Trade Liberalization and Investment in Foreign Capital Goods: Evidence from India *

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Abstract

We evaluate the impact of trade liberalization on the firm's decision to invest in foreign capital goods. We employ Indian firm-level panel data from a period of a large-scale trade liberalization (1989-1997) to estimate an investment equation using the system-GMM estimator. Importantly, we control separately for the tariffs on capital goods, intermediate inputs and final goods, which allows us to estimate the price elasticity of investment in foreign capital goods. Consistent with theory, we find that reductions in the tariffs on capital goods, and intermediate inputs led to higher investment in foreign capital goods, whereas reduction in the output tariff resulted in lower investment. The impact of the capital goods tariffs is the largest.

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1 Introduction

One of the often emphasized benefits of international trade is that it stimulates investment in new technologies and thereby enhances productivity and promotes economic growth (e.g. Keller (2004)). For developing countries, investment in new technologies involves importing capital goods since the production of capital equipment, as well as that of R&D intensive goods, is concentrated in a few developed countries (Eaton and Kortum (2001)). In the last few decades, a large number of developing countries and emerging economies have significantly reduced trade barriers in an attempt to boost economic growth (e.g. Brazil, Chile, Colombia, Mexico, and India). To date, however, only a few studies have investigated the impact of trade liberalization on capital accumulation (e.g., see Wacziarg and Welch (2008), Ibarra (1995)). In this paper, we estimate the effect of the Indian trade liberalization in the 1990s on investment in foreign capital goods using firm-level panel data. To our knowledge, our work provides the first estimate of the elasticity of investment in foreign capital with respect to its own tariff. Producing this estimate is important for at least two reasons. First, the elasticity of investment in foreign capital with respect to its own tariff could play a central role in the parametrization of growth models that seeks to evaluate the importance of the contribution of foreign equipment to domestic growth (e.g. Mutreja et al. (2016)). Second, knowledge of the magnitude of this estimate would be essential for policy-makers eager to foster domestic productivity, especially in the context of emerging economies. The gap in the existing literature when it comes to the elasticity of investment in foreign capital with respect to its own tariff, provides a compelling reason for our empirical analysis.

In our work, we distinguish between two kinds of investment the firm can make— investment in imported capital goods and investment in domestic capital goods. Furthermore, we use input-output tables to construct three distinct tariff measures— tariffs on capital goods, intermediate inputs, and final products— and estimate the impacts of all three types of tariffs on firms' investment decisions. By separating the effects of the tariff on capital goods from that of intermediate inputs, we are able to evaluate the direct channel (via reduction in the price of foreign capital) through which trade liberalization impacts investment decisions. In doing so, we provide a direct estimate of the price elasticity of investment in imported capital goods, and the gains from trade liberalization through reduction in the price of foreign capital.

The 1990s trade liberalization episode in India provides a natural setting to study this important question. High tariff and non-tariff barriers characterized India's trade policy regime in the decades preceding the 1990s. Following the balance of payments crisis the Indian economy experienced in 1991, India received support from the IMF and began a structural adjustment program. As part of the reforms undertaken, trade barriers on imports were significantly

reduced in the years that followed. Between 1989 and 1997, the average tariff rates on final goods, intermediate inputs, and capital goods declined by 50 to 65 percentage points, with considerable variation in reductions across industries.

We motivate the empirical specification by providing a theoretical framework in which monopolistically competitive firms import both capital goods and intermediate inputs and sell their output domestically where they face competition from foreign producers. The dynamic problem of the firm involves an investment decision, where domestic and foreign capital are imperfect substitutes for each other. The firm maximizes the expected present value of the stream of profits and optimally decides how much to invest in domestic and in foreign capital goods.[1] The model predicts that by reducing the relative price of imported capital goods, lower capital goods tariffs boost investment in foreign equipment. Similarly, a reduction in the intermediate input tariff leads to an increase in investment, since lower input prices raise the marginal profitability of capital used in production. On the other hand, lower output tariffs expose firms to heightened foreign competition and erode the marginal profitability of capital, which leads to lower investment in foreign capital goods.

To test these predictions, we use a panel data-set on Indian manufacturing firms obtained from the Center for Monitoring Indian Economy (CMIE) Prowess database for the period from 1989 to 1997. To identify the impacts of the three types of tariffs on investment in foreign capital goods, we take advantage of India's trade liberalization in the early 1990s that led to plausibly exogenous variation in the tariffs across manufacturing subsectors in that time period. Empirically, we estimate the reduced form dynamic investment equation implied in our theoretical framework by using the system-GMM estimator developed by Arellano and Bover (1995) and Blundell and Bond (1998). The use of firm-level panel data allows us to control for time-invariant firm-level unobservables relevant to the firm's investment decision, as well as time-varying unobservable shocks common to all firms. In addition, we are also able to include other firm-level relevant factors, such as export status and mark-up, that influence how tariff reductions might impact the firm's investment decision.

Consistent with our theoretical framework, we find that the reduction in capital goods tariffs led to an increase in investment in foreign capital goods, but not in domestic capital goods. Specifically, we show that a 10 percentage point decrease in the capital goods tariff led to a 9.44 percent increase in the average firm's investment rate in foreign capital goods. A similar 10 percentage point reduction in the input tariff led to a 6.11 percent increase in investment in foreign capital. Also in line with theory, we find that the reduction in the output tariff affected investment adversely. By increasing competition and lowering the marginal profitability of

[1]The implications from our theoretical and empirical model are in terms of the investment rate for foreign capital goods $\left(\frac{I_M}{K}\right)$. We use investment and investment rate interchangeably throughout the paper.

capital, a 10 percentage point reduction in the output tariff brought about a 4.72 percent decline in investment in foreign capital. Combining the effects of the three types of tariffs, we find that the trade liberalization in India resulted in a net increase of 62.31 percent in the manufacturing sector investment rate over the course of our sample period (1990-1997). Given the average investment rate $\left(\frac{I_M}{K}\right)$ of 0.036 over the sample period, our results imply that the trade liberalization led to an increase in the investment rate of 0.022, or 2.2 percentage points. Over the sample period, the investment rate in foreign capital in the Indian manufacturing industry grew from 0.022 to 0.080, or 5.8 percentage points. Consequently, the estimates from our empirical model imply that about 38 percent of this growth was a result of the decline in tariffs. Moreover, nearly all of the increase stemmed from the decline in capital goods tariff alone.

