new entrants and actual exiting firms, the empirical analysis does not discuss the contribution of entrants and exiting firms to aggregate innovation. Goldberg et al. (2010a) also use the Prowess database and provide a similar discussion regarding to entering and exiting firms.

Models of firm and industry frictions, which can stem from several different causes including market regulations, highlight several possible channels of impact. First, competition from reform may cause reallocation of production factors across firms. More competition by new entrants and peers may push firms to increase their efficiency by curtailing costs (Help-

[7] Şeker (2012b), Criscuolo, Haskel, and Slaughter (2010), and (Almeida and Fernandes, 2008) provide empirical evidence on the relationship between FDI and innovation. There are also studies like Haddad and Harrison (1993) and Sinha (1993) that find a positive impact of foreign ownership on firms' productivity levels.

man and Krugman (1985)) , concentrate on products of firms comparative advantage(Bernard, Redding, and Schott, 2011) , raise incentives to innovate in order to respond to the threat of new firm entries ((Aghion et al., 2005)) and so on.

To discipline our thinking on firm product innovation, we borrow equation 1 from Lentz and Mortensen (2008) which describes the optimality condition for innovation rate decision of firms in their stylized model. λ is the the innovation rate that firm is expected to innovate new products for each of its existing products given that firm invests $c(\lambda)$ amount on R&D. $c'(\lambda)$ is the marginal cost of investing on R&D and the right hand side of the equation is the marginal benefit from this investment. $\pi(\varphi) - wc(\lambda)$ is the per-period net profit from inventing a new product. r is the market interest rate and μ is the exogenous destruction rate for each existing product.

Based on the motivation provided by the analytical model , the empirical analysis measures the impact of the licensing reform on the change in product mix of firms. The impact of reform can be incorporated in the model in several ways. Restuccia and Rogerson (2008) analyze the effects of policy distortions on firm performance where they formalize these distortions as output tax. They find that distortions in firms' profits can lead to sizable decreases in productivity. A similar interpretation is also used in Hsieh and Klenow (2009). They introduce a tax on output for firms that face government restrictions on size or that face high transportation costs. Interpreting policy distortion as an output tax can be applied in the model presented above. Being required to provide a license to increase capacity or start a new product line firms have to deal with government officials which is likely to take time and it is costly. This distortion can be considered as a tax on firm's profit or revenue. License requirements prevents firms from responding quickly to the changes in market conditions and lead to loss of competitiveness.

$$c'(\lambda) = \frac{\pi(\varphi) - wc(\lambda)}{r + \mu - \lambda} \tag{1}$$

An alternative way to model licensing requirement is introducing it as a tax on innovation costs particularly because one of the activities that require license is starting a new product line. Such a license requirement would provide disincentive to invest in R&D which will result in reduction of innovative effort. In the model, representation of the distortion caused by license requirement either as a tax on profit or on R&D investment is analogous to each other. In the first order condition presented in equation 1, if this distortion is represented as a tax $\tau_R > 0$ on R&D investment we get the condition in equation 2,

$$(1+\tau_R)c'(\lambda) = \frac{\pi(\varphi) - (1+\tau_R)wc(\lambda)}{r+\mu-\lambda} \tag{2}$$

In this equation, higher distortion in innovation cost simultaneously increases the marginal cost and decreases the marginal benefit of innovation which results in a lower level of λ. If we divide both sides of the equation by we get the result in equation 3

$$c'(\lambda) = \frac{\frac{\pi(\varphi)}{(1+\tau_R)} - wc(\lambda)}{r+\mu-\lambda} \tag{3}$$

In this equation since $1/(1+\tau_R) < 0$, it is equivalent to a tax on profit or revenue level $(1-\tau_\pi = 1/(1+\tau_R))$. In either representation of licensing requirements, we see that it increases the opportunity cost of investing in R&D and results in lower innovation performance. This relationship is represented in Figure 2. When tax on profit level is imposed, marginal benefit of innovation shifts downward causing a decline in the optimal value of innovation rate from λ_1 to λ_2.

[Fig. 2 about here.]

Finally, product growth rates of firms can be affected by the other policy reforms that took place in India. The importance of trade policies was discussed in the previous section. Goldberg et al. (2010b) and (Topalova and Khandelwal, 2011) show how reductions in tariff rates increased introduction of new varieties and improved productivity. To control for the effects of trade reforms, we include tariff rates at NIC4 industry level.

3.1. Baseline Specifications

We start by examining the impact of delicensing on number of products of individual firms. The main variables of interest are the indicator variables for the years following the the reforms. $Delicen1_{it}$ and $Delicen2_{it}$ are the indicator variables that takes value 1 only for the year after and the second year after industry of the firm is deregulated, respectively and 0, otherwise. Our approach is to compare innovative output of firms delicensed firms in the first and second year after delicensing with the same firms' innovation in other years as well as innovation of firms in the control group which are either the ones delicensed before 1989 or the ones that are never delicensed.

Using a measure that spans the entire life of a firm after reform is perhaps the most economically relevant measure. However, firm innovations long after the reform naturally tend to capture macroeconomic and firm-specific shocks more so than the impact of reform, which is our main interest. The choice of only two years is also due to the data attrition and the catch-up between the firms that are delicensed earlier versus later. These two issues will also be discussed shortly.

$$log(n_{it}) = \beta_0 + \beta_1 Delicen1_{it} + \beta_2 Delicen2_{it} + \theta_4 Industry4_{t-1} + \gamma_i + \mu_{Industry2,t} + \varepsilon_{it} \tag{4}$$

n_{it} is the product scope (number of products) of firm i at year t. $Industry4_{t-1}$ are the control variables which are the lagged values of the three policy reform measures: output tariff OTariff, input tariff ITariff, and industry level foreign direct investment openness measure FDI. γ_i is firm fixed effect which controls for all time-invariant firm characteristics. $\mu_{Industry2,t}$ is NIC2-year fixed effect where NIC2 is the 2-digit NIC industry of the firm and accounts for all yearly macro and industry-specific shocks including NIC2 level demand or supply volatilities across years. To allow for correlation of error terms, we report robust standard errors that are heteroskedasticity-consistent and clustered at the industry(NIC2) level. In all specifications we use lagged tariff and FDI variables because the changes in all of these variables are unlikely to have impact on firm product scope instantaneously.[8]

Our identification strategy depends on the intertemporal and across-industry variation industrial policy. Specifically, our strategy exploits the specific timing as well as the differential degree of deregulation across industries to identify the impact of delicensing reform on firms' innovation behavior. We study not only the impact of industrial policy on firm product scope

[8]One other specification option is including Tfp_{t-1} as a control variable. Since such an inclusion causes losing around 10% of observations we do not prefer to keep it in the baseline specifications. However, we tried regressions including Tfp_{t-1} as another control and we neither detected a significant change in power and magnitude of the estimated coefficients nor the Tfp_{t-1} variable had a significant effect on firm product scope. These results are also available upon request.

which accounts for product innovation but also firm sales revenues even after controlling for firm product scope, which can proxy the extent of process innovation.

[Table 4 about here.]

Table 4 reports the baseline results for firm product scope in nine columns. In column 1, we find that in the year after delicensing average product scope of a firm in a delicensed industry grows by 3.2%. One year may not be long enough to observe the unfolding effect of delicensing. In column 2 we add another dummy variable $Delicen2$ to capture the impact in the second year after delicensing. We find that the total impact scattered over two years add up to almost 8%. We also realize that adding $Delicen2$ causes an increase in the estimated impact of $Delicen1$. In fact, this is an expected outcome when the impact of delicensing is spread over multiple years. If we do not include $Delicen2$, observations with higher n's due to delicensing are treated as control group observations and hence biases the estimated coefficient downwards.

In column 3, we add $Delicen3$ to capture the impact on the third year following a reform, as well. We cannot detect a significant impact on the third year. As it is also noticed in the number of observations for each specification, we can enrich the specifications by adding more $Delicen$ variables at the expense of losing more observations. This attrition of the data is because of the unbalanced nature of the data.

