TRADE LIBERALIZATION AND FIRM PRODUCTIVITY: THE CASE OF INDIA

Petia Topalova and Amit Khandelwal*

Abstract—This paper exploits India's rapid, comprehensive, and externally imposed trade reform to establish a causal link between changes in tariffs and firm productivity. Pro-competitive forces, resulting from lower tariffs on final goods, as well as access to better inputs, due to lower input tariffs, both appear to have increased firm-level productivity, with input tariffs having a larger impact. The effect was strongest in import-competing industries and industries not subject to excessive domestic regulation. While we find no evidence of a differential impact according to state-level characteristics, we observe complementarities between trade liberalization and additional industrial policy reforms.

I. Introduction

OVER the past two decades, trade liberalization has become an important part of many countries' development strategies. Advocates of liberalization argue that opening up local markets to foreign competition and foreign direct investment (FDI) can lead to a more efficient allocation of resources that will result in productivity improvements in domestic industries and higher overall output. Critics warn that domestic firms may not be able to realize efficiency gains because they are unable to adapt foreign technologies to local methods of production or because domestic firms face binding credit constraints that prevent the expansion of efficient industries as well as investments in new technology. Which of these two views is closer to the truth has important implications for trade policy: if the latter holds, benefits of liberalization may not be realized unless additional policies are devised to facilitate technology transfer or ease credit constraints.

This paper exploits the 1991 liberalization episode in India to examine the effects of trade reform on firm-level productivity. The nature of India's trade opening is particularly useful to study the change in productivity stemming from trade liberalization, the mechanisms that contributed to this change, and the differential impact of the reforms across industries, firms, and economic environments. In response to a severe balance-of-payments crisis in 1991, India turned to the International Monetary Fund (IMF) for assistance. Financial assistance from the IMF was conditional on a structural adjustment program, of which liberalizing trade was a key component. As a result, over a short period of time, India drastically reduced tariffs and narrowed the dispersion in tariffs across sectors. Since the reform was rapid, comprehensive, and externally imposed, it is reasonable to assume that the changes in the level of protectionism were unrelated to firm- and industry-level productivity. India's 1991 economic liberalization therefore provides an excellent setting to analyze the impact of trade reforms on productivity because it sidesteps the endogenous nature of trade policies that typically present major challenges to empirical studies. For instance, governments may reduce tariffs only after domestic firms have improved productivity, which would result in a spurious relationship between trade and productivity. As we argue below, this is unlikely to be a concern in India's case.

We adopt the standard approach in the literature to estimate the effect of trade liberalization on firm-level productivity (Pavcnik, 2002; Muendler, 2004; Amiti & Konings, 2007; Fernandes, 2007). First, we estimate the parameters of industry-level production functions using the methodology of Levinsohn and Petrin (2003) in order to construct firm-level productivity measures. Next, we examine the relationship between changes in trade policies and changes in manufacturing productivity. We focus on the pre- and immediately postreform period to exploit plausibly exogenous intertemporal variation in trade protection across industries. This mitigates confounding effects that may arise because of selective protection of industries.

We find that reductions in trade protection led to higher levels of productivity. Two forces drove this finding. First, increases in competition resulting from lower output tariffs caused firms to increase their efficiency. Second, the trade reform lowered the tariffs on inputs, which led to an increase in the number and volume of imported inputs from abroad (Goldberg et al., henceforth GKPT, 2009). Firms were thus able to access more and cheaper imported inputs, which boosted firm-level productivity. Our estimates suggest that the input channel was a larger force in driving the productivity gains compared to the pro-competitive channel.

We also document heterogeneity in the impact of the reform across industries, firms, and economic environments. The productivity impact varied across industries, with import-competing industries showing a much higher responsiveness to the decline in protection. Firms in industries that were particularly burdened by regulations on the eve of the reforms did not respond to the competitive pressures with higher productivity because they did not have the freedom to adjust their production technology.

Firms also differed in the way they responded to the trade liberalization shock. Domestic companies significantly increased productivity. However, there is no evidence that trade liberalization led to productivity improvements for foreign companies, probably because these firms were already exposed to foreign competition and the learning

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* Topalova: IMF; Khandelwal: Columbia University, BREAD, and NBER.

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opportunities from superior inputs. State-level characteristics, such as being a coastal state, labor regulations, and financial development, did not seem to influence the effect of trade liberalization on productivity on this sample of firms.

During this period, India also enacted additional industrial policy reforms, including delicensing and liberalization of FDI. These reforms appear to have had an effect, but trade reform nevertheless remains an important driver of the increases in productivity. Moreover, we observe strong complementarities between the trade reform and the additional market reforms. The efficiency gains from trade reforms were largest in industries that also experienced the most deregulation and biggest progress in FDI liberalization.

This study contributes to the literature in important ways. First, this paper provides direct evidence that trade policies are endogenous to productivity levels, a fact that to our knowledge has not been previously shown.[1] Moreover, we account for the endogeneity by exploiting a narrow time frame in which tariff movements are plausibly exogenous. Second, the paper not only disentangles the role of import competition versus access to better and cheaper inputs for productivity improvements, but also examines how this impact is shaped by industry, firm, and environment characteristics.[2] Finally, the Indian context allows us to provide microlevel evidence to inform the debate on the importance of policy complementarities on economic growth.

The rest of the paper proceeds as follows. Section II describes the 1991 Indian reforms and focuses in particular on trade liberalization. Section III discusses the empirical methodology and data and places this study within the existing literature. Section IV discusses the empirical estimates of the relationship between trade reforms and productivity, and section V concludes.

II. Details of India's Trade Liberalization

India's postindependence development strategy was one of national self-sufficiency and stressed the importance of government regulation of the economy. In particular, with high nominal tariffs and extensive nontariff barriers, India's trade regime was among the most restrictive in Asia. The regime included a complex import licensing system, a user policy that restricted imports by intermediaries, restrictions of certain exports and imports to the public sector (canalization), phased manufacturing programs that mandated progressive import substitution, and government purchase preferences for domestic producers. During the 1980s, India embarked on market reforms to ease import and industrial licenses. However, during this period, trade policy remained restrictive. By the end of the 1980s, only 12% of manufactured products could be imported under an open general license, and the average tariff was still among the highest in Asia, at more than 90% (Cerra & Saxena, 2000).

However, concurrent to the gradual liberalization of the late 1980s was a rise in macroeconomic imbalances—fiscal and balance of payments deficits—which increased India's vulnerability to shocks. As a result, the sudden increase in oil prices due to the Gulf War in 1990, the drop in remittances from Indian workers in the Middle East, slackened demand of important trading partners, and political uncertainty all served to undermine investor confidence and resulted in large capital outflows. To deal with its external payments problems, the government of India requested a Stand-By Arrangement from the IMF in August 1991. The IMF support was conditional on macroeconomic stabilization policies and structural reforms, and trade policy was an important component of these reforms.[3] The first review of the Stand-By Arrangement included a reduction in the level and dispersion of tariffs and a removal of quantitative restrictions on imported inputs and capital goods for export production (Chopra et al., 1995). The government's trade policy under the Eighth Five-Year Plan (1992–1997) ushered in radical changes to the trade regime by sharply reducing the role of the import and export control system.[4] The share of products subject to quantitative restrictions decreased from 87% in 1987–1988 to 45% in 1994–1995, and the actual user condition on imports was discontinued. Furthermore, all 26 import licensing lists were eliminated, and a negative list was established (Hasan, Mitra, & Ramaswamy, 2003). Thus, apart from goods in the negative list, all goods could be imported without licenses (Goldar, 2002).

In addition to easing import and export restrictions, tariffs were drastically reduced. Table 1 shows that average tariffs fell from more than 87 percentage points in 1990 to 43 percentage points in 1996, and the standard deviation of tariffs dropped by about 30% during the same period. The reform changed the structure of protection across industries. Figure 1 demonstrates a strikingly linear relationship between the prereform tariff levels and the decline in tariffs the industry experienced. This graph indicates that the reform reduced the level and dispersion of tariffs, as well as simplified the tariff system and abolished the exemptions and concessions.