We also find that there is substantial heterogeneity across firms in how they responded to reductions in tariffs. We find that the net impact of the trade liberalization ranged between a 4 and 167 percent increase in investment rates across different industries, and that firms in the middle of the productivity and size distributions benefitted the most from lower tariffs on capital goods. Moreover, we show that following the reductions in output tariffs, firms with greater market power lowered investment in foreign capital goods more aggressively, and firms in industries with more scope for product differentiation and quality upgrading (Khandelwal (2010)) lowered investment less. Additionally, we find that the effects of lower capital goods and lower intermediate input tariffs were more pronounced for exporters.

Our paper contributes to the growing literature that evaluates the impact of trade liberalization on capital accumulation. The estimate of the elasticity of investment in foreign capital with respect to its own tariff that we obtain from an investment equation complements the findings in Bas and Berthou (2017), who show that reductions in tariffs on intermediate inputs increase the probability of importing capital goods. Mainly focusing on the discreet choice of importing capital, they also estimate a Tobit specification in order to assess the impact of intermediate input tariffs on the share of imported capital goods in total imports. Because imports of foreign capital represent part of the firm's investment in productive assets, in contrast to Bas and Berthou (2017), we estimate a theoretically grounded investment equation (see Bond and Van Reenen (2008)) using the investment rate $\left(\frac{I_M}{K}\right)$ as a dependent variable. This approach allows us to obtain the first (to our knowledge) estimate of the elasticity of investment in foreign capital goods with respect to the capital goods tariff, which we find to be both statistically and economically significant. Moreover, our paper extends the results in Kandilov and Leblebicioglu (2012), who study the impact of trade liberalization on firm investment in Mexico. In their paper, they treat all investment as domestic investment and examine how lower tariffs influence investment decisions through the marginal profitability of capital as a result of greater compe-

tition and lower costs of variable inputs. Importantly, in this paper, we additionally analyze the direct effect of changes in the price of imported capital goods through changes in tariffs on capital equipment, on investment in foreign and domestic capital goods. Hence, we provide the first direct evidence showing that the largest gains from trade liberalization for capital accumulation occurs through the reduction in the price of foreign capital.[2]

Our work is also related to the broader literature on trade liberalization and productivity. Evidence from Colombia, Chile, Indonesia and India suggest that lower tariffs lead to efficiency gains for firms. Topalova and Khandelwal (2011) and Amiti and Konings (2007) find positive effects of both lower input and output tariffs on productivity in India and Indonesia, respectively. Fernandes (2007), Muendler (2004), and Pavcnik (2002) show that tariff liberalization led to higher firm-level productivity in Colombia, Brazil, and Chile, respectively. Tybout and Westbrook's (1995) findings suggest that average costs fell in most industries following the Mexican trade liberalization. Similarly, Tybout et al. (1991) find evidence that Chilean industries which experienced relatively large reductions in protection also experienced relatively large improvements in average efficiency levels.[3] One mechanism through which trade liberalization can improve efficiency is by lowering the cost of investing in highly efficient, R&D intensive capital goods that are produced in a short-list of technologically advanced countries (see Table 1 for the list of countries from which India imported capital goods during our sample period). Our paper provides insight into this mechanism and complements the findings in Mutreja et al. (2016), who use a neoclassical growth model with Ricardian trade to show that trade in capital goods has quantitatively important effects on economic development.[4]

The rest of the paper is organized as follows. Section 2 describes the trade liberalization experience in India. In Section 3, we develop a theoretical framework, which motivates the empirical specification. In Section 4 we describe the data and how we construct the tariffs of interest. Section 5 presents our empirical model, and section 6 discusses our findings. Finally, section 7 concludes the paper.

[2]Previous studies on trade policy reform and aggregate investment have been cross country or industry level studies which have analyzed the impact of output tariff reductions. For example, see Wacziarg and Welch (2008), Ibarra (1995).

[3]Also, there exists a literature that relates exporting opportunities to investment. For example, using data from Mexico during 1994-2004, Iacovone and Javorcik (2008) show that future exporters increase product quality (unit value) and investment before they start servicing the foreign market. Similarly, Alvarez and Lopez (2005) use data from Chile and present evidence that exporters invest more, perhaps to upgrade product quality, even before they enter the foreign market compared to firms that supply to the domestic market alone.

[4]In particular, Mutreja et al. (2016) find that cross-country income differences would decline by more than 50 percent if trade barriers are eliminated.

2 Background on the Indian Trade Liberalization

India adopted a highly restrictive trade policy post-independence. It was characterized by high tariff and non-tariff barriers on imports across industries. In the 1980s, the government began the process of gradual deregulation of the economy in order to promote exports. However, import tariff rates continued to be high. In 1990, the average tariff rates were over 90 percent while the maximum tariff rates in some industries was close to 300 percent.

A combination of several factors contributed to the balance of payment crisis of 1991. The conflict in the Middle East resulted in high oil prices and a fall in worker remittances from abroad. There was a decline in export growth due to slow growth in India's major trading partners. This combined with the political uncertainty lead to a loss in investor confidence and large capital outflows from the country (see Cerra and Saxena (2002)). Foreign exchange reserves reached dangerously low levels and the government requested a standby arrangement with the IMF in August 1991. Subsequently, India embarked upon a structural adjustment program and began the process of liberalizing its economy. As part of the reforms, India reduced the levels and dispersions of tariffs on imports in the years that followed.

By 1997, import tariffs were cut to less than half of 1992 levels. Figure 1 shows the evolution of mean tariffs levels on final goods, intermediate inputs, and capital goods between 1989 and 2001. In addition to a reduction in average tariff levels, the standard deviation of final goods tariffs, intermediate input tariffs, and capital input tariffs were also reduced over the period as can be seen in Figure 2. Thus, industries with the highest tariff levels experienced the largest cuts.[5] Table 10 provides the details of the changes in tariffs on final goods, intermediate inputs and capital goods across all two digit manufacturing industries. While there was variation in 1990 tariff levels across industries, the table convincingly shows that the tariff reductions in final goods, intermediate inputs, and capital inputs occurred across the board in all industry groups.