The specifications in columns 1-3 control for firm and industry(NIC2)-year fixed effects, other factors such as the concurrent trade liberalization reforms may affect firm performance. Hence, in columns 4-6 we introduce three additional variables to account for the impact of these reforms. Specifically, we control for input tariff $Itariff$, output tariff $Otariff$ and FDI. If the licensing reform across industries and over time is correlated with the process of tariff reduction and openness to FDI, then the empirical strategy could erroneously attribute the impact of these other reforms to licensing reform. With addition of these $Industry4_{t-1}$ variables which are at NIC4 level industries we still find similar magnitudes for the $Delicen$ variables. We cannot get any significant coefficient for these variables in columns 4 & 5 whereas we observe negative and somewhat significant impact of FDI on product scope. Our inclusion of industry(NIC2)-year fixed effects seems to capture a significant variation and hence we cannot find strong estimates for $Industry4_{t-1}$ variables. We use the specification in column 5 as our baseline specification in our following analysis due to the aforementioned reasons.

Columns 7-9 displays the gradual impact of adding fixed effects to the regression specification. In column 7, no fixed effects are introduced. Only the $Industry4_{t-1}$ variables are controlled for. In column 8 only industry-year fixed effect is accounted for and in column 9 only firm fixed effects are controlled for. These results also show how important it is to take firm and industry-year fixed effects into account for measuring the actual impact of the reform.

In the regression sample average yearly firm product scope growth for the treatment group after treatment is 4.37%, and the reform explains 2.47/4.37=57% and 1.62/4.37=37% of the growth in the first and second years following the reform, respectively.[9] for the treatment group after treatment.

In the estimations, coefficients of tariff rates are not significant. However Goldberg et al. (2010b) find significant increase in product growth rate caused by the reduction in input tariffs. Our analysis differs from their study in several ways. In their model input tariff rates are used as instruments for a conventional price index and a variety index. They show that both indices affect product growth. According to their model lower tariffs lead to lower prices of inputs which result in increased imported varieties. Higher use of varieties is associated with an expansion of firm scope. In the estimations of product growth they do not control for the licensing reform. Moreover the model presented in their study does not show the dynamics of product evolution.

FDI reform is another factor that can affect innovation performances of firms. It can reduce the cost of innovation by increasing R&D capacity or lowering capital and transactions costs. Using the Prowess database, Vishwasrao and Bosshardt (2001) find that foreign ownership is among the variables that impact a firm's probability of adoption new technology. The baseline results of column 5 confirms the positive impact of FDI reform using a more detailed product information. The estimation results presented in Table 4 columns 4-9 provide a complete set of controls of policy reforms during the time period included in the analysis. Accounting for the other two major reform areas, licensing reform significantly increases product creation rates.

[9] 2.47 and 1.62 are mean values of 0.049*$Delicen1$ and 0.033*$Delicen2$

Change in number of products is a very neat metric for measuring the impact on innovative output following the reform. However, changes in sales revenue and measured productivity can be other reflections of the change in innovative output, and may represent improvements in process innovation. In Table 5 we examine the impact of the reform on firms' real sales and productivity. In the year after delicensing on average real firm sales grows by 17.7% and in the second year after the reform sales grow by 8.8% (column 1 of Table 5). In column 2, we examine the impact on firms' total factor productivity (Tfp), and delicensing boosts firm productivity by 3.8% in the year following the reform. This finding is also in line with the findings of (Chari, 2011) where delicensing reform is responsible for a 5-6% aggregate TFP improvement.

In column 3, we rerun the sales revenue regression of column 1 controlling for also the product scope of firms. With this additional control we still find positive and significant coefficients for the reform dummies which is consistent with the presence of process innovations after reform. Now reform dummies measure the impact of process innovation or quality upgrades of products on firms' sales revenues . We also find the coefficient for log(n) to be 0.109 which means that if a single-product firm adds one more product to its scope its sales revenue is expected to grow by 10.9 percent. We still find coefficients for the $Delicen$ variables at similar magnitudes with the ones in column 1 and it implies that process and quality improvements on "cash cow" products are not affected very much from accounting for the new product innovations. It may also take longer time periods to increase customer awareness for the new products and construct distribution channels for them.

As we suspect if adding $log(n_t)$ as an explanatory variable while explaining $log(sales_t)$ may cause some simultaneity problem in column 4 we use per-product sales revenue $log(sales_t/n_t)$ as the dependent variable and again we get significant coefficient estimates for the impact of deregulation.

Although the unexpected development of the reforms has already been discussed, in columns 5-6 we use $Delicen1$ and $Delicen2$ as instruments of contemporaneous Tfp_t so that we can isolate the Tfp channel of delicensing on firm product scope and sales. Contemporaneous Tfp is expected to be correlated with both firm product scope and sales. Hence, by instrumenting Tfp_t with the reform dummies we segregate the the effect on product scope and sales through the increase in Tfp induced by the reform. We get larger effects compared to the OLS effects. One percent increase in Tfp caused by the delicensing increases firm product scope and sales by 1.4% and 2.8%, respectively. Compared to the OLS results for $Delicen1$ and $Delicen2$, these high numbers indicate that some other channels that the delicensing reform interacts with have dampening impacts on the size of the Tfp channel.

As Table 3 highlighted almost half of the observations were delicensed before 1989 and they make make up most of our control group. Hence, what we identify with the delicensing reform dummies measure a catch-up between the firms that are delicensed early and relatively later. Results also highlight that this catch-up takes up to two years and coefficients start becoming insignificant afterwards.

[Table 5 about here.]

Table 5 shows that unlike in Aghion et al. (2008) licensing reform significantly increases sales. Although the estimation method and the controls used in this study differs from those used in Aghion et al. (2008), magnitude of the coefficient is quite higher than 3.1 percent increase obtained in their study. However the coefficient in their estimation is not significant. Aghion et al. (2008) can only show the impact of licensing reform on **industry** sales through its differential effect on states with varying levels of labor regulations. They show in Table 2 of their study that without the interaction terms, licensing reform does not have any impact on sales. We test the direct relationship between licensing reform and log(sales) using firm-level data from Prowess and find a positive and significant relationship.

The average yearly Tfp and sales growth rates are are 1.74% and 7.27% in the treatment group after the treatment, and estimated coefficients indicate that delicensing reform causes growth in firm Tfp and sales even larger than the yearly average growth rates (corresponding coefficients are 0.038 and 0.177). In the second year after the reform 46%(0.8/1.74) of Tfp growth and 60%(4.33/7.26) of sales growth are due to the impact of delicensing reforms.

The results indicate that delicensing reform hikes the two mentioned forms of firm innovation -product and process innovation- through boosting firm productivity. These findings are in line with the findings of (Topalova and Khandelwal, 2011), (Aghion et al., 2005, 2008, 2009), (Chamarbagwala and Sharma, 2011), and (Chari, 2011)

3.2. Subsamples

As discussed in Section 2.1 several other reforms were concurrently put into place in India, and we tried to control for them by including the $Itariff$, $Otariff$ and FDI variables along with the NIC2-year fixed effects. But if we still suspect about some unpurged impact of these reforms we can rerun the same specifications by excluding the firms that are affected the most from these other reforms. The economic reforms that took place around 1991 did not affect all industries in the same magnitude. Share of products that were opened to FDI and tariff rate reductions were not homogeneous across industries. Among the firms that had tariff reductions or FDI liberalization, the ones with the highest reduction are more likely to increase their innovation rates. We exclude firms that belong to industries that had the highest benefit from these reforms as a robustness test.

The results with sub-samples are presented in Table 6. In three panels we present the impact on $log(n)$, $log(sales)$ and $log(Tfp)$, respectively. In the first column we exclude 4-digit industries that had more than half of the industry liberalized in FDI by 1995. We see that the baseline result (Table 4 column 5) on number of products is quite robust to this exclusion while the results for $log(sales)$ and $log(Tfp)$ lose some power. In column 2, we exclude the top quartile of industries that had the highest drops in output tariff rates between 1989 and 1995. Again the estimated coefficients are at the same order of magnitude with some small swings around the baseline results. In column 3 we exclude top quartile of industries that had the highest drops in input tariffs for the same time period. In all three columns licensing reform significantly increases innovation performances of firms which provide further support that the relationship between licensing reforms and innovation that we exhibited in the previous sections is not affected by these other reforms.

[Table 6 about here.]