Following the reduction in trade distortions, overall imports increased, particularly among intermediate inputs (GKPT, 2009). Trade volumes growth outpaced real output, and as a result, the ratio of India's manufacturing trade to GDP increased from an average of 13% in the 1980s to nearly 19% of GDP by 1999–2000.

[1] The seminal contribution of Trefler (1993) highlighting the endogeneity of tariffs does not analyze industry productivity.

[2] For additional theoretical and empirical evidence on the impact of import tariffs on productivity, see Amiti and Konings (2007), Kasahara and Rodrigue (2008), and Halpen, Koren, and Szeidl (2009).

[3] The guidelines were outlined in the Chelliah report of the Tax Reform Commission constituted in 1991.

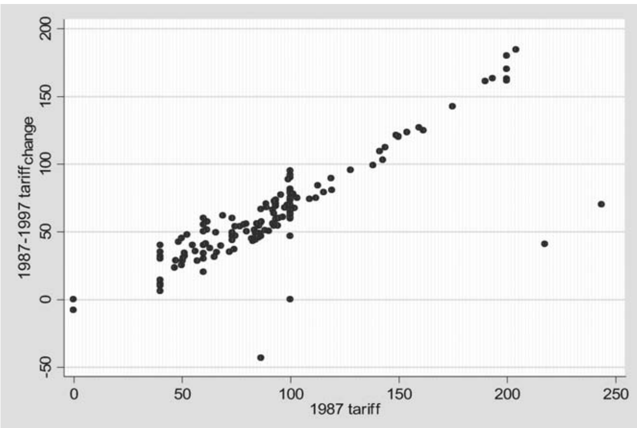
[4] India's trade policy is developed according to five-year plans. While these plans may be modified during the implementation phase, they are by and large carried out according to the original draft.

TABLE 1.—INDIA'S OUTPUT TARIFFS, EFFECTIVE RATES OF PROTECTION, AND INPUT TARIFFS

Year	Output Tariff (1)	S.D. Tariff (2)	ERP (3)	S.D. ERP (4)	Input Tariff (5)	S.D. Input Tariff (6)
1989	0.97	0.41	0.93	0.43	0.36	0.09
1990	0.87	0.40	0.86	0.42	0.31	0.08
1991	0.89	0.39	0.89	0.41	0.31	0.08
1992	0.63	0.36	0.60	0.17	0.22	0.06
1993	0.82	0.42	0.77	0.22	0.30	0.08
1994	0.62	0.43	0.59	0.19	0.21	0.06
1995	0.47	0.30	0.44	0.16	0.17	0.05
1996	0.43	0.29	0.42	0.19	0.14	0.04
1997	0.35	0.25	0.34	0.15	0.11	0.03
1998	0.35	0.24	0.35	0.14	0.11	0.03
1999	0.34	0.16	0.34	0.14	0.12	0.03
2000	0.34	0.19	0.33	0.12	0.12	0.03
2001	0.35	0.20	0.33	0.12	0.12	0.03
1989–1996	0.70	0.42	0.68	0.35	0.25	0.10

Table reports the mean and standard deviation of tariffs across industries. Columns 1–2 report statistics for tariffs. Columns 3–4 report statistics for the effective rate of protection; see equation (3). Columns 5–6 report statistics for input tariffs; see equation (4). Input tariffs are constructed using the 1993–1994 Input-Output Transactions Matrix for India. Authors' calculations from data.

FIGURE 1.—1987 INDUSTRY TARIFFS AND SUBSEQUENT DECLINES



Source: Topalova (2007).

India remained committed to further trade liberalization, and since 1997 there have been further adjustments to import tariffs. However, at the time the government announced the export-import policy in the Ninth Five-Year Plan (1997–2002), the sweeping reforms outlined in the previous plan had been undertaken, and pressure for further reforms from external sources had abated. In particular, if policy decisions on tariff changes across industries were indeed based on expected future productivity or on industry lobbying, isolating the impact of the tariff changes would be difficult. Simply comparing productivity in liberalized industries to productivity in nonliberalized industries would possibly give a spurious correlation between total factor productivity (TFP) growth and trade policies.

To check the validity of the empirical strategy, we examine the correlation between output tariffs and effective rates of protection with past industry-level performance during two periods: the period before and immediately after the crisis (1989–1996), when India's trade policy was significantly affected by externally imposed benchmarks, and the period 1997–2002, when external pressure was virtually absent. Indeed, we provide evidence that in contrast to the immediate postreform period, subsequent tariff reductions under the Ninth-Year Plan appear to have been selectively manipulated to protect less efficient industries.

III. Related Literature, Empirical Strategy, and Data

Most theoretical models of trade predict that liberalization will increase productivity. This increase can occur through several possible channels. First, competition from trade reforms could result in a reallocation of resources from less productive to more productive firms (Melitz, 2003; Melitz & Ottaviano, 2008). Trade reforms are likely to increase within-firm productivity as well. Increased competition may force firms to improve their efficiency by moving down their average cost curves (Helpman & Krugman, 1985), force firms to focus on their core competency products (Bernard, Redding, & Schott, 2006), reduce managerial slack and generate x-efficiency gains (Hicks, 1935), or raise innovation incentives among domestic producers in order to deter entry from foreign competitors (Aghion et al., 2005).[5]

In addition to the pro-competitive effects of trade, theoretical models predict productivity gains resulting from better access to superior inputs and technology that increase technical efficiency.[6] This channel may be particularly salient for developing countries that have emerged from import substitution policies under which firms faced significant technological constraints because of inadequate access to imported inputs.

[5] We note that the core competency channel, however, is unlikely to explain the findings in the context of India. See GKPT (2010a) for more details.

[6] See Ethier (1982), Grossman and Helpman (1991) and Rivera-Batiz and Romer (1991).

Finally, it is important to note that not all theoretical models of trade predict aggregate increases in productivity. Young (1991), for instances, argues that trade liberalization by a developing economy may force the country into particular sectors that are not conducive to economic growth. Moreover, other studies have found that the potential benefits of trade reforms will not be realized unless complementary policies are in place (Bolaky & Freund, 2004; Hoekman & Javorcik, 2004). For example, Bolaky and Freund (2004) find that trade does not stimulate growth in economies with excessive business and labor regulations; this could be because these regulations prevent the reallocation of resources discussed in the models. Thus, empirical evidence is required to examine whether trade reforms did in fact increase firm productivity.

Several studies analyze the impact of trade reforms on firm productivity in developing countries. Tybout, De Melo, and Corbo (1991) find no evidence of increased productivity following liberalization in Chile. On the other hand, Harrison (1994), Tybout and Westbrook (1995), Pavcnik (2002), Fernandes (2007), and Muendler (2004) observe productivity increases following liberalization in, respectively, Côte d'Ivoire, Mexico, Chile, Colombia, and Brazil. These studies use output tariffs to measure the extent of the trade reforms. Schor (2004) and Amiti and Konings (2007) extend this research by also looking at the effect of intermediate input tariffs in Brazil and Indonesia, respectively. The evidence in these two papers suggests that in comparison to the competition effect of trade, the access to cheaper intermediates has a larger impact on firm productivity.[7]

Our analysis complements two existing studies of the impact of trade reform on productivity in India. Krishna and Mitra (1998) attempt to rigorously estimate the effects of trade liberalization on firm performance in Indian manufacturing for the 1986–1993 period, and more recently, Sivadasan (2009), analyzes productivity changes in response to market reforms in the Indian manufacturing sector. Our approach differs from these studies in two important ways. First, Krishna and Mitra (1998) and Sivadasan (2009) measure the trade liberalization using dummy variables, while we exploit the actual line item tariffs. Second, rather than using a repeated cross-section of Indian plants, we exploit firm-level panel data, which have the advantage of controlling for firm-specific unobservables. Our identification strategy therefore relies on the intertemporal and across-industry variation in trade protection to identify the effect of trade policies. Moreover, we study not only the effect of output tariffs on productivity but also the impact of tariffs on intermediate inputs, as well as the effective rates of protection.