Figure 1 and Table 10 also show that most of the reductions in tariffs took place in the years immediately following the crisis between 1992 and 1997. While tariff cuts continued into the second half of the period (between 1997 and 2001), they had more or less leveled off in the later years. Tariffs on final goods dropped from 85 to 42 percent between 1992 and 1997 and were reduced to 34 percent by 2001. Similarly, tariffs on capital goods fell from 83 to 34 percent between 1992 and 1997, and to 30 percent by 2001, while tariffs on intermediate inputs were reduced from 72 to 32 between 1992 and 1997, and to 29 percent by 2001. These patterns are

[5] Average tariffs for manufacturing was calculated as the simple average of tariffs of all two digit manufacturing industries, where the tariffs on the two digit industries was the simple average of all four digit industries within each two digit industry. The standard deviation of tariffs was calculated across five digit industry levels, the lowest industry classification.

displayed across the major industries.

We confine our study to the early part of the trade liberalization episode, from 1990 to 1997. We do so because of concerns about trade policy being endogenously determined in the period after 1997. The literature on the political economy of trade policy has recognized that groups of firms and workers can influence governments when trade policy is set and that governments may protect industries with low productivity or investment levels (see, for example, Grossman and Helpman (1994); Hillman (1982)). In India, economic policy is broadly set according to five-year plans. Trade policy was determined in the Second Plan (1956-1961) and had not changed over the years even as industries evolved over time. Given the earlier inward looking economic policies and the crisis of 1991, Hasan et al. (2007) argue that tariff reforms in 1992 came as a surprise and were externally driven.

Topalova and Khandelwal (2011) use the Annual Survey of Industry data to check whether the changes in tariffs between 1987 and 1997 across industries were motivated by political considerations. They use a range of industry characteristics such as employment, wages and average factory size to capture electoral power, industry concentration measures and political pressure groups and find no correlation between tariff reductions and pre-reform (1987) industry characteristics. By the end of the Eighth Plan (1992-1997), external pressures had abated. India continued with trade reforms in the Ninth Plan (1997-2002). Trade policy in later years could have been influenced by political factors. Topalova and Khandelwal (2011) find evidence that in the years after 1997, tariff cuts may have been more selective to protect less efficient industries. Thus, similar to Goldberg et al. (2010), Topalova and Khandelwal (2011), and De Loecker et al. (2012), we focus on the first half of the period of trade reforms until 1997.

We extend the analysis on trade endogeneity in Topalova and Khandelwal (2011) by providing additional evidence that tariffs levels between 1992-1997 were uncorrelated with the firm outcome measures we consider in this paper. One potential issue that may affect the reliability of our estimates of the impact of tariff liberalization on firm-level investment decisions is if the Indian policy makers chose import protection measures in response to industry level investment rates in domestic and foreign capital goods. If this was indeed the case, we would expect current investment rates in domestic and foreign capital goods to predict future measures of import protection.

We calculate industry level investment rates in foreign and domestic capital as the sales weighted average of firm-level investment rates in foreign and domestic capital goods respectively.[6] We then regress industry level output tariffs, intermediate input tariffs, and capital goods tariffs in period $t+1$ on industry level domestic good investment rates in period t. The results are presented in Table 2, Panel A. We also regress industry level output tariffs, interme-

[6]Here, industry refers to the five digit industry level.

diate input tariffs and capital good tariffs in period $t+1$ on industry level investment rates in imported capital goods during period t and present the results in Table 2, Panel B. We control for industry and year fixed effects in these regressions and weight each industry by the number of firms in the industry in the particular year.

The results show that for the period of our study, overall, the three tariff rates (on final output, intermediate inputs, and capital goods) do not depend on industry level investment rates in either domestic or foreign capital goods. Except for the coefficient on domestic investment on capital goods tariffs, which is marginally significant, the estimated coefficients are not statistically significant, with a mix of positive and negative estimates.

3 Theoretical Framework

In order to motivate the empirical specification, and to illustrate how tariffs on capital goods, intermediate inputs, and final output can affect the investment decisions of a firm, we present a simple model of investment. We consider the investment problem of a monopolistically competitive firm that imports some of its capital, in addition to some of its variable inputs of production, and sells its output in the domestic market, where it faces foreign competition. Investment in domestic and imported capital goods are imperfect substitutes. At the beginning of period t, the firm optimally chooses the level of variable inputs, output price, and how much to invest in the two types of capital.

Firm i enters period t with K_{it-1} units of capital. Due to a one period time-to-build lag, the new capital resulting from total investment becomes productive in the following period, i.e., production in period t depends on K_{it-1}. The firm chooses total investment expenditures I_{it} to maximize the expected present value of current and future profits subject to the standard capital accumulation equation. Total investment comprises purchases of domestic and imported capital goods that are combined with a constant elasticity of substitution (CES) aggregator

$$I_{it} = \left[(1-\mu_i)^{\frac{1}{\omega}} I_{Dit}^{\frac{\omega-1}{\omega}} + \mu_i^{\frac{1}{\omega}} I_{Mit}^{\frac{\omega-1}{\omega}} \right]^{\frac{\omega}{\omega-1}}, \tag{1}$$

where I_{Dit} and I_{Mit} are the purchases of domestic and imported capital goods, $\omega > 0$ is the elasticity of substitution between them, and μ_i is the weight on imported capital goods in the investment basket.[7] We normalize the price of the investment basket to 1, and denote the relative price of imported capital goods with $\tau_t^K P_{Mt}$, where τ_t^K is the tariff imposed on foreign capital goods. From the firm's cost-minimization problem, we obtain the following demand

[7] We assume that the elasticity of substitution between domestic and foreign capital goods is constant across firms and across time, but the weights, μ_i, are firm-specific.

function for imported capital goods:

$$I_{Mit} = \mu_i \left(\tau_t^K P_{Mt}\right)^{-\omega} I_{it}. \tag{2}$$

This demand function reveals the direct mechanism through which tariffs on capital goods affect investment in foreign capital goods. All else constant, a reduction in the tariffs on capital goods, τ_t^K, lowers the relative price of investment in foreign capital, and thereby increases the demand for them.