We also want to be sure if the results have been driven by only a subcategory of firms not only due to their exposure to other reforms but also some other firm characteristics such import and export orientations or employee skill level of a firm. In his survey on technology diffusion, Keller (2004) summarizes theoretical and empirical literature on how imports provide knowledge and technology transfer in a macroeconomic setting. Using micro-level data from developing countries Almeida and Fernandes (2008) and Şeker (2012b) provide evidence on importing and exporting firms being more innovative. Criscuolo et al. (2010) reach a similar conclusion on the contribution of exporting on innovation for British firms. In the fourth and fifth columns of Table 6 we exclude export oriented and import oriented industries, respectively. The coefficient of licensing reform indicators continues to be significant with magnitudes similar to their whole sample counterparts.

Another test with sub-samples is with employee income levels. Industries with high wage payments are likely to employ more skilled workers and produce more knowledge embodied products. This could facilitate the innovation activities in high-wage paying industries. In the last column we exclude the top quartile of the industries with the highest wage payments.[10] These results indicate that the firms that are likely to employ less skilled workers are the ones that experience more increase in their product scope. The size of coefficients of interest almost doubles (from 0.049 to 0.106 and from 0.033 to 0.083 for $Delicen1$ and $Delicen2$, respectively) with exclusion of firms with high skilled workers. However, the impact of reform is dampened for $log(sales)$ and Tfp

Some of the industries went through multiple reforms and the sub-sample used in each column of Table 6 could include overlapping industries which could affect the results. Although there are industries that have been included in multiple groups, their numbers are not large with a possible exception of industries with highest input and output tariff drops. 50 percent of firms that belong to industries in the top quartile of input tariff drop also exist in industries that are in the top quartile of output tariff drop.[11] The overlap of industries among other groups is much smaller.

3.3. Which Industries are Affected More?

Our main finding so far is that the delicensing reform caused a significant increase in deregulated firms' innovative performance. To understand what firm and industry characteristics are effective in this process, in this subsection we trace the impact of delicensing on firms of different characteristics. Industries are likely to vary in intrinsic volatility of demand

[10] The wage data is from 1987 Annual Survey of Industries database.

[11] This is expected as input tariffs are constructed using output tariffs and input-output table of production.

and supply shocks due to differences in technological or market characteristics which affect innovation performance. (Topalova and Khandelwal, 2011) show that certain industry groups like basic goods, capital goods, and intermediate goods had substantial reduction in non-tariff barriers which could affect their innovation capacity. Studies like Şeker (2012b) and (Almeida and Fernandes, 2008) show that exporting firms are more innovative than non-trading firms.

Table 7 reports the results. In column 1, the coefficients on the interaction of $Delicen$ and export-oriented firm dummy is positive and significant for both years after delicensing. The coefficient estimates (0.090 and 0.088 for the two years following a delicensing) imply that average number of products of a delicensed firm is expected to grow by 9% and 8.8% in the year after and the second year after delicensing.

Column 2-4 reports the impact on consumer durables producer, intermediate good producer and basic goods producer firms. The interaction term for the first year after delicensing and intermediate good producer is negative for both consumer durables and intermediate goods producers but not significant for intermedite good producers whereas the similar coefficient for the second year following a delicensing indicates that compared to remaining firms that produce consumer durables and intermediate goods do not expand their product scope following a delicensing and their product scope shrinks by 4,6% and 11.5% by the second year after reform. Using interactions of variables of firm characteristics with the $Delicen$ variables, we also check the following firm characteristics: if a firm is in an import-competing sector, if it is a capital good, consumer non-durables producer, if it is a foreign or government owned company or a group company. We cannot detect any significant interaction of the listed firm characteristics and the delicensing reform.[12]

[Table 7 about here.]

$Delicen$ variables vary across 430 distinct NIC4-year pairs and so far we have been controlling for NIC2-year fixed effects to control for the idiosyncratic shocks that hit industries and firms over time other than the delicensing reform. We can increase the level of control to NIC3-year fixed effects at the expense of absorbing a great fraction of variation which is

[12]None of the listed firm characteristics pass the Chow tests which means that subsamples of firms that differ from each other along the listed characteristics are disparately affected.

expected to identify the $Delicen$ variables. Columns 5-7 of the table display the results with NIC3-year fixed effects. Although the time composition and levels slightly change, we still get positive and significant impact of delicensing on innovative performance of firms.

3.4. Placebo

To check if what we find so far as the link between delicensing reform and firms' innovative output is results of a time varying unobservable that even our strict set of fixed fixed effects cannot account for. To this end, we create synthetic $Delicen$ variables by treating the year and two years before and actual delicensing as a placebo reform. Results for this specification is presented in columns 1-3 of Table 8. For the number of products, sales and Tfp specifications we cannot identify any significant coefficient for the synthetic (placebo) variables.

[Table 8 about here.]

By its construction our data is not suitable for analysis of firm entry and exit as it is already discussed in section 2.1. However, there still is some firm turnover in the data. To see if this turnover hurts health of the findings we restrict the sample to firms that unremittingly have information throughout the 1991-95 period. Results of this specification is presented in columns 4-6 of Table 8 and it is observed that none of the previously found results lose statistical significance and magnitudes of the coefficients are quite stark against this test. This restriction does not change significance of the coefficient estimates for the reform variables dramatically. Hence, these results confirm that although the entry/exit margin of firms might contribute to improvements in firm innovation and product scope, it does not drive the findings so far.

3.5. Economic Environment

In this section, we investigate if characteristics of the states that firms operate in have an influence on firms' response to the reform. The characteristics that are analyzed are being a coastal or non-coastal state, being a highly financially developed state or not and being a state with pro-employer labor regulations or vice versa. In unreported results we interacted the mentioned state characteristics with $Delicen$ variables and we could not detect any significant interaction coefficients for none of the outcome variables $log(n), log(sales)$ and $log(Tfp)$.

Table9 exhibits the regression results where the sample is split into two along the mentioned state characteristics. being located at a coastal may ease transportation opportunities and also may increase foreign competition or allow access to a more diverse set of intermediate goods. Columns 1 and 2 tests this hypothesis. However, we cannot find significant differences across coastal and non-coastal states.

Indian states also show variation in access to external finance. Financial development can be an important facilitator for innovation by allowing firms to spare more resources for investments in R&D. We define a state as financially developed if the average state credit level per capita is above median. Columns 3 and 4 of Table 9 shows the result for firms from high and low financially developed states, respectively. Licensing reform has a larger benefit on firms that are located in states that are financially more developed. This finding could be interpreted as follows. Easier access to finance helps firms take advantage of the liberation. Thus the states that have sufficient financial development might have outperform in innovation activities upon delicensing. The level of financial development of the state of a firm does not seems to cause too big differences for the estimated impact of reform on $log(sales)$ and $log(Tfp)$, either .

India is a federal democracy and industrial relations fall under the joint jurisdiction of central and state governments in the constitution. Labor regulations are affected by both jurisdictions. Although all states have the same starting labor regulations, they have diverged from one another over time. Besley and Burgess (2004) divide states into three groups: pro-worker, pro-employer, and neutral. A state has a pro-worker labor regulation if the legislations benefited workers compared to employers. They show that states which had pro-worker labor regulations experienced lower output, employment, investment, and productivity in registered or formal manufacturing sector. Following their work, Aghion et al. (2008) find that when licensing reform occurred, industries in states with pro-worker regulations experienced less increase in output and employment relative to pro-employer states. These differences across states can affect firms' innovation performances. Aghion et al. (2008) use a dataset at industry level obtained from ASI which prevents them from analyzing firm dynamics.

In the Prowess database some firms provided information on the geographic location of their headquarters. Following Besley and Burgess (2004) we set a dummy equal to one if the firm is located in a state that has pro-worker labor regulations. We analyzed whether the relationship between licensing reform and innovation varied with the labor regulations in the states. However, we could not find a significant relationship between innovation and labor regulations.

[Table 9 about here.]

3.6. Treatment on Treated

One other concern about the measured impact of reform on firm product scope is the possibility of cross industry product innovations such that a firm from an already delicensed sector or a never-delicensed sector may prefer to enter the newly delicensed sector by innovating new products for this sector. Such observations may cause an underestimation of the impact of delicensing. To address this concern we estimate a treatment on treated effect by restricting the sample to firms which are ever delicensed in the sample period and the firm survived at least one year after the reform. We present the results in table 10. In columns 1 and 2 the coefficient estimates for the reform dummies are quite larger than the baseline estimations and the results are statistically significant. While the impact over the two years after reform on product scope is measured to be around eight percent column 2 implies 26% and 20% increases in the first two years after a reform.