A. *Productivity Measures*

We first construct measures of firm-level TFP following the methodology of Levinsohn and Petrin (2003). They use a firm's raw material inputs as a proxy for the unobservable productivity shocks to correct for the simultaneity in the firm's production function. The inclusion of a proxy that controls for the part of the error correlated with inputs ensures that the variation in inputs related to the productivity term will be eliminated. Assuming a Cobb-Douglas production function, the estimating equation for company i in industry j at time t is

$$y_{ijt} = \alpha + \beta_l l_{ijt} + \beta_p p_{ijt} + \beta_m m_{ijt} + \beta_k k_{ijt} + \omega_{ijt} + \varepsilon_{ijt}, \quad (1)$$

where y denotes output, l denotes labor, p denotes power and electricity expenditures, m denotes raw material expenditures, and k denotes capital used. All variables are expressed in natural logarithm.[8] The simultaneity problem arises from the ω_{ijt} term, a firm-specific, time-varying productivity shock that cannot be observed by the econometrician but may be correlated with the firm's choice of variable inputs: p, m, and l. Levinsohn and Petrin (2003) show that if the demand function for intermediate inputs is monotonic in the firm's productivity for all relevant levels of capital, $m_{ijt} = m_{jt}(\omega_{ijt}, k_{ijt})$, then raw materials can serve as a valid proxy. Inverting the raw materials demand function gives an expression for productivity as a function of capital and raw materials: $\omega_{ijt} = \omega_{jt}(m_{ijt}, k_{ijt})$ This expression can be substituted in equation (1), and the coefficients on the variable inputs, l and p, can be estimated using semiparametric techniques. In a second stage, the coefficients on k and m are recovered using GMM techniques with the identifying assumption that productivity follows a Markov process and capital adjusts to productivity with a lag.[9]

This approach provides consistent estimates of the parameters of the production functions for each industry j. Due to the small number of companies in some of the four-digit-level industries, the production function parameters were estimated at the two-digit National Industrial Classification (NIC) codes. We also allow the input demand function and the production function to differ before and after 1996. This partially addresses the concern that the changing economic environment may have affected the production technology of firms.[10]

Since data on physical quantities of output, capital, and intermediate inputs are not available, the productivity estimation follows the literature using deflated sales revenue, capital spending, and input expenditures as proxies for the physical quantities. Ideally one would use firm-specific price deflators (De Loecker, 2009). Unfortunately, as is the

[7] In recent work, GKPT (2010b) found that India's trade reform substantially increased firms' access to new types of intermediate inputs from abroad. This paper examines how India's trade reform affected one margin of adjustment by firms: product scope. Here, we instead focus on the overall impact of the trade reform on firm TFP by adopting widely used methodologies to estimate TFP.

[8] See the appendix for details on variables and deflators.

[9] We refer readers to Levinsohn and Petrin (2003) for a detailed description of the methodology.

[10] In a separate robustness check, we also allowed the input demand function to differ before and after 1993. There is virtually no change in the impact of tariffs on productivity.

case in most firm-level data sets, such information is not available, and so we must rely on industry-specific deflators. Thus, the productivity measure is likely to capture both technical efficiency and price-cost markups (Katayama, Lu, & Tybout, (2009)), and the estimated coefficients on trade protection may reflect the response of price-cost markups in addition to actual changes in productivity. However, as long as price-cost markups are correlated with true efficiency (as models such as Bernard et al., 2003, would predict), then the revenue-based TFP measure captures technical efficiency.[11]

Once we obtain the input coefficients, we construct estimates of the firm's Hicks-neutral TFP by subtracting firm i's predicted output from its actual output at time t. In order to make the estimated TFP comparable across industries, we create a productivity index following the standard methodology in the literature (Aw, Chen, & Roberts, 2001).[12]

B. Empirical Strategy

The empirical strategy employed in this paper exploits the specific timing as well as the differential degree of liberalization across industries to identify the effect of trade policy on firm-level productivity. The baseline specification takes the following form:

$$pr_{ijt} = \alpha + \alpha_t + \alpha_j + \beta \text{trade}_{j,t-1} + X'y + v_{ijt}, \tag{2}$$

where Pr_{ijt} is the productivity index of company i in industry j at time t, $\text{trade}_{j,t-1}$ is a measure of lagged trade protection at the four-digit NIC level, and X is a vector of company characteristics. These characteristics include age, age squared, ownership categories (private stand-alone, private group, government owned, and foreign firms), and size categories.[13] We also include a full set of year (α_t) and industry (α_j) fixed effects, and in many specifications, we also include firm fixed effects. The inclusion of industry fixed effects absorbs unobserved heterogeneity in the determinants of productivity that are industry specific, while the year dummies control for macroeconomic shocks common to all firms. The coefficient of interest is β, which captures the percentage change in firm-level productivity associated with industry-level differences in trade protection.

Not controlling for lagged productivity in equation (2), however, is inconsistent with the assumption that TFP follows a Markov process in the estimation of the production function. Fernandes (2007) addresses the problem of serial correlation by controlling for lagged productivity, potentially introducing some bias from the inclusion of both fixed effects and the lagged dependent variable. We adopt her methodology by estimating equation (2) using the Arellano and Bond (1991) GMM technique for dynamic panels with lagged dependent variable.

Most previous studies have focused on the nominal tariffs an industry faces as a measure of trade protection. Using nominal tariffs is attractive since tariffs are both well measured and comparable across time. However, at a time when the structure of tariffs across industries undergoes such a drastic change, the disciplining effect of lowering output tariffs may be offset by lower tariffs on intermediate inputs. We therefore also construct effective rates of protection (ERP), as defined by Corden (1966), to capture the net effect of lowering tariffs on output and intermediate inputs,

$$erp_{jt} = \frac{\text{outputtariff}_{jt} - \text{inputtariff}_{jt}}{1 - \sum_s \alpha_{js}}, \tag{3}$$

where α_{js} is the share of input s in the value of output j. The ERP measure uses input tariffs, and in our analysis, we also attempt to disentangle the productivity impacts caused by lower output tariffs from those caused by lower tariffs on intermediate inputs. The input tariff for industry j is constructed as[14]

$$\text{inputtariff}_{jt} = \sum\nolimits_s \alpha_{js} \cdot \text{outputtariff}_{st}. \tag{4}$$

Table 1 provides the evolution of the different measures of trade protection over time.

C. Data Description

The firm-level information comes from the Prowess database provided by the Centre for Monitoring the Indian Economy. Prowess contains information primarily from the income statements and balance sheets of publicly listed companies. The companies in the database account for more than 70% of the economic activity in the organized industrial sector of India. While the firm-level information is of high quality, since the database is not a census of all manufacturing firms in India, Prowess is not well suited to study the entry and exit of firms (if firms exit the database, it is unlikely that they have truly disappeared from the economy). We therefore use an unbalanced panel of companies for estimation purposes and verify the robustness of the results by conducting the analysis using only the subset of companies whose information is available for all years.

[11] The results are robust to alternative measures of productivity, such as labor productivity or a direct measure of technical efficiency. We report these results in the online appendix.

[12] The productivity index is calculated as the logarithmic deviation of a firm from a reference firm's productivity in the particular industry in a base year. In other words, we subtract the productivity of a firm with the mean log output and mean log input level in 1989–1990 from the estimated firm-level TFP.

[13] The firm size categories are small if average sales over the sample are less than the median, medium if sales are larger than median but less than the 99th percentile, and large if sales exceed the 99th percentile.

[14] Note that the definition of input tariffs differs slightly from the one used by Schor (2004) and Amiti and Konings (2007) who define input tariffs as $inputtariff_{jt} = \sum_s \theta_{js} \times outputtariff_{st}$ where θ_{js} is the share of input s in the total inputs' cost of output j. The results presented in this paper are robust to their definition, though, as expected, the magnitude of the coefficient on input tariff is substantially larger.