Let Π_{it} be the maximum profit of firm i obtains by choosing the optimal level of variable inputs and the output price. The expected present value of profits is given by:

$$V_{it}(K_{it-1}) = \max_{I_{it}} \left\{\Pi_{it} - G\left(K_{it-1}, I_{it}\right) - I_{it} + \beta E_t\left[V_{it+1}(K_{it})\right]\right\} \tag{3}$$

subject to

$$K_{it} = (1-\delta)K_{it-1} + I_{it}, \tag{4}$$

where β is the discount factor; δ is the rate of depreciation; and $G\left(K_{it-1}, I_{it}\right)$ denotes the cost of altering the capital stock, which leads to a loss of a fraction of total investment. The first order conditions of the firm's problem yield the following equation:

$$1 + \frac{\partial G\left(K_{it-1}, I_{it}\right)}{\partial I_{it}} = \beta E_t\left[\frac{\partial \Pi_{it+1}}{\partial K_{it}} - \frac{\partial G\left(K_{it}, I_{it+1}\right)}{\partial K_{it}} + (1-\delta)\left(1 + \frac{\partial G\left(K_{it}, I_{it+1}\right)}{\partial I_{it+1}}\right)\right]. \tag{5}$$

This standard Euler equation implies that along the optimal path, the marginal cost of investing in a new unit of composite capital equals the present discounted value of the marginal return to capital. The marginal return depends on the marginal profitability of capital (net of adjustment costs) and the value of undepreciated capital.

In order to characterize the marginal profitability of capital, $\frac{\partial \Pi_{it+1}}{\partial K_{it}}$, we assume that the firm sells its product in the imperfectly competitive domestic market. The demand firm faces is given by

$$x_{it} = \left(\frac{p_{it}}{P_t}\right)^{-\theta} X_t, \tag{6}$$

where x_{it} is the demand for firm i's product, p_{it} is the price the firm charges, P_t and X_t are the aggregate price level and aggregate demand, respectively. The parameter $\theta > 1$ denotes the price elasticity of demand, which indicates the substitutability between the varieties.[8] Given the

[8]We assume that individuals consume a continuum of imperfectly substitutable domestic and foreign goods ($x(z)$ and $x^*(z)$, respectively), and the consumption basket is formed by the following CES aggregator:

$$X_t = \left(\int_0^a x(z)^{\frac{\theta-1}{\theta}}\, dz + \int_a^1 x^*(z)^{\frac{\theta-1}{\theta}}\, dz\right)^{\frac{\theta}{\theta-1}}.$$

demand function and the amount of capital at the beginning of the period, the firm optimally chooses the price of its output, in addition to the levels of domestic and foreign variable inputs. Hence, at the beginning of each period, firm i maximizes profits conditional on all available information:

$$\Pi_{it} = \max_{p_{it}, L_{it}, L^*_{it},} \left[x_{it} p_{it} - w_t L_{it} - \left(\tau^I_t w^*_t \right) L^*_{it} \mid \Omega_{t^-} \right] \tag{7}$$

subject to

$$x_{it} = F(K_{it-1}, L_{it}, L^*_{it})$$

where x_{it} is the product demand given in equation (6); L_{it} and L^*_{it} are the domestic and foreign inputs with prices (in units of the domestic currency) w_t and w^*_t, respectively, and τ^I_t is the tariff imposed on imported inputs; and Ω_{t^-} is the information set available at the beginning of period t.

Using the first order conditions from the optimization problem (7), and assuming that the production function, $F(\cdot)$, is homogeneous of degree one, we differentiate the resulting profit function to obtain the expression for the marginal profitability of capital:

$$\frac{\partial \Pi_{it}}{\partial K_{it-1}} = \left[\frac{1}{K_{it-1}} \left(\frac{x_{it} p_{it}}{\psi_i} - w_t L_{it} - \left(\tau^I_t w^*_t \right) L^*_{it} \right) \mid \Omega_{t^-} \right], \tag{8}$$

where $\psi_i = \frac{\theta}{\theta - 1}$ denotes the mark-up (price-to-cost margin). It is straightforward to show how changes in input tariffs can affect marginal profitability of capital, and therefore investment decisions in foreign capital goods, using equation (8). For a given level of imported inputs, L^*_{it}, a reduction in input tariffs, τ^I_t, lowers the cost of using imported inputs, and thereby raises the marginal profitability of capital and investment.

We can also demonstrate how output tariffs affect investment decisions using equation (8). Changes in output tariffs affect marginal profitability of capital through changes in foreign competitors' prices, and as a result the firm's revenue, $x_{it} p_{it}$. In order to illustrate this effect, first consider the aggregate price index, which enters the demand function in equation (6):

$$P_t = \left[\int_0^a p_t(z)^{1-\theta} \, dz + \int_a^1 \left(\tau^O_t p^*_t(z) \right)^{1-\theta} \, dz \right]^{\frac{1}{1-\theta}}, \tag{9}$$

where $p_t(z)$ is the price of a domestic variety z in the interval [0,a), and $p^*_t(z)$ is the price of a foreign competitor z^* in the interval [a,1]. The effective price of a foreign good is $\tau^O_t p^*_t(z)$, where τ^O_t is the output tariff levied on foreign products. Next, consider how changes in τ^O_t

affect sales through competitor's prices:

$$\frac{\partial\left(x_{it}p_{it}\right)}{\partial\tau_t^O}=\theta\frac{x_{it}p_{it}}{P_t}\frac{\partial P_t}{\partial\tau_t^O}=\theta\frac{x_{it}p_{it}}{\tau_t^O}(1-a)\left(\frac{P_{Ft}}{P_t}\right)^{1-\theta}>0, \tag{10}$$

where P_{Ft} is the foreign competitors' price index.[9] The positive relationship in expression (10) between sales and output tariffs implies that a reduction in τ_t^O lowers the effective price individuals pay on foreign varieties, and thereby reduces the demand for firm i's product. As a result, the reduction in output tariff lowers marginal profitability of capital and investment.

Equation (8) reveals an additional important factor that mediates the relationship between investment and changes in tariffs. Firm's mark-up, ψ_i, which is closely linked to the degree of competition, as well as the industry structure, plays an important role in determining the sensitivity of investment to changes in tariffs. A firm with a higher monopoly power, hence a higher mark-up, may be affected more adversely by a reduction in output tariffs due to the import competition that lower tariffs generate. On the other hand, the reduction in output tariffs may not affect a low mark-up firm as much, since it has already been exposed to ample domestic competition.[10]

To characterize the investment Euler equation (5), we adopt the standard convex adjustment cost assumption, and adopt the following functional form:

$$G\left(K_{t-1},I_t\right)=\frac{\gamma_0}{2}\left(\frac{I_t}{K_{t-1}}-\gamma_1\right)^2K_{t-1}, \tag{11}$$

where γ_0 and γ_1 are the adjustment cost parameters. We can obtain the fully-parametrized investment equation by substituting the partial derivatives of the adjustment cost function in equation (11), and the marginal profitability of capital in equation (8) into the Euler equation in (5). Furthermore, by combining the demand for imported capital goods in equation (2) with the Euler equation, we can obtain the decision rule for investment in foreign capital. Given the functional forms, this generates a non-linear equation in the variables of interest. In order to simplify the interpretation of the coefficients and to obtain an equation that can be used as the basis for our empirical specification, we linearize the Euler equation using a first-order Taylor approximation around the steady state. After linearizing and rearranging the terms, we obtain

[9]The foreign competitors' price index is given by $P_{Ft}=\frac{1}{1-a}\left[\int_a^1(\tau_t^Op^*(z)^{1-\theta})\,dz\right]^{\frac{1}{1-\theta}}$.