[Table 10 about here.]

When we compare column 4 of Table10 with column 1 of Table 5 we realize that the impact in the second year after reform is far higher than what is measured for the same coefficient in Table 5. Similarly when column 6 of Table 10 is compared with column 3 of Table 5 again the the impact is far higher and significant for the second year after reform and the impact for the first year is dampened.

3.7. Dynamic Model Estimation

One other concern may be controlling for lagged dependent variables model estimation. Table 11 estimates the same outcome variables, $log(n), log(sales), log(tfp)$, controlling for their lagged values using the Arellano-Bover/Blundell-Bond estimator returns estimates similar or slightly weaker in both magnitude and significance. But still we find significant impact of reform on firm innovation and productivity within two-years after the reform. We should also mention that the estimates for the impact of delicensing from both the direct and indirect approaches are not exactly comparable.

[Table 11 about here.]

Since the Arellano-Bouver/Blundell-Bond estimator uses first differences, firm fixed effects are already washed away. When we try to add NIC2 or NIC2-year fixed effected variance-covariance matrix of the two-step estimator is not full rank. Hence we introduce only year fixed effects into the estimation. The measured impact of delicensing on product scope and sales revenue, presented in columns 1-3 of Table 11, is lower when compared to the estimates in Tables 4 and 5. However, both magnitude and significance is slightly higher for $log(Tfp)$.

4. Conclusion

This study investigates the impact of regulatory environment on the success of firms' innovative efforts. Using data from Indian manufacturing sector, it focuses on a particular reform on license requirements of firms. This reform liberalized product markets in introducing new products, increasing capacities, and establishing new plants. It employs a difference-in-differences strategy including firm and industry-year fixed effects in its baseline examination. The analysis shows that the reform significantly increased the rate at which firms introduce new product varieties to the market, product innovation, along with the sales revenue even after accounting for the increase in firm product scope, process innovation. This key finding stands out against a variety of robustness exercises, passes placebo tests. In addition to the licensing reform, India had several major economic reforms on liberalizing trade and allowing foreign ownership. The relationship between licensing reform and innovation is also robust to inclusion of controls for these reforms. Innovation activities have been accepted as the engine of growth. This study shows the importance of regulatory environment to prosper in innovation activities which has an important policy implication. In order to fully benefit from investments in human capital and physical capital to achieve sustainable growth and increased welfare, a favorable investment climate is required. The inefficiencies in investment climate will leave the efforts to improve the economy and increase innovation incomplete.

References

Aghion, P., Bloom, N., Blundell, R., Griffith, R., Howitt, P., 2005. Competition and innovation: An inverted-u relationship. The Quarterly Journal of Economics 120, 701–728.

Aghion, P., Blundell, R., Griffith, R., Howitt, P., Prantl, S., 2009. The effects of entry on incumbent innovation and productivity. The Review of Economics and Statistics 91, 20–32.

Aghion, P., Burgess, R., Redding, S. J., Zilibotti, F., 2008. The unequal effects of liberalization: Evidence from dismantling the license raj in india. The American Economic Review 98, 1397–1412.

Aghion, P., Howitt, P., 1992. A model of growth through creative destruction. Econometrica 60, 323–351.

Almeida, R., Fernandes, A. M., 2008. Openness and technological innovations in developing countries: evidence from firm-level surveys. The Journal of Development Studies 44, 701–727.

Bernard, A. B., Redding, S. J., Schott, P. K., 2010. Multiple-product firms and product switching. The American Economic Review 100, 70–97.

Bernard, A. B., Redding, S. J., Schott, P. K., 2011. Multiproduct firms and trade liberalization. The Quarterly Journal of Economics 126, 1271–1318.

Bertschek, I., 1995. Product and process innovation as a response to increasing imports and foreign direct investment. The Journal of Industrial Economics pp. 341–357.

Besley, T., Burgess, R., 2004. Can labor regulation hinder economic performance? evidence from india. The Quarterly Journal of Economics 119, 91–134.

Chamarbagwala, R., Sharma, G., 2011. Industrial de-licensing, trade liberalization, and skill upgrading in india. Journal of Development Economics 96, 314 – 336.

Chari, A., 2009. Industrial licensing. In: Basu, K., Maertens, A. (eds.), *Oxford Companion to Economics in India*, Oxford University Press, New Delhi, India.

Chari, A., Gupta, N., 2008. Incumbents and protectionism: The political economy of foreign entry liberalization. Journal of Financial Economics 88, 633 – 656, darden - {JFE} Conference Volume: Capital Raising in Emerging Economies.

Chari, A. V., 2011. Identifying the aggregate productivity effects of entry and size restrictions: An empirical analysis of license reform in india. American Economic Journal: Economic Policy 3, 66–96.

Criscuolo, C., Haskel, J. E., Slaughter, M. J., 2010. Global engagement and the innovation activities of firms. International Journal of Industrial Organization 28, 191–202.

Şeker, M., 2012a. Importing, exporting, and innovation in developing countries. CBRT Working Paper Series pp. 299 – 314.

Şeker, M., 2012b. A structural model of firm and industry evolution: Evidence from chile. Journal of Economic Dynamics and Control 36, 891 – 913.

Debroy, B., Santhanam, A., 1993. Matching trade codes with industrial codes. Foreign Trade Bulletin 24, 5–27.

Foster, L., Haltiwanger, J., Syverson, C., 2008. Reallocation, firm turnover, and efficiency: Selection on productivity or profitability? The American Economic Review 98, 394–425.

Fritsch, M., Meschede, M., 2001. Product innovation, process innovation, and size. Review of Industrial Organization 19, 335–350.

Goldberg, P. K., Khandelwal, A. K., Pavcnik, N., Topalova, P., 2010a. Imported intermediate inputs and domestic product growth: Evidence from india. The Quarterly Journal of Economics 125, 1727–1767.

Goldberg, P. K., Khandelwal, A. K., Pavcnik, N., Topalova, P., 2010b. Multiproduct firms and product turnover in the developing world: Evidence from india. The Review of Economics and Statistics 92, 1042–1049.

Grossman, G. M., Helpman, E., 1993. Innovation and growth in the global economy. MIT press.

Haddad, M., Harrison, A., 1993. Are there positive spillovers from direct foreign investment? Journal of Development Economics 42, 51 – 74.

Helpman, E., Krugman, P. R., 1985. Market structure and foreign trade: Increasing returns, imperfect competition, and the international economy. MIT press.

Hsieh, C.-T., Klenow, P. J., 2009. Misallocation and manufacturing tfp in china and india. The Quarterly Journal of Economics 124, 1403–1448.

Katayama, H., Lu, S., Tybout, J. R., 2009. Firm-level productivity studies: Illusions and a solution. International Journal of Industrial Organization 27, 403 – 413.

Keller, W., 2004. International technology diffusion. Journal of Economic Literature 42.

Krishna, P., Mitra, D., 1998. Trade liberalization, market discipline and productivity growth: new evidence from india. Journal of Development Economics 56, 447 – 462.

Lentz, R., Mortensen, D. T., 2008. An empirical model of growth through product innovation. Econometrica 76, 1317–1373.

Parisi, M. L., Schiantarelli, F., Sembenelli, A., 2006. Productivity, innovation and r&d: Micro evidence for italy. European Economic Review 50, 2037 – 2061.

Restuccia, D., Rogerson, R., 2008. Policy distortions and aggregate productivity with heterogeneous establishments. Review of Economic Dynamics 11, 707 – 720.

Sinha, R., 1993. Foreign participation and technical efficiency in indian industry. Applied Economics 25, 583–588.

Topalova, P., Khandelwal, A., 2011. Trade liberalization and firm productivity: The case of india. The Review of Economics and Statistics 93, 995–1009.

Vishwasrao, S., Bosshardt, W., 2001. Foreign ownership and technology adoption: evidence from indian firms. Journal of Development Economics 65, 367 – 387.