The data set contains information on about 4,100 individual manufacturing companies. Firms are categorized by industry according to the four-digit NIC (1998 revision) and span the industrial composition of the Indian economy. There are 116 industries represented in the sample. For the estimation of the production function and TFP, all relevant variables were deflated using all-India wholesale industry-specific deflators published by the Ministry of Commerce and Industry.[15]

The data on firm economic activity are complemented by measures of trade protection. We construct a database of annual tariff data for 1987 to 2001 at the six-digit level of the Indian Trade Classification Harmonized System (HS) Code based on various publications of the Ministry of Finance (see also Topalova, 2010). We then match the 5,045 HS6 product lines to the 116 NIC codes, using the concordance by Debroy and Santhanam (1993), to calculate average industry-level tariffs. We combine these industry-level output tariffs with the Input-Output Transaction Table from 1993–1994 to calculate the input tariffs and effective rates of protection. Finally, we also collect industry-level measures of delicensing and FDI openness from the *Handbook of Industrial Statistics* (Government of India, 1987, 1997).

D. *Endogeneity of Trade Policy*

Before proceeding with estimating equation (2), we address the concern of the possible endogeneity of trade policy. Specifically, the timing of trade reform might have reflected Indian authorities' perception of domestic industries as mature enough to face foreign competition. The cross-sectional variation in changes of protection may therefore be related to economic and political factors. The relatively less efficient industries might have enjoyed a higher degree of protection; the political strength of labor as well as business is also often cited as a determinant of trade protection. If authorities did not liberalize as intensively the least productive industries, one might observe small declines in tariffs associated with small increases in productivity and erroneously conclude that trade liberalization boosted productivity.

While several studies of India's reform argue that the external crisis of 1991 came as a surprise and opened the way for market-oriented reforms (Hasan et al., 2003; Goyal, 1996; Varshney, 2000), the significant variation in the tariff changes across industries could confound inference.[16] It is therefore important to understand whether the changes in tariffs reflected authorities' perceptions of industry's ability to compete internationally or the lobbying power of the industry.

We investigate the endogeneity of the trade reform by first examining the extent to which tariffs moved together. An analysis of the tariff changes of the 5,045 HS products for 1992 to 1996 and for 1997 to 2001 reveals that movements in tariffs were strikingly uniform until 1997.[17] During the Eighth Five-Year Plan, India had to meet certain externally imposed benchmarks, and the majority of tariff changes across products exhibited similar behavior (they increased, decreased, or remained constant each year). After 1997, tariff movements were not as uniform. Policymakers may have been more selective in setting product tariffs between 1997 and 2001, and the problem of potential cross-sectional endogenous trade protection is more pronounced.

A second check uses data from the Annual Survey of Industries (ASI) to test for political protection. We test whether measures of trade protection are correlated with politically important characteristics by regressing the change in output tariffs, input tariffs, and effective rates of protection between 1987 and 1997 on various industrial characteristics in 1987.[18] These characteristics include employment (a larger labor force may lead to more electoral power and more protection), output, average wage (policymakers may protect industries where relatively low skilled or vulnerable workers are employed), concentration (measured by the average factory size, which captures the ability of producers to organize political pressure groups to lobby for more protection), share of skilled workers, and the growth of industry output and employment in the 1980s. The results are presented in table 2. The first panel reports the correlation between changes in output tariffs (1987–1997) and industry characteristics. Each cell is a separate regression of output tariffs on the industry characteristics reported in the column. The panel indicates no statistical correlation between output tariffs and any of the industry characteristics. Panels B and C report correlations between industry characteristics and changes in input tariff and effective rates of protection, respectively. With the exception of the statistically significant correlation between the prereform wage and change in input tariffs, none of the other prereform characteristics is correlated with the trade reform.

A possible explanation for these results can be found in Gang and Pandey (1996). They conducted a careful study of the determinants of protection across manufacturing sectors across three plans—1979–1980, 1984–1985, and 1991–1992—showing that none of the economic and political factors are important in explaining industry tariff levels in India.[19] They explain this phenomenon with the hysteresis

[15] Summary statistics of key variables are provided in the online appendix.

[16] This view is confirmed by R. J. Chelliah, one of the architects of the reforms: "We didn't have the time to sit down and think exactly what kind of a development model we needed.... There was no systematic attempt to see two things; one, how have the benefits of reforms distributed, and two, ultimately what kind of society we want to have, what model of development should we have?" (Topalova, 2010).

[17] The online appendix provides evidence that the tariff movements were uniform before 1997 and less uniform after 1997. Since the Eighth and Ninth Five-Year Plans overlapped in 1997, it is not entirely clear when to cut the sample. The main results of this paper are unaffected if we estimate the impact of tariff reform on productivity for 1989 to 1997.

[18] The results are robust to using 1988, 1989, or 1990 as the initial year.

[19] In other developing countries, protection tends to be highest for unskilled, labor-intensive sectors. See Goldberg and Pavcnik (2005), Hanson and Harrison (1999), and Currie and Harrison (1997) for evidence from Colombia, Mexico, and Morocco, respectively.

TABLE 2.—DECLINES IN TRADE PROTECTION AND PRE-REFORM INDUSTRIAL CHARACTERISTICS

Log Real Wage (1)	Share of Nonproduction Workers (2)	Capital Labor Ratio (3)	Log Output (4)	Factory Size (5)	Log Employment (6)	Growth in Output, 1982–1987 (7)	Growth in Employment, 1982–1987 (8)	Observations in Each Regression (9)
A: Output Tariffs								
0.049	0.300	0.000	0.002	0.000	−0.028	0.000	0.001	135
[0.069]	[0.425]	[0.033]	[0.035]	[0.000]	[0.024]	[0.000]	[0.001]	
B: Input Tariffs								
0.096**	0.553	0.011	−0.007	0.000	−0.033	0.000	0.000	129
[0.045]	[0.347]	[0.019]	[0.010]	[0.000]	[0.020]	[0.000]	[0.000]	
C: Effective Rates of Protection								
0.039	0.348	−0.006	0.018	0.000	−0.031	0.000	0.001	129
[0.130]	[0.864]	[0.059]	[0.060]	[0.000]	[0.046]	[0.001]	[0.001]	

The data used in this table are from the 1987 ASI, which covers all mining and manufacturing industries. Each cell represents a separate regression on either output tariffs (panel A), input tariffs (panel B), or effective rates of protection (panel C) on the variable in the column heading. The number of observations is reported in column 9 (note that the number of observations for regressions in column 6 is 1 less than that reported column 9). All regressions include indicators for industry use type: capital goods, consumer durables, consumer nondurables, and intermediate. The regressions are weighted by the square root of the number of factories. Robust standard errors are reported in parantheses. Significant at *10%, **5%, ***1%.

of policy: trade policy was determined in the Second Five-Year Plan and never changed, even as the circumstances and natures of the industries evolved. Their evidence, combined with table 2, suggests that the differential tariff changes across industries between 1991 and 1997 were as exogenous to the state of the industries as a researcher might hope for in a real-world setting.

Finally, we investigate whether policymakers adjusted tariffs in response to industry productivity levels. If this were the case, one should expect current productivity levels to predict future measures of trade protection. Therefore, we calculate industry-level productivity as the sales-weighted average of firm TFP. We then regress industry-level output tariffs, input tariffs, and ERP in period $t + 1$ on industry-level productivity in period t, controlling for industry and year fixed effects and weighting each industry by the number of companies in the industry for the particular year. The results are presented in table 3. The correlation between future trade protection and current productivity is indistinguishable from 0 for the 1989–1996 period for all three measures used in the study. The pattern, however, is quite different for the 1997–2001 period. Here, the coefficient on current productivity is negative and significant at the 5% level, suggesting that trade policy may have been adjusted to reflect industries' relative performance.[20] This test implies that to identify correctly the effect of trade policies on productivity, one should restrict attention to the period immediately before and after the major trade reforms (1989–1996). In each specification, we use lag tariffs because the trade reform was implemented toward the end of 1991 (initiated in August 1991) and because productivity is unlikely to have adjusted instantaneously.

[20] In an alternative specification available on request, we also condition on the current tariff, thus de facto performing a Granger causality test. These results indicate that conditional on current tariffs, current productivity adds no information to the explanation of movements of future tariffs in the 1989–1996 period. However, from 1997 to 2001, there is a strong, statistically significant relationship between current productivity and future tariffs.