[10]We can formally show that the elasticity of mark-up adjusted sales with respect to the output tariff is increasing in the size of the mark-up: $\frac{\partial(x_{it}p_{it}/\psi_i)}{\partial\tau_t^O}\frac{\tau_t^O}{(x_{it}p_{it}/\psi_i)}=\frac{1}{(1+\psi_i)^2}(1-a)\left(\frac{P_{Ft}}{P_t}\right)^{1-\theta}>0$.

the following investment equation:

$$\frac{I_{Mit}}{K_{it-1}} = E_t\left[\phi_0 + \phi_1\frac{I_{Mit+1}}{K_{it}} + \phi_2\frac{S_{it+1}}{K_{it}} - \phi_3\frac{Z_{it+1}}{K_{it}} - \phi_4\frac{Z^*_{it+1}}{K_{it}} + \phi_5\left(\tau^K_{t+1}P_{Mt+1}\right) - \phi_6\left(\tau^K_t P_{Mt}\right)\right] \tag{12}$$

where S_{it+1} is the value of total sales ($x_{it+1}p_{it+1}$), Z_{it+1} is the cost of domestic inputs ($w_{t+1}L_{it+1}$), and Z^*_{it+1} is the cost of imported inputs ($\tau^I_{t+1}w^*_{t+1}L^*_{it+1}$). The ϕ's are positive constants that are functions of the structural parameters of the model. See the Appendix for the details of the Taylor approximation and the expressions for the ϕ's.[11] Equation (12), which presents the first-order approximation of the model, shows that the investment process depends on future investment, expected sales, expected domestic costs and imported input costs, as well as the current and expected prices of imported capital. The coefficients on the tariff terms suggest that if the current tariff rates on capital goods are high, then the firm's investment in foreign capital goods during that period will be low. At the same time, if the firm expects tariff rates to be higher in the future, keeping current rates constant, they will choose to invest more today to circumvent the higher rates in the future.

4 Data

The firm level variables are from Prowess, a panel data of Indian firms. The data are collected by the Centre for Monitoring of the Indian Economy (CMIE), and contain information on the listed and unlisted firms and account for about 70 percent of the organized industrial activity.[12] In addition to the variables commonly found in most firm-level data-sets (capital stock, sales, wages, expenditure on intermediate inputs etc.), the data also contain information on the foreign exchange transactions of firms, including the imports of capital goods. This information, along with the capital stock series allows us to construct the domestic and foreign capital investment measures for the firms.

Firms are classified into industries based on the 2008 National Industrial Classification (NIC). The NIC 2008 classification is based on the International Standard Industrial Classification (ISIC) Rev.4. We use data on manufacturing firms (NIC two digits, 10 through 31). For the period of the study, we have data on $9,486$ firm-year observations. The $2,512$ unique firms in the data-set are classified into 236 five digit industry groups. To construct firm-level total investment expenditures, we take the annual difference in the current value of the gross fixed

[11] We can similarly obtain a linear equation for total investment or investment in domestic capital goods, which can be used to estimate the impact of trade liberalization on total investment or on investment in domestic capital goods.

[12] The data have been used in several papers including Goldberg et al. (2010) and Topalova and Khandelwal (2011).

assets, which measures the value of the firm's capital. As imports of capital goods measure investment expenditures in foreign capital, we subtract imports of capital goods from total investment expenditures to calculate investment in domestic capital goods.

As shown in Section 3, firm's market power could determine how investment rates respond to changes in tariffs. Firms with high market power can be more sensitive to reductions in output tariffs due to increased competition from abroad, while they can also be less sensitive to changes in intermediate input tariffs. We use use firm-level markups as a proxy for market power in our estimations. We construct the markup variable using the information provided in Prowess. Following Campa and Goldberg (1999), we define the average markup, ψ_i, for firm i (averaged over our sample period from 1990 to 1997) as

$$\psi_i = \frac{value\,of\,sales_i + \Delta inventories_i}{payroll_i + cost\,of\,materials_i}. \tag{13}$$

We examine whether the scope for quality differentiation within an industry impacts how firms respond to reductions in output tariffs. Firms belonging to industries with "long" quality ladders or greater scope for product differentiation may be less sensitive to reductions in output tariffs since firms may upgrade quality in order not to lose out on the marginal profitability. The data on quality ladders, a proxy for vertical differentiation, are from Khandelwal (2010). The variable is a time invariant industry specific measure. The data are made available at the four-digit SIC (rev.1987) classification and are matched to the NIC 2008 industrial classification.

We supplement the firm-level data with information on policy variables. The data on final goods tariffs are from Topalova and Khandelwal (2011). These data were made available at the three-digit NIC 1987 classification and were matched to four- or five-digit NIC 2008 industries.[13] We use the data on output tariffs to construct input tariffs similar to Amiti and Konings (2007) by passing output tariff through the input-output (I-O) matrix. However, unlike Amiti and Konings (2007), who construct an aggregate input tariff, we construct separate tariffs for intermediate inputs and capital goods. Classification of industries into intermediate and capital goods was done based on the United Nations classification by Broad Economic Categories. We use the I-O Transactions Table from India for $1993-1994$ to obtain the weights for constructing the intermediate inputs and capital inputs tariffs. Sectors $77-84$ and $87-96$ are classified as capital goods industries and the remaining sectors up until sector 98 are classified as intermediate inputs industries. The sectors from the I-O Table were matched

[13]Typically, three-digit NIC 1987 industries correspond to four-digit NIC 2008 industries. However, because of reclassification of industrial groups over time, in many cases, they were matched to five-digit industries. For about 25 percent of four-digit NIC 2008 industries there is variation in tariffs within the four-digit industry at the five-digit level.

to the NIC Industries and the input tariffs were constructed as follows:

$$\tau_{kt}^{j} = \sum_{s} w_{sk}^{j} \tau_{st}, \tag{14}$$

where j refers to capital or intermediate inputs, τ_{kt}^{j} is the j input tariff of industry k in period t, w_{sk}^{j} is the value share of industry s in output of industry k and τ_{st} is the output tariff of industry s in period t. The weights are constructed from the I-O coefficient matrix of $1993-1994$ such that $\sum_s w_{sk}^{j} = 1$ for each j.