Appendix A. Definitions of key variables

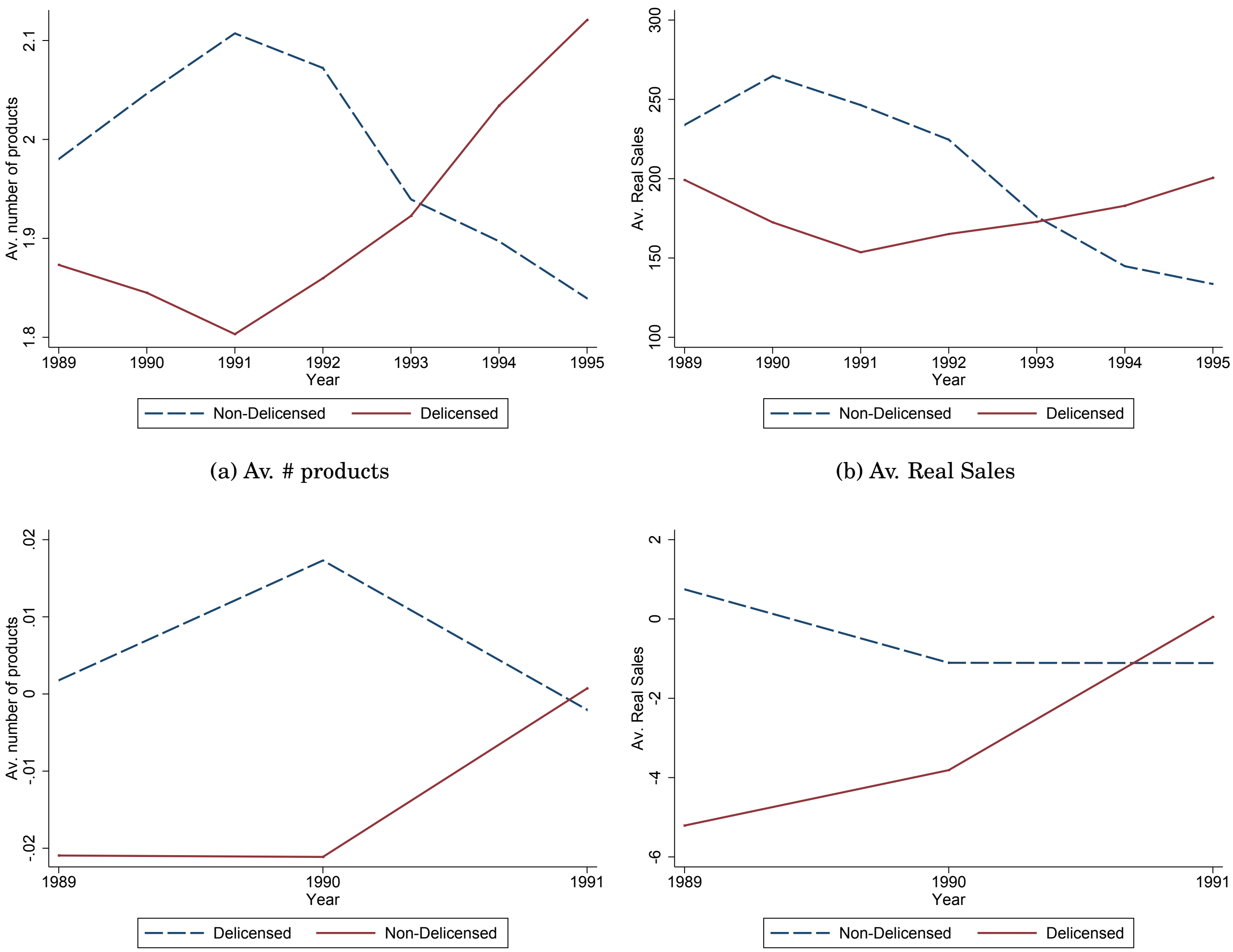
Appendix B. Data compilation

We use the data on licensing reform compiled by Aghion et al. (2008). They use various issues of Handbook of Industrial Policy and Statistics, press notes, and notifications issued by the federal government to code when different industries were exempted from industrial licensing.

We obtain the data on tariff rates at four digit industry level from (Topalova and Khandelwal, 2011). They construct a database of annual tariff rates at 6-digit level according to Indian Trade Classification Harmonized System Code based on various publications of the Ministry of Finance. Then they match the products at 6-digit with 4-digit NIC codes using the concordance by Debroy and Santhanam (1993) to calculate average industry level tariffs. These industry-level output tariffs are combined with input-output transaction table from 1993-1994 to calculate the input tariffs.

We also use the data compiled by (Topalova and Khandelwal, 2011) which is a 4-digit industry level, time varying measure of openness to foreign direct investment. They obtain the data from the publications of Handbook of Industrial Statistics.