TABLE 3.—TRADE POLICY ENDOGENEITY: CURRENT PRODUCTIVITY AND SUBSEQUENT TRADE POLICY

Period	1989–2001 (1)	1989–1996 (2)	1997–2001 (3)
A: Output Tariffs			
Productivity	−0.133**	−0.033	−0.177***
	[0.054]	[0.070]	[0.067]
Observations	1,413	913	500
B: Input Tariffs			
Productivity	−0.032**	−0.025	−0.047**
	[0.016]	[0.024]	[0.019]
Observations	1,359	878	481
C: Effective Rates of Protection			
Productivity	−0.211**	−0.068	−0.235**
	[0.097]	[0.138]	[0.093]
Observations	1,347	870	477

The table regresses industry-level output tariffs (panel A), input tariffs (panel B), and effective rates of protection (panel C) in period t on industry-level productivity in period $t + 1$. Industry-level productivity is calculated as a real sales-weighted average of firm-level TFP. All regressions include industry and year fixed effects and are weighted by the number of firms in each industry for each particular year. Standard errors are clustered at the industry level. Significant at *10%, **5%, ***1%.

IV. Results

A. Trade Policy Measures and Productivity

Output tariffs. The results from estimating equation (2) for the period 1989 to 1996 with output tariffs as a measure of protection are presented in panel A of table 4. The regression in column 2 includes four-digit NIC industry fixed. Column 3 includes firm-level fixed effects, and in column 4 we repeat the analysis on the balanced panel of companies. In column 5, we control for lagged productivity to address the potential problem of serial correlation in equation (2) (see Fernandes, 2007). However, including the lagged dependent variable in a fixed-effects model renders the estimates inconsistent, and so columns 6 and 7 adopt a GMM procedure that instruments the lagged dependent variable with one and two lags, respectively (see Arellano & Bond, 1991). The related specification tests are also presented. Finally, column 8 presents estimates from the direct approach of estimating the productivity impacts of trade reforms in which the measures of trade policy are included

TABLE 4.—OUTPUT TARIFFS, EFFECTIVE RATES OF PROTECTION AND TOTAL FACTOR PRODUCTIVITY

A: Output Tariffs and Total Factor Productivity

	(1)	(2)	(3)	(4)	(5) Lagged Dependent Variable	(6) AB1	(7) AB2	(8) Direct Approach
Lagged output tariff	−0.056***	−0.088***	−0.053***	−0.059***	−0.039***	−0.048***	−0.067***	−0.116***
	[0.020]	[0.018]	[0.016]	[0.017]	[0.013]	[0.013]	[0.015]	[0.032]
Lagged TFP					0.309***	0.455***	0.383***	
					[0.044]	[0.068]	[0.072]	
Private group firm	−0.025**	−0.027**						
	[0.012]	[0.011]						
Government owned	−0.131***	−0.140***						
	[0.030]	[0.031]						
Foreign	0.026	−0.013						
	[0.020]	[0.019]						
Medium	−0.028**	−0.032**						
	[0.014]	[0.015]						
Small	−0.059***	−0.092***						
	[0.017]	[0.018]						
Industry FEs		Yes						Yes
Firm FEs			Yes	Yes	Yes	Yes	Yes	
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Balanced panel				Yes				
AR1						−5.097	−5.042	
AR2						−0.672	0.419	
Observations	14,808	14,808	14,808	8,059	11,526	8,639	6,355	11,928

B: Effective Rates of Protection and Total Factor Productivity

	(1)	(2)	(3)	(4)	(5) Lagged Dependent Variable	(6) AB1	(7) AB2	(8) Direct Approach
Lagged ERP	−0.013	−0.047***	−0.025**	−0.028***	−0.015*	−0.021***	−0.034***	−0.062***
	[0.013]	[0.011]	[0.010]	[0.010]	[0.008]	[0.008]	[0.009]	[0.021]
Lagged TFP					0.308***	0.455***	0.384***	
					[0.045]	[0.068]	[0.072]	
Private group firm	−0.023**	−0.026**						
	[0.012]	[0.011]						
Government owned	−0.122***	−0.134***						
	[0.030]	[0.032]						
Foreign	0.034*	−0.007						
	[0.020]	[0.019]						
Medium	−0.026*	−0.031**						
	[0.014]	[0.015]						
Small	−0.056***	−0.089***						
	[0.018]	[0.018]						
Industry FEs		Yes						Yes
Firm FEs			Yes	Yes	Yes	Yes	Yes	
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Balanced panel				Yes				
AR1						−5.070	−5.026	
AR2						−0.776	0.444	
Observations	14,648	14,648	14,648	7,958	11,399	8,539	6,279	11,928

Table reports regressions of firm productivity on lagged effective rates of protection. All regressions include firm age and age squared, and the "private stand alone" and large are the omitted firm characteristics. In columns 6–7, the Arellano-Bond estimator is presented using one and two lags, respectively. Column 8 uses the direct method for estimating the productivity impact of tariffs, as explained in the main text. Robust standard errors are in parentheses. Standard errors are clustered at the firm level in columns 1–5. Standard errors in column 8 are bootstrapped using the block-bootstrapping method described in Efron and Tibshirani (1994), which takes into account the serial correlation in the data by keeping all observations that belong to the same firm together. Significance: *10%, **5%, ***1%.

in the production function itself (see Fernandes, 2007, for details).[21]

The estimates of β are robust across a wide variety of specifications. In the main specification that includes firm fixed effects (column 3), the estimates imply that a 10% reduction in output tariffs raises firm TFP by .53%. The results are highly statistically significant and similar in magnitude to the estimates of Fernandes (2007), Schor (2004), and Amiti and Konings (2007).

Melitz (2003) has shown that trade liberalization may result in a reallocation from low- to high-productivity firms, which would increase average productivity because of selection. Unfortunately, the Prowess database is not suitable for

[21] This approach corrects for the inconsistency introduced by the assumption that current productivity depends on lagged trade protection, which is known to the firm, while the Markov process of productivity assumes that the current productivity realization is a surprise conditional on lagged productivity. See Fernandes (2007) for more details.

TABLE 5.—OUTPUT AND INPUT TARIFFS ON TOTAL FACTOR PRODUCTIVITY

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	8
					Lagged Dependent Variable	AB1	AB2	Direct Approach
Lagged output tariff	−0.011	−0.066***	−0.032*	−0.046**	−0.020	−0.036**	−0.059***	−0.157***
	[0.022]	[0.018]	[0.017]	[0.018]	[0.014]	[0.014]	[0.016]	[0.040]
Lagged input tariff	0.060	−0.508***	−0.480***	−0.276**	−0.464***	−0.257**	−0.278**	−0.292
	[0.075]	[0.107]	[0.098]	[0.108]	[0.090]	[0.107]	[0.117]	[0.201]
Lagged TFP					0.307***	0.455***	0.384***	
					[0.045]	[0.068]	[0.073]	
Private group firm	−0.022*	−0.026**						
	[0.012]	[0.011]						
Government owned	−0.121***	−0.135***						
	[0.030]	[0.032]						
Foreign	0.034*	−0.008						
	[0.020]	[0.019]						
Medium	−0.026*	−0.031**						
	[0.014]	[0.015]						
Small	−0.056***	−0.089***						
	[0.017]	[0.018]						
Industry FEs		Yes						Yes
Firm Fes			Yes	Yes	Yes	Yes	Yes	
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Balanced panel				Yes				
AR1						−5.087	−5.048	
AR2						−0.729	0.413	
Observations	14,648	14,648	14,648	7,958	11,399	8,539	6,279	11,928

Table reports regressions of firm productivity on lagged output and input tariffs. All regressions include firm age and age squared, and the "private stand alone" and large are the omitted firm characteristics. In columns 6–7, the Arellano-Bond estimator is presented using one and two lags, respectively. Column 8 uses the direct method for estimating the productivity impact of tariffs, as explained in the main text. Robust standard errors are in parentheses. Standard errors are clustered at the firm level in columns 1–5. Standard errors in column 8 are bootstrapped using the block-bootstrapping method described in Efron and Tibshirani (1994), which takes into account the serial correlation in the data by keeping all observations that belong to the same firm together. Significance: *10%, **5%, ***1%.

studying firm entry and exit (see the previous discussion). Nevertheless, column 4 provides some evidence against the selection channel by reestimating equation (2) on a constant set of firms. Notice that the coefficient on tariffs is virtually unchanged. This suggests that while the exit of less efficient companies might contribute to improvements in productivity, it does not drive the results within this sample. Sivadasan (2009) also finds little evidence of the across-firm reallocation mechanism using the representative ASI database.[22]

Controlling for lagged productivity or using the Arellano-Bond estimator (columns 5–7) yields estimates that are similar in magnitude and statistically significant. Finally, the impact of trade policy on productivity when estimated using the direct approach is substantially larger in magnitude. Note, however, that the estimates in the direct and indirect approach are not easily comparable, as the direct approach assumes the same production function across all industries and does not control for firm fixed effects.