To our knowledge, all of the existing literature, with the exception of Bas and Berthou (2017), has considered only the output tariff and an aggregate intermediate input tariff that combines tariffs on both intermediate inputs and imported capital goods (see, for example, Amiti and Konings (2007) as well as Topalova and Khandelwal (2011)). This is largely because previous work has not analyzed the behavior of investment in foreign capital goods in response to a trade liberalization, which often involves a large reduction in tariffs imposed on capital goods. Instead, existing research has focused on investigating another very important aspect of a trade liberalization, namely the impact of lower tariffs on firm productivity. We find that variation in the combined aggregate input tariff in our sample reflects mostly variation in input tariffs and not variation in capital goods tariffs. The input-output table we use suggests that when the aggregate industry input tariff is constructed using equation (14) above, about 90 percent of the weight is given to intermediate inputs tariffs and only about 10 percent of the weight is given to tariffs on capital goods. To provide more evidence on this point, we regress the combined aggregate input tariff on the input tariff and the capital goods tariff. The results, which are presented in Table 3 show that a significantly larger portion of the variation in the combined aggregate intermediate input tariff is explained by the variation in the intermediate input tariffs than the variation in the capital goods tariffs. Hence, it is important to separately control for capital goods tariffs in the context of estimating the impact of trade liberalization on investment.

During the trade liberalization episode in the 1990s, the Indian government also introduced other industrial reforms. These policy changes include liberalizing the licensing requirements (for setting up and expanding capacity) and lowering of entry barriers to foreign investment. In order to identify the distinct effects of trade liberalization, we control for these concurrent reforms in our empirical specifications. The data on these policy variables are from Topalova and Khandelwal (2011). The data are coded between 0 and 1 and are industry and time varying. They represent the share of products in an industry subject to licensing requirements (License) and the share of products which have automatic approval for foreign investment (FDI). Table 4 presents the summary statistics for investment rates, and all the explanatory variables (both

firm-level variables and policy variables) used in our specifications.

5 Empirical Investment Equation and Estimation

The theoretical framework in Section 3 motivates the relationship between investment and different types of tariffs. For brevity, we refer to the tariffs on intermediate inputs as input tariffs and the tariffs on capital goods as capital tariffs. The theoretical framework illustrates how capital, input and output tariffs affect investment decisions, and it also suggests other firm-specific determinants of investment (such as sales and costs). Because our main goal is to estimate the impact of trade liberalization on investment in imported capital goods, instead of focusing on the structural process, we estimate a reduced form equation for investment in foreign capital goods.[14]

We start by estimating the following baseline specification, which takes equation (12) as its basis, and focuses on the main effect of tariffs on investment:

$$\frac{I_{ijt}}{K_{ijt-1}} = \alpha_1 \frac{I_{ijt-1}}{K_{ijt-2}} + \alpha_2 \frac{S_{ijt}}{K_{ijt-1}} + \alpha_3 \frac{S_{ijt-1}}{K_{ijt-2}} + \alpha_4 \frac{C_{ijt}}{K_{ijt-1}} + \alpha_5 \frac{C_{ijt-1}}{K_{ijt-2}} + \alpha_6 \tau^K_{jt} + \alpha_7 \tau^I_{jt} + \alpha_8 \tau^O_{jt} + \upsilon_i + \eta_t + \varepsilon_{ijt}, \tag{15}$$

where $\frac{I_{ijt}}{K_{ijt-1}}$ denotes investment in imported capital goods (I_M) for firm i, in industry j in year t; and $\frac{S_{ijt}}{K_{ijt-1}}$ and $\frac{C_{ijt}}{K_{ijt-1}}$ are the firm's total sales and cash flow, respectively, normalized by its capital stock.[15] The terms τ^K_{jt}, τ^I_{jt}, and τ^O_{jt} denote the capital, input, and output tariff measures for industry j, in year t, respectively. Note that we include industry specific input, capital and output tariffs as measures of protection in the baseline specification (15) simultaneously. It is important to include all of these three measures together in the model because they are positively correlated (see Figure 1). As we demonstrate in the results section, if we exclude one or more from the specification, for example if we only include output tariffs, omitted variable bias becomes a potential issue.

In order to address some of the econometric issues in estimating the empirical relationship between investment and these tariff measures, we modify equation (12) in a number of ways. First, following Fazzari et al. (1988), we include cash flow as a proxy for financing constraints, which arise due to capital market imperfections. Cash flow can be an important determinant of investment for Indian firms, since firms might find it difficult to smooth investment via

[14] In their review of the empirical literature that uses firm- or plant-level data to estimate an investment equation, Bond and Van Reenen (2008) note that this type of reduced form model can be interpreted as representing an empirical approximation to the underlying investment process.

[15] The normalization by capital stock naturally arises in a model with quadratic adjustment costs, and it allows us to control for the size of the firm.

external capital markets.[16] Empirically, cash flow is constructed as the difference between sales and total costs, adjusted for taxes and depreciation.[17] Because costs and cash flow are highly correlated, we include only cash flow in the specification in order to minimize collinearity problems.[18] Second, to allow for serial correlation in sales and cash flow, we include the current and the lagged values of those variables. Moreover, we include the lagged investment rate to control for the autocorrelation that may arise due to adjustment costs. Since the adjustment costs presumably depend on all investment expenditures, in more exhaustive specifications, we include the lagged investment rates for both foreign and domestic capital goods.

The specification also includes firm specific fixed effects, υ_i, that capture the time-invariant plant-level determinants of investment, as well as year dummies, η_t, that capture aggregate economy-wide fluctuations. Macroeconomic factors common to all firms, such as changes in the exchange rates, will be captured by these year effects. However, firms in different industries might face different economic conditions or different productivity trends. In order to allow for industry-specific productivities, we include interaction terms between two-digit industry dummies and a linear time-trend. Moreover, in some specifications, we include interaction terms between the time trend and a full set of state dummies in order to control for economic trends that differ across various regions.