Fig. 1. Average Product Scope and Real Sales by Treatment Status



(a) Av. # products

(b) Av. Real Sales

(c) Av. Residuals of Product Scope

(d) Av. Residuals of Real Sales

Fig. 2. Licensing Reform and Innovation

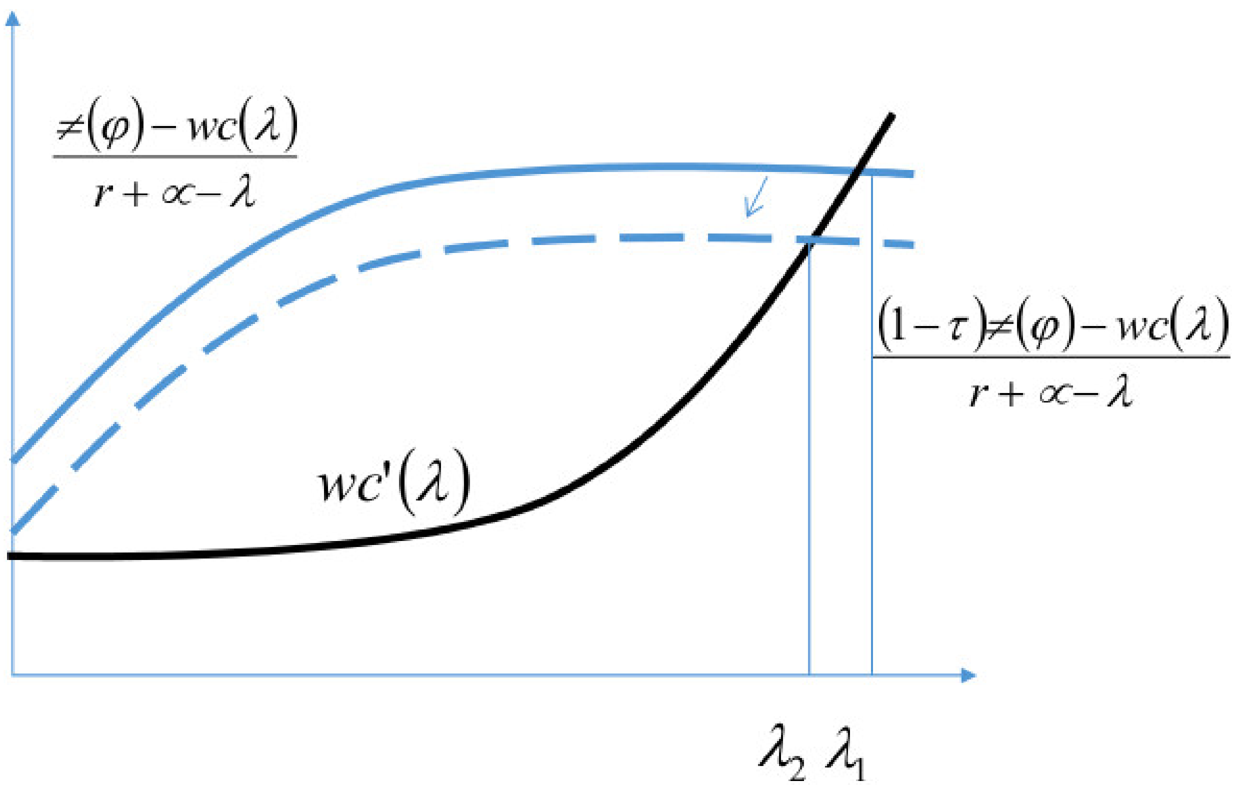


Table 1: **Descriptive Statistics of Variables**

Variable		Mean	Std. Dev.	Min	Max	No of Obs.
$Delicen1$	overall	0.06	0.24	0.00	1.00	N = 7,426
	between		0.08	0.00	1.00	n = 1,992
	within		0.22	-0.44	0.92	
$Delicen2$	overall	0.07	0.25	0.00	1.00	N = 6,145
	between		0.09	0.00	1.00	n = 1,723
	within		0.24	-0.43	0.92	
$Delicen3$	overall	0.07	0.26	0.00	1.00	N = 5,172
	between		0.08	0.00	0.50	n = 1,563
	within		0.25	-0.43	0.93	
# products	overall	1.95	1.67	1.00	32.00	N = 7,426
	between		1.38	1.00	26.33	n = 1,992
	within		0.52	-20.38	7.62	
Sales	overall	176	1020	0.00	341145	N = 7,426
	between		797	0.00	27412	n = 1,992
	within		123	-3273	6880	
Tfp	overall	0.04	0.28	-1.15	1.07	N = 6,896
	between		0.28	-1.15	1.07	n = 1,877
	within		0.10	-1.03	0.70	
$Itariff$	overall	0.76	0.28	0.14	3.51	N = 7,426
	between		0.22	0.14	3.51	n = 1,992
	within		0.16	-0.16	1.73	
$Otariff$	overall	0.27	0.09	0.04	0.55	N = 7,426
	between		0.07	0.04	0.54	n = 1,992
	within		0.05	0.13	0.44	
FDI	overall	0.30	0.39	0.00	1.00	N = 7,426
	between		0.33	0.00	1.00	n = 1,992
	within		0.27	-0.45	1.05	
Add	overall	0.09	0.29	0.00	1.00	N = 6,458
	between		0.19	0.00	1.00	n = 1,812
	within		0.24	-0.57	0.93	
Drop	overall	0.03	0.17	0.00	1.00	N = 6,458
	between		0.09	0.00	1.00	n = 1,812
	within		0.14	-0.47	0.86	

Notes: Data covers 1989-1995 period. N and n represents total number of observations and number of firms, respectively. Between component measures variation between firms while within component measures variation over time.

Table 2: **Descriptive Statistics of Variables**

	All Firms				Multi-Product Firms				Single-Product Firms			
	Stay	Add	Drop	Add& Drop	Stay	Add	Drop	Add&Drop	Stay	Add	Drop	Add&Drop
Annual	88.2	8.9	2.3	0.6	82.4	11.5	5	1.2	93.2	6.7	-	0.2
Three year	74	20.6	3.4	2	64.9	24.4	7.1	3.6	82.1	17.2	-	0.7
Five year	62.4	30.7	4.1	2.8	52.1	34.7	8.5	4.7	72	26.9	-	1.1

Table shows firm evolution annually, over three and five year periods separately for all firms, multi-product firms, and single-product firms. Product addition is defined as a firm starting to produce a product that was not produced before. Product dropping is stopping production of a product that was previously produced.

Table 3: **Percentage of Firms that are in Delicensed Industries**

Year	% Delicensed	Total # of Firms
1989	0.43	762
1990	0.45	973
1991	0.45	1,187
1992	0.88	1,293
1993	0.89	1,494
1994	0.91	1,934
1995	0.91	2,334

This table presents the fraction firms whose transactions are already delicensed in a given year (% Delicensed) alonf with the number of firms in the sample for that year.

Table 4: **Scope**

Explanatory variables	log(n)								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$Delicen1$	0.032[a]	0.048[a]	0.073[a]	0.032[a]	0.049[a]	0.074[a]	-0.035	-0.096	-0.034[a]
	(0.011)	(0.013)	(0.025)	(0.011)	(0.012)	(0.024)	(0.063)	(0.093)	(0.012)
$Delicen2$		0.029[b]	0.049[a]		0.033[b]	0.057[a]	-0.005	-0.086	-0.059[a]
		(0.013)	(0.013)		(0.013)	(0.017)	(0.046)	(0.103)	(0.015)
$Delicen3$			-0.007			-0.005			
			(0.012)			(0.013)			
$Pre/post$	-0.011	0.029	-0.022	-0.010	0.026	-0.031	0.042	0.358[a]	0.071[a]
	(0.010)	(0.032)	(0.031)	(0.009)	(0.029)	(0.031)	(0.059)	(0.012)	(0.006)
$Otariff$				-0.008	-0.003	0.043	-0.307[a]	-0.238[b]	-0.026
				(0.071)	(0.068)	(0.052)	(0.081)	(0.096)	(0.067)
$Itariff$				-0.142	-0.048	-0.193	1.019[a]	1.064[a]	-0.151
				(0.240)	(0.186)	(0.228)	(0.348)	(0.314)	(0.178)
FDI				0.038	0.054[c]	0.095[b]	-0.046	-0.117	0.088[a]
				(0.039)	(0.026)	(0.042)	(0.070)	(0.077)	(0.015)
Observations	7,426	6,145	4,992	7,426	6,145	4,992	6,145	6,145	6,145
R-squared	0.922	0.929	0.933	0.922	0.929	0.934	0.024	0.100	0.925
Firm F.E.	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes
Industry(NIC2)-year FE	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No
# firms	1992	1,723	1,549	1,992	1,723	1,549	1,723	1,723	1,723
# Industry-year pairs	138	129	120	138	129	120	129	129	129

This table presents estimates from regression 4 explaining firm product scope which is measured as the log of number firm product $log(n)$. $Delicen1_{it}$ and $Delicen2_{it}$ are the indicator variables that takes value 1 only for the year after and the second year after industry of the firm is deregulated, respectively and 0, otherwise. $OTariff$ and $ITariff$ are input and output tariffs for firms of NIC4 level industries, FDI is the foreign direct investment openness measure for an industry. Columns 1-3 do not control for industry(NIC4) level control variables. Columns 1-6 include firm and industry(NIC2)-year fixed effects. Column 7 does not include any fixed effects while columns 8 and 9 include only industry(NIC2)-year and only firms fixed effects, respectively. Standard errors are clustered at industry(NIC2) level are reported in parentheses beneath coefficient estimates. ***, **, or * indicates that the coefficient estimate is significant at the 1%, 5%, or 10% level, respectively.

Table 5: **Log(Real Sales) & Log(Productivity)**

	OLS				IV:$Delicen1$+$Delicen2$	
	$log(sales)$	$log(Tfp)$	$log(sales)$	$log(sales/n)$	$log(n)$	$log(sales)$
Explanatory variables	(1)	(2)	(3)	(4)	(5)	(6)
$Delicen1$	0.177***	0.038***	0.172***	0.128***		
	(0.037)	(0.011)	(0.037)	(0.041)		
$Delicen2$	0.088**	0.017	0.085*	0.055		
	(0.041)	(0.011)	(0.042)	(0.046)		
$Pre/post$	0.012	-0.008	0.009	-0.014	0.044	0.005
	(0.034)	(0.015)	(0.032)	(0.026)	(0.046)	(0.040)
$Otariff$	-0.035	-0.032	-0.035	-0.033	0.034	0.084
	(0.080)	(0.039)	(0.086)	(0.139)	(0.097)	(0.099)
$Itariff$	-0.523	-0.173	-0.518	-0.475	0.311	-0.009
	(0.497)	(0.275)	(0.503)	(0.568)	(0.435)	(0.498)
FDI	0.006	-0.020	0.000	-0.048	0.080	0.089
	(0.058)	(0.030)	(0.059)	(0.063)	(0.049)	(0.071)
$log(n)$			0.109***			
			(0.032)			
$IV : log(Tfp_t)$					1.371**	2.813***
					(0.643)	(0.853)
Observations	6,144	5,736	6,144	6,144	5,736	5,736
R-squared	0.957	0.898	0.958	0.940	0.893	0.973
Firm F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Industry(NIC2)-year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
# firms	1722	1626	1722	1722	1626	1626
# Industry(NIC2)-year pairs	129	129	129	129	129	129
J-stat (p val)					0.566	0.290
weakID F-stat 9.326 9.326						
C-stat (p val) 0.566 0.290						

This table presents estimates from regressions explaining firms' real sales revenues and productivities. All columns include NIC4 level industry controls $Industry4_{t-1}$along with firms and industry(NIC2)-year fixed effects. Columns 1-4 estimate the regression specification presented in Eq 4 with the exception that column 3 adds one other control variable log(n) while estimating the log(sales) specification. Columns 5 and 6 estimate an IV regression where contemporaneous firm productivity $log(Tfp_t)$ is instrumented with both $Delicen1$ and $Delicen2$ variables. $Delicen1_{it}$ and $Delicen2_{it}$ are the indicator variables that takes value 1 only for the year after and the second year after industry of the firm is deregulated, respectively and 0, otherwise. $OTariff$ and $ITariff$ are input and output tariffs for firms of NIC4 level industries, FDI is the foreign direct investment openness measure for an industry. In columns 3 and 4 Tfp_t is instrumented with $Delicen1$ and $Delicen2$. Standard errors are clustered at the industry(NIC2) level are reported in parentheses beneath coefficient estimates. ***, **, or * indicates that the coefficient estimate is significant at the 1%, 5%, or 10% level, respectively.