Effective Rates of Protection. Focusing on nominal output tariffs may give a misleading picture of the impact of the comprehensive trade liberalization in India if the competitive pressure on the output side was undermined by the availability of cheaper inputs. To capture the net competition effect of trade reform, panel B of table 4 presents the results from estimating equation (2) using effective rates of protection as a measure of trade liberalization.[23] Lower effective rates of protection increase firm productivity: a 10% reduction in ERP leads to a 0.25% increase in TFP. The estimated effects are similar in magnitude and robust across all specifications. The estimations using this alternative measure of trade protection also suggest that the productivity effect comes from changes within the firm.

Input Tariffs. While the effective rates of protection reveal the net competition effect of trade liberalization, it is interesting to separate the impact of lowering output tariffs versus lowering tariffs of intermediate inputs. We therefore reestimate equation (2) including both output and industry input tariffs and present the results in table 5. The inclusion of the input tariff slightly reduces the estimated impact of output tariffs, though the differences are not statistically significant. Reductions in both output and input tariffs lead to higher productivity levels, but the coefficient on input tariffs is larger than the coefficient on output tariffs across all specifications. Using the estimates in column 3, which

[22] To further check the selection story, we decompose aggregate productivity by the intensive and extensive margins using the methodology in Olley and Pakes (1996) and Pavcnik (2002). This exercise confirms that virtually all aggregate productivity gains occurred because of improvements in average firm productivity rather than because of reallocation. The high barriers to exit in the Indian economy are one potential explanation for this finding.

[23] Note that unlike output tariffs, ERP suffers from potentially important measurement error as they were calculated using the input-output matrix from 1993. Thus, we are abstracting from the variation in ERP due to changes in an industry input mix.

include firm fixed effects, a 10 percentage point decline in output tariffs leads to a .32% increase in productivity. A similar decline in input tariffs increases productivity by 4.8%. Table 1 indicates that output and input tariffs between 1989 and 1996 declined, on average, by 54 and 22 percentage points, which implies that the two-policy variable increased firm productivity by 1.7% and 10.6%, respectively. Firm-level productivity over this same period increased, on average, by 8%. Thus, output and input tariff liberalization can explain about 21% (1.7/8) and 130% (10.4/8) of the increase in productivity over this period. Input tariffs can therefore explain a much larger fraction of the increase in productivity than output tariffs can.

The results indicate that an important way through which trade reforms induce productivity improvements is through the intermediate inputs channel: the potentially wider choice of varieties of possibly higher quality and exposure to new technologies through imported inputs. Moreover, the impact of lower input tariffs on productivity is larger than the pro-competitive effects due to lower output tariffs.[24] This finding is in line with recent evidence from GKPT (2010b), who demonstrate that lower input tariffs resulted in large increases in the volume and variety of imported intermediate inputs following the reform in India. Access to these inputs alleviated constraints on Indian firms under import substitution policies prior to the reform. Firms adjusted to lower input tariffs by increasing their product mix (see GKPT, 2010b) and ultimately, their productivity, as highlighted in table 6.

B. *Trade Liberalization and Industry Characteristics*

Trade liberalization allows us to examine whether the regulatory environment in which different industries operated shaped how firms in these industries responded to trade liberalization. First, we study whether the presence of nontariff barriers (NTB) to trade reduced the competitive effect of output tariff reductions. We classify the four-digit NIC codes based on the output of the industry as basic, intermediate, capital goods, consumer durables, and consumer nondurables (Nouroz, 2001).[25] Only 34% of product lines could be imported without any license by 1996 among the set of consumer nondurables industries, as compared to 93% for the set of basic industries. As data on nontariff barriers are not available at a disaggregated level, especially for the prereform period, to implicitly account for the potential impact of NTBs, we reestimate equation (2) for two groups of industries: basic, intermediate, and capital goods, which experienced substantial reduction in NTBs,

TABLE 6.—TRADE LIBERALIZATION AND INDUSTRY CHARACTERISTICS

	Basic, Intermediate and Capital Goods		Consumer Durables and Consumer Nondurables		Highly Regulated Pre-1991		Less Regulated Pre-1991		Export Oriented		Non–Export Oriented	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
A: Output Tariffs												
Lagged tariff	−0.092***	−0.089***	−0.004	−0.005	0.016	−0.009	−0.058***	−0.071***	0.096	−0.152	−0.066***	−0.060***
	[0.020]	[0.017]	[0.040]	[0.027]	[0.075]	[0.038]	[0.018]	[0.015]	[0.147]	[0.144]	[0.017]	[0.015]
Observations	7,050	3,135	4,796	1,949	1,024	451	12,689	5,431	891	367	10,632	4,603
B: Output and Input Tariffs												
Lagged tariff	−0.082***	−0.104***	0.026	0.050	−0.020	−0.011	−0.028	−0.055***	0.097	−0.146	−0.054***	−0.066***
	[0.020]	[0.019]	[0.049]	[0.037]	[0.160]	[0.062]	[0.018]	[0.017]	[0.147]	[0.140]	[0.017]	[0.017]
Lagged input tariff	−0.202	0.303**	−0.511***	−0.608***	−0.593*	−0.370	−0.499***	−0.233**	−1.109**	−0.356	−0.331***	−0.026
	[0.155]	[0.145]	[0.183]	[0.175]	[0.328]	[0.318]	[0.116]	[0.113]	[0.561]	[0.582]	[0.118]	[0.114]
Observations	7,011	3,114	4,681	1,894	957	418	12,602	5,388	852	346	10,517	4,548

Table reports regressions of firm productivity on lagged output and input tariffs by industry characteristics. All regressions include firm age, age squared, and firm and year fixed effects. Even-numbered columns present the Arellano-Bond estimator with two lags. Robust standard errors in parentheses. Standard errors are clustered at the firm level in odd-numbered columns. Significance: *10%, **5%, ***1%.

[24] We perform an analysis that checks the sensitivity of the results to alternative measures of productivity. The results are robust for all measures and policy variables and are available in the online appendix.

[25] The output tariffs across the different industries were roughly similar in the 1989–1996 period. However, nontariff barriers (as measured by the share of product lines that require any license to be imported) were removed at a slower pace. These figures are available in the online appendix.