In order to analyze the heterogeneity in the investment behavior of firms, we augment the baseline specification (15) in several important ways. First, to check how the impact of trade liberalization on investment depends on the firm's mark-up, we include an interaction term between the average mark-up of the firm and the output tariff measure. As discussed in Section 3, a reduction in output tariffs can reduce investment more in high mark-up firms, as they begin to face more stiff competition from abroad and experience a decrease in marginal profitability. Hence, we expect this interaction term to intensify effects of output tariffs.

Next, we examine whether the scope for quality differentiation within an industry impacts how a firm responds to increased competition by including two interaction terms: (i) an term between output tariffs and the quality ladder index; (ii) and an interaction term between the Herfindahl index of domestic competition and the quality ladder index. These interaction terms show how the impact of greater foreign and domestic competition on firm investment in foreign capital goods is mediated by the level of vertical differentiation in the industry.

We then move on to some sub-sample analysis with respect to importing and exporting

[16]Examples of previous work that have shown the importance of financing constraints for investment in developing countries include Jaramillo et al. (1996), Love (2003), and Harrison et al. (2004).

[17]Total costs include domestic and imported material costs, as well as labor costs and costs of industrial and non-industrial services.

[18]The results including costs in addition to sales and cash flow are similar to those reported in the following sections, and they are available upon request.

status of the firm. We recognize that imported intermediate goods may be complementary to imported capital goods. Therefore, importers of intermediates might not only respond to reductions in input tariffs more strongly, but also respond to reductions in capital tariffs more intensely. To examine this, we estimate the baseline specification for the sub-sample of firms that are importers of intermediate inputs. We also provide sub-sample analysis for exporters versus non-exporters.

Finally, we analyze the heterogeneity in the impact of lower tariffs on investment in imported capital goods based on where firms are located in the productivity distribution. We classify firms into four quartiles based on their productivity levels and generate dummies. We then interact these dummy variables with the tariff measures, and estimate an augmented investment equation with twelve tariff interaction terms (three tariff measures times the quartile dummies).

We estimate the dynamic investment equation (15) and the augmented specifications using the *system-GMM estimator* of Arellano and Bover (1995) and Blundell and Bond (1998). This estimator for panel data sets with short time dimension addresses the potential biases that arise from the correlation between the firm fixed effects, υ_i, and the lagged dependent variable, $\frac{I_{ijt-1}}{K_{ijt-2}}$, as well as the endogeneity of sales, $\frac{S_{ijt}}{K_{ijt-1}}$, and cash flow, $\frac{C_{ijt}}{K_{ijt-1}}$. The system-GMM estimator combines the first-difference equations, whose regressors are instrumented by their lagged levels, with equations in levels, whose regressors are instrumented by their first-differences.[19] We treat all of the firm specific variables as endogenous, and use lagged values dated $t-2$ and $t-3$ as the GMM-type instruments.[20] We also include lags 2 and 3 of total intermediate costs and other expenses in the set of GMM-type instruments. We employ and report the second order serial correlation tests and the Sargan-Hansen tests of over-identification to check the validity of our instruments. In all specifications, we cluster the standard errors at the five-digit NIC 2008 industry level, which is the level at which the main variables of interest, the three tariff measures, vary.

6 Results

We start by estimating the impact of capital, input, and output tariffs on the firm's investment in foreign capital goods in India, as specified in equation (15). In this first set of

[19]The *system-GMM estimator* builds on the *difference-GMM estimator* of Arellano and Bond (1991), which uses only the differenced equations, instrumented by the lagged levels of the regressors. If the regressors are persistent, then their lagged levels are shown to be weak instruments. See Arellano and Bover (1995) and Blundell and Bond (1998) for more details. To avoid this drawback of the *difference-GMM estimator*, we opt for the *system-GMM estimator*.

[20]In some specifications, including lagged value dated $t-2$ of the investment rate as a GMM-type instrument violates the validity of the Sargan-Hansen tests of over-identification. In those cases, we include only the lagged value dated $t-3$ of the investment rate in the instrument set.

results, we evaluate the average impact of the trade liberalization on investment in imported capital goods and illustrate how changes in capital, input and output protection measures affect investment differently, as our theoretical framework suggests. Next, we present results from alternative specifications that include a measure that combines tariffs on intermediate inputs and capital goods, past tariffs, and specifications for total investment and investment in domestic capital goods. In doing so, we show that the significant gains from trade liberalization emerged from investment in foreign capital goods, and not domestic capital goods. In subsection 6.3, we document the importance of the firm's market power, and the product market's scope for differentiation in mediating the effects of trade liberalization on investment in foreign capital. In subsection 6.4, we analyze whether exporting status and importing intermediate inputs matter for investment in imported capital goods. Next, we discuss the heterogeneity in the impact of the trade liberalization across firms of different size and productivity levels in subsection 6.5. Finally, in subsection 6.6, we evaluate the overall impact of the trade liberalization in India on the investment in foreign capital goods at the aggregate and industry levels.

6.1 Main Effects of Trade Liberalization on Investment in Foreign Capital Goods

Table 5 presents the results from our baseline specification (15) for investment in foreign capital goods, which includes firm and year fixed effects, as well as industry-specific time trends. In order to highlight the importance of distinguishing between tariffs on capital goods, intermediate inputs, and final products to evaluate the impact of trade liberalization on investment decisions, first we present the results from a specification with just the output tariff measure. In the second and third columns, we progressively add input and capital goods tariff measures, and evaluate the direct and indirect effects of trade liberalization on investment decisions. Column (1) of Table 5 shows that, as our theoretical model suggests, the coefficient on output tariffs is positive, but it is not statistically significant. The positive coefficient suggests that a reduction in output tariffs might lower the marginal profitability of capital due to intensified foreign competition, and thereby lower investment in imported capital. When we add input tariffs in column (2), the coefficient on output tariffs increases slightly but remains insignificant. While we estimate a negative coefficient on the input tariff, unlike Bas and Berthou (2017), we find it to be small and statistically insignificant. This may suggest that a reduction in input tariffs would increase investment in foreign capital by lowering the cost of intermediate inputs and therefore increasing the marginal profitability of capital, but inferences are problematic. Next, we include tariffs on capital goods in column (3). As expected, the coefficient on capital goods tariffs is negative and it is highly significant at the 1 percent level, providing direct evidence

that trade liberalization allows firms to invest more in foreign capital by making it cheaper.[21] The coefficients on output and input tariffs remain insignificant.