Table 6: **Subsamples**

Explanatory variables	(1)	(2)	(3)	(4)	(5)	(6)
	Panel A: log(n)					
*Delicen*1	0.030***	0.037**	0.039**	0.052***	0.032***	0.106***
	(0.006)	(0.013)	(0.018)	(0.012)	(0.010)	(0.019)
*Delicen*2	0.044***	0.032*	0.006	0.041**	0.032**	0.083***
	(0.012)	(0.017)	(0.030)	(0.015)	(0.014)	(0.022)
Observations	2,946	5,059	4,081	5,753	5,170	2,579
R-squared	0.944	0.927	0.934	0.930	0.930	0.920
	Panel B: log(sales)					
	(1)	(2)	(3)	(4)	(5)	(6)
*Delicen*1	0.143***	0.197***	0.239***	0.167***	0.210***	-0.042*
	(0.023)	(0.044)	(0.058)	(0.043)	(0.042)	(0.020)
*Delicen*2	0.019	0.061	0.162***	0.106**	0.071*	0.098**
	(0.028)	(0.037)	(0.046)	(0.050)	(0.037)	(0.036)
Observations	2,945	5,058	4,080	5,752	5,169	2,579
R-squared	0.960	0.950	0.956	0.957	0.956	0.963
	Panel C: log(Tfp)					
	(1)	(2)	(3)	(4)	(5)	(6)
*Delicen*1	0.026	0.042**	0.013	0.033***	0.036**	0.017*
	(0.039)	(0.016)	(0.008)	(0.008)	(0.013)	(0.009)
*Delicen*2	0.010	0.011	0.029***	0.021	0.008	0.066**
	(0.022)	(0.011)	(0.010)	(0.013)	(0.010)	(0.025)
Observations	2,690	4,687	3,813	5,375	4,793	2,414
R-squared	0.907	0.890	0.918	0.898	0.897	0.893
Firm F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Industry-year F.E.	Yes	Yes	Yes	Yes	Yes	Yes

This table presents regression estimates explaining $log(n)$, $log(sales)$ and $log(Tfp)$ in three panels A-C by focusing on different subsamples in each column. $Delicen1$ and $Delicen2$ are the indicator variables that takes value 1 only for the year after and the second year after industry of the firm is deregulated, respectively and 0, otherwise. $OTariff$ and $ITariff$ are input and output tariffs for firms of NIC4 level industries, FDI is the foreign direct investment openness measure for an industry. Column (1) excludes industries that had least 50% of the industry opened to FDI by 1995, (2) excludes top 25% of industries that had the highest drop in output tariff rates between 1989 and 1995, (3) excludes top 25% of industries that had the highest drop in input tariff rates between 1989 and 1995, (4) excludes export oriented industries, (5) excludes import oriented industries, (6) excludes top 25% of the industries with the highest wage payments. All specifications include $Itariff$, $Otariff$, FDI and $Pre/post$ controls. Standard errors are clustered at the industry(NIC2) level are reported in parentheses beneath coefficient estimates. ***, **, or * indicates that the coefficient estimate is significant at the 1%, 5%, or 10% level, respectively.

Table 7: **Industry Characteristics**

	Export oriented	Consumer durables	Intermediate goods		*NIC3-year F.E.*		
VARIABLES	$log(n)$	$log(n)$	$log(n)$	$log(n)$	$log(n)$	$log(sales)$	$log(Tfp)$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$Delicen1 * Ind.char$	0.090**	-0.097**	-0.022	0.020			
	(0.040)	(0.034)	(0.048)	(0.049)			
$Delicen2 * Ind.char$	0.088**	-0.046	-0.115***	0.054*			
	(0.041)	(0.036)	(0.030)	(0.026)			
$Delicen1$	0.028*	0.040***	0.037**	0.024	0.054	0.142**	0.060**
	(0.014)	(0.011)	(0.015)	(0.021)	(0.039)	(0.061)	(0.024)
$Delicen2$	-0.003	0.002	0.021*	-0.019	0.045**	0.044	0.022
	(0.018)	(0.017)	(0.011)	(0.027)	(0.021)	(0.026)	(0.023)
$Pre/post$	-0.029	0.052***	0.008	0.029	0.337***	0.690***	0.088
	(0.025)	(0.016)	(0.014)	(0.020)	(0.054)	(0.152)	(0.053)
$Otariff$	0.053	0.056	0.049	0.051	-0.034	0.078	0.000
	(0.051)	(0.049)	(0.047)	(0.054)	(0.072)	(0.064)	(0.020)
$Itariff$	0.052	0.050	-0.016	0.009	-0.296	-0.302	0.009
	(0.227)	(0.216)	(0.199)	(0.181)	(0.295)	(0.877)	(0.506)
FDI	0.019	0.021	-0.002	0.018	0.063	0.047	-0.019
	(0.028)	(0.027)	(0.030)	(0.027)	(0.040)	(0.104)	(0.028)
Observations	4,151	4,151	4,151	4,151	6,145	6,144	5,736
R-squared	0.934	0.934	0.934	0.934	0.932	0.959	0.903
Firm F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry*year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
# firms	1,129	1,129	1,129	1,129	1,723	1,722	1,626
# Industry-year pairs	124	124	124	124	268	268	267
Chow(p-val) 1	0.03	0.01	0.66	0.69			
Chow(p-val) 2	0.04	0.22	0.00	0.05			

In columns 1-4, this table presents regression estimates for interaction of reform with industry characteristics, and in columns 4-7 it presents the estimation results where industry-year fixed effects are tightened up one more step by including industry(NIC3)-year fixed effects. $Delicen1$ and $Delicen2$ are the indicator variables that takes value 1 only for the year after and the second year after industry of the firm is deregulated, respectively and 0, otherwise. $OTariff$ and $ITariff$ are input and output tariffs for firms of NIC4 level industries, FDI is the foreign direct investment openness measure for an industry. In columns 3 and 4 Tfp_t is instrumented with $Delicen1$ and $Delicen2$. Standard errors are clustered at the industry(NIC2) level are reported in parentheses beneath coefficient estimates. ***, **, or * indicates that the coefficient estimate is significant at the 1%, 5%, or 10% level, respectively.