Table 7.—Trade Liberalization and Firm Characteristics

	Domestic		Foreign		Large		Medium		Small	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
A: Output Tariffs										
Lagged tariff	−0.062***	−0.068***	0.041	−0.039	−0.096***	−0.045**	−0.033	−0.093***	−0.065*	−0.031
	[0.018]	[0.016]	[0.037]	[0.034]	[0.033]	[0.018]	[0.021]	[0.021]	[0.036]	[0.047]
Observations	13,618	5,718	1,190	637	2,673	1,538	7,474	3,572	4,661	1,245
B: Output and Input Tariffs										
Lagged tariff	−0.041**	−0.061***	0.047	−0.028	−0.078**	−0.016	−0.012	−0.087***	−0.034	−0.053
	[0.019]	[0.018]	[0.041]	[0.039]	[0.034]	[0.019]	[0.022]	[0.025]	[0.036]	[0.049]
Lagged input tariff	−0.508***	−0.301**	−0.058	−0.134	−0.289*	−0.452***	−0.449***	−0.345*	−0.802***	0.119
	[0.102]	[0.123]	[0.351]	[0.227]	[0.158]	[0.112]	[0.134]	[0.195]	[0.245]	[0.242]
Observations	13,485	5,657	1,163	622	2,649	1,523	7,394	3,531	4,605	1,225

Table reports regressions of firm productivity on lagged output and input tariffs by firm characteristics. All regressions include firm age, age squared, and firm and year fixed effects. Even-numbered columns present the Arellano-Bond estimator with two lags. Firm sizes are classified as follows: small if average sales over the sample are less than the median, medium if sales are larger than median but less than the first percentile, and large if sales in the first percentile. Robust standard errors are in parentheses. Standard errors are clustered at the firm level in odd-numbered columns. Significance: *10%, **5%, ***1%.

and consumer nondurables and consumer durables, which remained relatively protected from foreign competition. If NTBs were an important part of trade protection in India, one would expect the roughly similar tariff reductions across the broad industry groups to have a differential impact on productivity. Table 6 confirms that this is indeed the case. The table presents the results from estimating equation (2) for the two sets of industries separately, with firm fixed effects in columns 1 and 3 and the Arellano-Bond estimator in columns 2 and 4.[26] Panel A in table 6 presents the result with output tariff as a measure of trade protection, and panel B includes both output and input tariffs.[27] The impact of the reduction in output tariffs and effective rates of protection is much larger for basic, intermediate, and capital goods industries, and there is no evidence that these tariff reductions resulted in substantial increases in productivity in the consumer goods category. The impact of input tariffs is not precisely estimated for the basic, intermediate, and capital goods industries.

Domestic industrial policy may have also affected the way firms responded to foreign competition. In particular, we examine whether the productivity impact of trade reforms was related to the extent to which an industry was subject to licensing at the onset of the trade liberalization reforms.[28] Following Aghion et al. (2005) and using various publications of the Government of India's *Handbook of Industrial Statistics*, we construct an industry-level license variable that denotes the share of products within a four-digit industry that were subject to licensing. Aghion et al. (2005) find that delicensing was associated with significant entry into an industry. We define highly regulated industries as of 1989 as those for which 100% of products are subject to licensing and split the sample according to this criteria. Not surprisingly, the competitive pressure of trade reforms did not spur productivity gains in firms in the most regulated industries, as they were unable to change their production technology, input mix, or manufacturing scale. The results are presented in columns 5 to 8 of table 6. Since the regulation status of an industry in 1989 was potentially correlated with other factors that might have affected firms' response to tariff reductions, it is difficult to attach a causal interpretation to results. Nevertheless, it is consistent with cross-country evidence presented by Bolaky and Freund (2004) that the growth effect of trade depends on a country's business regulation.

One might also expect the impact of reductions in trade protection to be larger for industries that actually compete with foreign imports. In columns 9 to 12 of table 6, we reestimate equation (2) for export-oriented and nonexport-oriented industries (which include import-competing and nontraded industries).[29] As expected, the disciplining effect of trade liberalization is much larger for the nonexport-oriented industries.

C. Trade Reform and Firm Characteristics

The results establish that certain industry characteristics such as regulatory burden, exposure to NTBs, and exporting status play a role in the transmission of the trade liberalization shock. In this section, we examine the impact of the liberalization across firms of different sizes and ownership status. Firms are classified as either domestic or foreign and placed into one of the three firm size categories. The results are presented in table 7. For each subgroup of firms, we estimate equation (2), allowing for firm and year fixed effects in the odd-numbered columns and using the Arellano-Bond estimator for the even-numbered columns.

[26] For brevity, we present the results from the Arellano-Bond estimator with two lags in the remaining specifications since the related specification test is rejected for some subsamples when using only one lag.

[27] For brevity, the remaining tables do not report the ERP estimates, but the qualitative message from the ERP regressions is similar to the output tariff regressions.

[28] The licensing of industries, outlined in the Industries (Development and Regulation) Act of 1951, was one of the most important tools of the Indian government to control private enterprise in India. According to the act, a license was required in order to establish a new factory, expand capacity by more than 25% of existing levels, or manufacture a new product (Aghion et al., 2005).

[29] Nouroz (2001) provides a classification of industries in India by export orientation.

Columns 1 to 4 of table 7 provide evidence that while the competitive pressure from trade liberalization raises productivity in domestically owned companies, foreign companies did not experience the same impact on efficiency. Although the coefficients on lagged tariffs, effective rates of protection, and input tariffs are imprecisely estimated, the point estimates in the sample of foreign enterprises are somewhat smaller in magnitude than those for domestic firms and statistically insignificant. This finding is perhaps not surprising given that foreign firms were already exposed to foreign competition and learning opportunities from superior intermediate inputs.

Columns 5 to 10 in table 7 indicate that the disciplining effect of foreign competition was roughly similar across companies of different size, and there is no significant difference in how firms of different sizes reacted to lower input tariffs.

D. *Trade Liberalization and Environment Characteristics*

In this section, we examine whether firms varied in their response to the trade reform according to characteristics of the states in which they operate, such as institutions, geography, and level of development (table 8). We present these results in table 9, and the specifications mirror those in the previous tables.

We first examine if firms that are located in coastal states were more affected by the reform.[30] In a country where product markets might not be fully integrated across regions due to the size of the country as well as poor infrastructure, firms in the heart of the country or in less accessible regions might not experience the threat of increased foreign competition or access imported intermediate inputs as much as firms in regions in more immediate contact with internationally traded goods. However, columns 1 to 4 of table 9 do not confirm this hypothesis. If anything, the point estimates of the effect of output tariffs and effective rates of protection are slightly larger in magnitudes for the set of firms operating in noncoastal states.

In columns 5 to 8, we examine the potential role of institutions with an emphasis on differences in state labor laws. Using the classification in Besley and Burgess (2004), we assign states as having proworker, neutral, or proemployer labor laws. One observes little difference in the estimated impact of reduction in trade protection. If anything, the firms in states with neutral and proworker labor laws seem to benefit more from the trade reforms.

The level of financial development of the state (measured as credit per capita in 1992, with states above the median classified as having high financial development) also does not appear to matter (columns 9 to 12). This finding is unexpected since a major concern regarding trade liberalization has been the ability of domestic firms to access sufficient credit to invest in more efficient technologies and survive in the face of foreign competition. This finding may be explained by the fact that the firms in our sample are relatively large and therefore potentially less credit constrained.

Table 8.—State Classifications by Environmental Characteristics

Geographical Classification	
Coastal State	Land-Locked States
Andhra Pradhesh	Assam
Daman and Diu	Bihar
Dadra and Nagar Haveli	Chandigarh
Goa	Chattisgarh
Gujarat	Delhi
Karnataka	Haryana
Kerala	Himachal Pradesh
Maharashtra	Jammu and Kashmir
Orissa	Jharkhand
Pondicherry	Madhya Pradesh
Tamil Nadu	Nagaland
West Bengal	Punjab
	Rajasthan
	Uttar Pradesh

Labor Laws (Besley & Burgess, 2004)		
Employer Friendly	Worker Friendly	Neutral
Andhra Pradhesh	Gujarat	Assam
Karnataka	Maharashtra	Bihar
Kerala	Orissa	Haryana
Madhya Pradesh	West Bengal	Punjab
Rajasthan		Uttar Pradesh
Tamil Nadu		Jammu and Kashmir

Financial Development (Credit per Capita, Reserve Bank of India)	
Above Median	Below Median
Andhra Pradesh	Andaman and Nicobar Islands
Chandigarh	Arunachal Pradesh
Daman and Diu	Assam
Delhi	Bihar
Goa	Dadra and Nagar Haveli
Gujarat	Lakshadweep
Haryana	Madhya Pradesh
Himachal Pradesh	Manipur
Jammu and Kashmir	Meghalaya
Karnataka	Mizoram
Kerala	Nagaland
Maharashtra	Orissa
Pondicherry	Rajasthan
Punjab	Sikkim
Tamil Nadu	Tripura
West Bengal	Uttar Pradesh

E. *Simultaneous Industrial Policies*

The 1991 trade liberalization was part of a package of reforms, that included further delicensing and relaxation of foreign direct investment rules. Both reforms aimed at increasing domestic competition, thus potentially enhancing productivity. If reduction in output tariffs across industries and over time is correlated with the process of delicensing and opening to FDI, then the empirical strategy could

[30] Since the Prowess data are at the company rather than plant level, a particular company may report data from business activity in more than one state. We assign companies to different states based on the location of the company's registered office. The registered office is the address each firm of more than twenty persons in India must submit to the Registrar of Companies as dictated by the Companies Act, 1956.

Table 9.—Trade Liberalization and Environment Characteristics

	Coastal		Noncoastal		Pro-Employer Labor Laws		Neutral or Proworker Labor Laws		High Financial Development		Low Financial Development	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
					A: Output Tariffs							
Lagged tariff	−0.045***	−0.060***	−0.091**	−0.083***	−0.028	−0.043	−0.064***	−0.084***	−0.053***	−0.066***	−0.076*	−0.078***
	[0.017]	[0.018]	[0.040]	[0.023]	[0.032]	[0.030]	[0.018]	[0.018]	[0.017]	[0.018]	[0.043]	[0.025]
Observations	11,007	4,857	3,607	1,467	4,478	1,894	9,063	3,996	12,735	5,552	1,879	772
					B: Output and Input Tariffs							
Lagged tariff	−0.026	−0.058***	−0.065	−0.076***	−0.009	−0.058*	−0.044**	−0.064***	−0.031*	−0.053***	−0.066	−0.095***
	[0.018]	[0.021]	[0.042]	[0.022]	[0.032]	[0.030]	[0.020]	[0.021]	[0.018]	[0.020]	[0.047]	[0.026]
Lagged input tariff	−0.422***	−0.148	−0.591***	−0.567*	−0.429**	0.017	−0.457***	−0.416***	−0.485***	−0.292**	−0.366	−0.281
	[0.113]	[0.118]	[0.195]	[0.296]	[0.177]	[0.189]	[0.123]	[0.159]	[0.108]	[0.138]	[0.245]	[0.191]
Observations	10,899	4,804	3,567	1,448	4,434	1,877	8,982	3,952	12,604	5,488	1,862	764

Table reports regressions of firm productivity on lagged output and input tariffs by state characteristics. All regressions include firm age, age squared, and firm and year fixed effects. Even-numbered columns present the Arellano-Bond estimator with two lags. States are classified according to table 8. Robust standard errors are in parentheses. Standard errors are clustered at the firm level in odd-numbered columns. Significance: *10%, **5%, ***1%.

erroneously attribute the impact of these other reforms to the trade liberalization. To control for the concurrent reforms, we compile an industry-level data set on industry-specific time-varying measures of licensing and openness to foreign direct investment for 1989 to 1996 from various publications of the Government of India's *Handbook of Industrial Statistics*. In table 10, we reestimate 2 and control for lagged openness to FDI (columns 1–2), lagged licensing (columns 3–4), and both measures in columns 5–6. The effect of trade liberalization on productivity is insensitive to these additional controls, and in some specifications, more intensive delicensing is associated with significantly higher TFP. The correlation with openness to FDI is most often indistinguishable from 0. So while there is some evidence that the introduction of domestic competition was associated with enhanced firm productivity, trade liberalization independently boosted productivity as well.

In the remaining columns, 7 and 8, we examine if industrial policies were complementary by interacting trade policy with openness to FDI and industrial regulation through licenses. Again, while assigning a causal interpretation is difficult, the evidence suggests that there may be strong complementarity among different industrial policies. The impact of trade reforms appears to be magnified as FDI was allowed or restrictive licensing requirements were removed. The increase in productivity from a 10% reduction in tariffs in a firm, operating in an industry that saw no change in FDI rules, was 0.63%. The same reduction in tariffs was associated with a 2.3% increase in productivity for firms for which FDI was fully liberalized during this period (FDI went from 0 to 1). A 10% tariff reduction resulted in an average productivity increase of 0.63% for firms operating in industries with no changes in FDI. For firms in industries for which FDI was fully liberalized during this period (that is, FDI went from 0 to 1), average productivity increased 2.3%. This evidence, though suggestive, points to the need for complementary domestic policies that can help firms' adjustment to globalization.

V. Conclusion

Since trade policy is determined by governments and governments naturally respond to specific interests, estimating how productivity evolves in response to trade reforms is challenging. This paper demonstrates that this endogeneity concern is valid. When the Indian government had discretion over its trade policy, tariff reductions were correlated with contemporaneous productivity levels. We circumvent this identification concern by focusing our analysis on a narrow window when India's trade policy was heavily influenced by external agencies. This enables us to isolate the effects of the trade reform on firm-level productivity.

We find that the trade reform did increase productivity among Indian firms. While there is evidence that the procompetitive effects of the tariffs led firms to become more efficient, the larger impact appears to have come from

Table 10.—Trade Liberalization Versus Other Reforms

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lagged tariff	−0.052***	−0.063***	−0.055***	−0.064***	−0.054***	−0.064***	−0.063***	−0.081***
	[0.016]	[0.014]	[0.017]	[0.015]	[0.017]	[0.014]	[0.017]	[0.015]
Lagged FDI	0.020*	−0.007			0.021*	−0.007	0.118***	0.057***
	[0.012]	[0.011]			[0.012]	[0.011]	[0.023]	[0.019]
Lagged licensing			−0.019	−0.019**	−0.02	−0.019**	−0.088***	−0.117***
			[0.015]	[0.010]	[0.015]	[0.010]	[0.030]	[0.025]
Tariff × FDI							−0.164***	−0.104***
							[0.031]	[0.025]
Tariff × Licensing							0.085**	0.126***
							[0.036]	[0.029]
Observations	13,713	5,882	13,713	5,882	13,713	5,882	13,713	5,882

Table reports regressions of firm productivity on lagged output tariffs, along with licensing and FDI liberalization. All regressions include firm age, age squared, and firm and year fixed effects. Even-numbered columns present the Arellano-Bond estimator with two lags. Robust standard errors are in parentheses. Standard errors are clustered at the firm level in odd-numbered columns. Significance: *10%, **5%, ***1%.

increased access to foreign inputs. Thus, India's break from import substitution policies not only exposed these firms to competitive pressure, but, more important, relaxed the technological constraint on production. This has important policy implications as governments often enact policies to protect upstream domestic producers. The results here suggest that such attempts potentially ignore benefits embodied in access to more and higher-quality foreign inputs, especially in the case of developing countries (Jones, 2009).

Finally, while the productivity impact is robust across specifications, disentangling the exact mechanisms by which firms improve their productivity remains a challenge for researchers due to data limitations. Exploring these mechanisms will be important to understand fully the entire adjustment processes that firms undertake in response to changes in market environments. We leave this task for future research.

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APPENDIX

Variables Used in the Estimation of the Production Function

To estimate the production function, the following variables were used: value of total output, gross fixed assets, salaries and wages, raw materials expenses, power and fuel expenses, and depreciation. The values of output and power and fuel expenses were converted in real terms by industry-specific wholesale price indices. For salaries, wages, and raw materials expenses, the wholesale price index was used.

We closely followed the methodology of Balakrishnan, Pushpangadan, Babu (2000) to measure the capital employed by the firm in its production process. It applies the perpetual inventory model, while correcting for the fact that the value of capital is recorded at historic, and not replacement, cost. In order to arrive at a measure of the capital stock at its replacement cost for a base year (in the case assumed to be 1997), we construct a revaluation factor assuming a constant rate of change of the price of capital and a constant rate of growth of investment throughout the twenty-year assumed lifetime of capital stock. This revaluation factor converts the capital in the base year into capital at replacement cost at current prices, which is then deflated using a deflator constructed from the series on gross capital formation. To get the capital stock for every time period, we take the sum of investment in subsequent years.