Table 8: **Placebo**

	Placebo			*Balanced 91-95*		
	$log(n)$	$log(sales)$	$log(Tfp)$	$log(n)$	$log(sales)$	$log(Tfp)$
Explanatory variables	(1)	(2)	(3)	(4)	(5)	(6)
$Synt.Delicen1$	0.006	0.077	0.019			
	(0.025)	(0.052)	(0.024)			
$Synt.Delicen2$	0.021	-0.021	-0.005			
	(0.025)	(0.047)	(0.022)			
$Delicen1$				0.048***	0.143***	0.039**
				(0.015)	(0.046)	(0.016)
$Delicen2$				0.033**	0.194***	0.015
				(0.014)	(0.042)	(0.016)
$Pre/post$	0.027	-0.040	-0.012	-0.000	-0.159***	-0.007
	(0.027)	(0.086)	(0.033)	(0.039)	(0.042)	(0.029)
$Otariff$	0.010	-0.082	-0.031	0.001	-0.012	-0.029
	(0.055)	(0.077)	(0.022)	(0.043)	(0.046)	(0.026)
$Itariff$	-0.188	-0.202	-0.216*	-0.028	-0.744**	-0.270
	(0.196)	(0.298)	(0.129)	(0.210)	(0.366)	(0.246)
FDI	0.021	-0.068	-0.004	0.058**	-0.023	-0.029
	(0.039)	(0.058)	(0.023)	(0.027)	(0.041)	(0.025)
Observations	4,554	4,552	4,208	4,517	4,161	4,325
R-squared	0.945	0.966	0.913	0.923	0.964	0.893
Firm F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Industry*year FE	Yes	Yes	Yes	Yes	Yes	Yes
# firms	1,347	1,346	1,273	874	874	129
# Industry-year pairs	105	105	105	129	117	870

In columns 1-3, this table presents the results for a placebo specification where the year and two years before and actual delicensing are treated as a synthetic reform period. $Synt.Delicen1$ and $Synt.Delicen2$ are the synthetic reform variables. In columns 4-6 we restrict the sample to the firms which are balanced in the 1991-95 period in the sample. $Delicen1_{it}$ and $Delicen2_{it}$ are the indicator variables that takes value 1 only for the year after and the second year after industry of the firm is deregulated, respectively and 0, otherwise. $OTariff$ and $ITariff$ are input and output tariffs for firms of NIC4 level industries, FDI is the foreign direct investment openness measure for an industry. In columns 3 and 4 Tfp_t is instrumented with $Delicen1$ and $Delicen2$. Standard errors are clustered at the industry(NIC2)-year level are reported in parentheses beneath coefficient estimates. ***, **, or * indicates that the coefficient estimate is significant at the 1%, 5%, or 10% level, respectively.

Table 9: **Economic Environment**

Explanatory variables	Coastal (1)	Non-costal (2)	HiFinDev (3)	LoFinDev (4)	Pro-Employer (5)	Neutral or Pro-worker (6)
	Panel A: log(n)					
$Delicen1$	0.026	0.022	0.039*	-0.018	0.031	0.023
	(0.023)	(0.059)	(0.023)	(0.101)	(0.051)	(0.028)
$Delicen2$	0.009	-0.027	0.011	-0.101	0.004	-0.014
	(0.027)	(0.047)	(0.019)	(0.071)	(0.057)	(0.011)
Observations	3,157	969	3,590	536	1,406	2,446
R-squared	0.936	0.938	0.937	0.936	0.944	0.936
	Panel B: log(Sales)					
$Delicen1$	0.096*	0.130*	0.109***	0.065	0.167	0.085**
	(0.051)	(0.067)	(0.038)	(0.086)	(0.099)	(0.034)
$Delicen2$	0.092***	0.137**	0.103***	0.138***	0.189***	0.065**
	(0.032)	(0.050)	(0.025)	(0.047)	(0.060)	(0.029)
Observations	3,157	969	3,590	536	1,406	2,446
R-squared	0.976	0.977	0.977	0.968	0.966	0.978
	Panel C: log(Tfp)					
$Delicen1$	0.043***	0.071**	0.049***	0.087***	0.096***	0.033***
	(0.010)	(0.031)	(0.009)	(0.026)	(0.016)	(0.006)
$Delicen2$	0.004	0.064**	0.018	0.020	0.032	0.005
	(0.016)	(0.028)	(0.015)	(0.052)	(0.022)	(0.016)
Observations	3,102	947	3,530	519	1,381	2,398
R-squared	0.902	0.934	0.904	0.933	0.878	0.924

This table presents the regression estimates by splitting the main sample by characteristics of the economic environment. Column 1 and 2 estimates the model in Eq. (4 by restricting the sample to firms whose main offices are in coastal and non-coastal states, respectively. Columns 3 and 4 presents the results for samples restricted to firms located in relatively financially underdeveloped states. Columns 5 and 6 split the sample by the level of labor regulation in sate of the firm. $Delicen1_{it}$ and $Delicen2_{it}$ are the indicator variables that takes value 1 only for the year after and the second year after industry of the firm is deregulated, respectively and 0, otherwise. $OTariff$ and $ITariff$ are input and output tariffs for firms of NIC4 level industries, FDI is the foreign direct investment openness measure for an industry. Standard errors are clustered at industry (NIC2) level are reported in parentheses beneath coefficient estimates. ***, **, or * indicates that the coefficient estimate is significant at the 1%, 5%, or 10% level, respectively. All specifications include $Itariff$, $Otariff$, FDI and $Pre/post$ controls, firm and industry(NIC2)-year fixed effects.

Table 10: **Treatment on Treated**

Explanatory variables	$log(n)$ (1)	(2)	$log(sales)$ (3)	(4)	(5)	(6)
$Delicen1$	0.212***	0.260***	0.045***	0.055***	0.025	0.031
	(0.009)	(0.009)	(0.013)	(0.014)	(0.019)	(0.022)
$Delicen2$		0.205***		0.503***		0.485***
		(0.009)		(0.004)		(0.008)
$Otariff$	0.242***	0.213**	-0.032	-0.051	-0.056	-0.070
	(0.077)	(0.078)	(0.055)	(0.056)	(0.053)	(0.055)
$Itariff$	-0.178	0.009	-1.241**	-1.102**	-1.224**	-1.103**
	(0.608)	(0.675)	(0.502)	(0.483)	(0.498)	(0.479)
FDI	-0.007	-0.005	-0.041	-0.040	-0.041	-0.040
	(0.046)	(0.040)	(0.101)	(0.105)	(0.104)	(0.107)
$log(n)$					0.097**	0.090**
					(0.039)	(0.039)
Observations	2,698	2,655	2,698	2,655	2,698	2,655
R-squared	0.913	0.914	0.942	0.942	0.942	0.942
Firm F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Industry(NIC2)-year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
# firms	448	447	448	447	448	447
# Industry-year pairs	96	94	96	94	96	94

In this table sample is restricted to the firms which are ever delicensed in the sample period and the firm survived at least one year after the reform. $Delicen1_{it}$ and $Delicen2_{it}$ are the indicator variables that takes value 1 only for the year after and the second year after industry of the firm is deregulated, respectively and 0, otherwise. $OTariff$ and $ITariff$ are input and output tariffs for firms of NIC4 level industries, FDI is the foreign direct investment openness measure for an industry. Standard errors are clustered at industry (NIC2) level are reported in parentheses beneath coefficient estimates. ***, **, or * indicates that the coefficient estimate is significant at the 1%, 5%, or 10% level, respectively.

Table 11:

VARIABLES	Arellano-Bover/Blundell-Bond		
	$log(n)$	$log(sales)$	$log(Tfp)$
	(1)	(2)	(3)
$Delicen1$	0.025*	0.025	0.028***
	(0.015)	(0.019)	(0.009)
$Delicen2$	0.023	0.055**	0.030***
	(0.016)	(0.022)	(0.010)
$Otariff$	0.015	0.088	-0.033
	(0.045)	(0.055)	(0.024)
$Itariff$	-0.021	-0.641**	-0.169
	(0.167)	(0.296)	(0.112)
FDI	0.008	0.037	0.003
	(0.022)	(0.033)	(0.013)
Constant	0.077	1.642***	0.044
	(0.056)	(0.295)	(0.039)
Observations	5,292	5,291	4,843
# firms	1,542	1,542	1,451
Year F.E.	Yes	Yes	Yes
Lagged dep. var.	Yes	Yes	Yes
Wald (p value)	0	0	0
AR(1) test pval	7.30e-11	0.0127	0
AR(2) test pval	0.895	0.262	0.128
# instruments	31	31	31

This table presents the regression estimates for the delicensing for the delicensing reform on firm product scope $log(n)$, sales revenue $log(sales)$ and productivity $log(Tfp)$ using Arellano-Bover/Blundell-Bond estimator. $Delicen1$ and $Delicen2$ are the indicator variables that takes value 1 only for the year after and the second year after industry of the firm is deregulated, respectively and 0, otherwise. $OTariff$ and $ITariff$ are input and output tariffs for firms of NIC4 level industries, FDI is the foreign direct investment openness measure for an industry. Estimation also includes a constant term. Robust standard errors are reported in parentheses beneath coefficient estimates. ***, **, or * indicates that the coefficient estimate is significant at the 1%, 5%, or 10% level, respectively.