In column (4), we augment the specification with a measure of licenses, which measures the share of products that are subject to an industrial license, and with a measure of openness to FDI, both of which are obtained from Topalova and Khandelwal (2011). The results show that the coefficients on the tariff measures remain very similar to the estimates presented in column (3). While the coefficient on both license coverage and FDI openness are negative, only the former is significant. This result suggests that the higher the share of products subject to licensing in an industry, the lower the marginal profitability of capital will be, and therefore, the lower the investment in imported capital goods will be. In column (5), we further augment the specification with state-specific time trends, capturing, for example, different dynamic productivity trends across the states in India.[22] Accounting for the state-level variation increases the precision of the estimates and yields a coefficient on output tariffs that is significant at the 10 percent level. The coefficient on capital goods tariffs remains highly significant at the 1 percent level when we include state-specific time trends, and the coefficient on input tariffs remains insignificant.

In the last column, we augment the general specification in column (5) with the lagged investment rate for domestic capital. A high level of investment in domestic capital goods in the previous year can lead the firm to invest less (more) in imported capital goods if the two types of goods are substitutes (complements). The negative and significant (at the 10 percent level) estimate in column (6) suggest that foreign and domestic capital goods can be substitutes, and as such, large domestic capital investments can be followed by smaller investments in foreign capital. The estimates also show that the coefficients on tariff measures increase slightly in magnitude when we account for past investment in domestic capital.

Focusing on the most general specification in column (6) of Table 5, we can quantify the impact of reductions in tariffs on investment in imported capital goods. The estimated coefficient on the capital goods tariffs of -0.034 indicates that the semi-elasticity of the investment rate, $\frac{I_{Mijt}}{K_{ijt-1}}$, with respect to capital goods tariffs is -0.00944 at the sample mean, which suggests that a 10 percentage point reduction in capital goods tariffs leads to a 9.44 percent increase in investment in foreign capital goods.[23] Although the coefficient on input tariffs of -0.022 is not statistically significant, it suggests that a similar 10 percentage point reduction in input tariffs

[21] Bas and Berthou (2017) do not report the estimated effect of the capital goods tariff on the share of foreign capital in total imports from their intensive margin Tobit specification. Therefore, we are unable to compare our estimates of the own price elasticity with their work.

[22] The state indicators in our data are based on the state where the firm headquarters is located, which might not necessarily be the location where the investment and the production take place.

[23] The semi-elasticity of the investment rate, $\frac{I_{Mijt}}{K_{ijt-1}}$, with respect to capital goods tariffs, τ_{jt}^{K}, at the sample mean is calculated as -0.00034/0.036=-0.00944.

can lead to a 6.11 percent increase in investment in foreign capital goods. The larger and statistically significant impact of the change in capital goods tariffs is not surprising, since lowering capital goods tariffs directly increases the demand for foreign capital goods by making them cheaper. The input tariffs, on the other hand, work indirectly through the demand for imported intermediate inputs. When intermediate inputs become cheaper as a result of a reduction in input tariffs, firms are able to import more intermediate inputs, increasing the marginal profitability of capital. This suggested mechanism conforms with the results in Bas and Berthou (2017), who find that reductions in input tariffs increased the probability of importing capital goods for Indian firms. Lastly, we evaluate the effect of output tariffs. The coefficient of 0.017 suggests that a 10 percentage point reduction in output tariffs leads to a 4.72 percent decrease in investment in imported capital goods by enhancing foreign competition and thereby reducing the marginal profitability of capital. Although neither the intermediate inputs tariff nor the output tariff are statistically significant at the conventional 5 percent level, an F-test for the joint significance of the three tariff measures demonstrates that they are jointly statistically significant at the 5 percent level. [24]

Turning to the other determinants of investment, lagged investment in foreign capital goods is positive and statistically significant in all six specifications, demonstrating the serial correlation in investment in imported capital goods. In terms of other firm-specific determinants, the coefficient on lagged sales is statistically significant at the 10 percent level in all specifications, and the lagged cash-flow is positive and significant at the 10 percent level in some of the cases. All specifications in Table 5 are supported by the tests of over-identifying restrictions, for which the Hansen test statistic fails to reject the validity of the instrument sets. Moreover, the tests for serial correlation, which are applied to the residuals in the first differenced equations ($\Delta\varepsilon_{ijt}$), show that we can reject the null hypothesis of no first-order serial correlation, but cannot reject the null hypothesis of no second order serial correlation.[25] The fact that the errors only have first order autocorrelation confirms the validity of instruments dated $t-2$ and $t-3$.

6.2 Alternative Specifications

In this subsection, we consider alternative specifications for evaluating the impact of the Indian trade liberalization on the firm's investment decision. We start by re-estimating our baseline specification using only the two types of tariffs that previous research work has employed– the output tariff and an aggregate intermediate input tariff that combines the intermediate input and the capital goods tariffs. As we previously discussed in the Data Section, this is

[24] The F statistics for joint significance of the three tariff coefficients is 3.02, with a p-value of 0.03.

[25] Assuming that the residuals, ε_{ijt}, in equation (15) are i.i.d, we expect $\Delta\varepsilon_{ijt}$ in the first-differenced equations to have first order autocorrelation.

the typical set-up in the existing literature, largely because previous work has focused on the impact of lower tariffs on the firm's productivity, not investment in foreign capital. The results, presented in column (1) of Table 6 show that the output tariff has a small, positive but statistically insignificant effect on investment in foreign capital goods. This is similar to the estimate in our benchmark model presented in column (6) of Table 5. Further, the results also demonstrate that the impact of the aggregate intermediate input tariff is negative, as expected, but statistically insignificant. The estimated effect of the aggregate input tariff in this specification is quite similar to that of the intermediate input tariff in our benchmark model presented in column (6) of Table 5. This is not surprising since, as we discussed in the Data section, the variation in the aggregate intermediate input tariff reflects mostly the variation in the intermediate input tariffs, and not the variation in capital goods tariffs.

In the next specification, we augment our benchmark model in column (6) of Table 5 with the lagged value of the capital goods tariff measure. The theoretical investment equation we obtain (see equation (12)) suggests that both the current and the expected tariffs on capital goods matter for inter-temporal investment decisions. Since the empirical specification in (15) corresponds to the theoretical investment equation lagged by one period, both the contemporaneous (dated t) and the lagged capital tariffs (dated $t-1$) can affect foreign capital investment decisions taken in period t. Column (2) of Table 6 presents the estimates obtained from this augmented equation. The coefficient on the contemporaneous capital tariff rate of -0.048 is larger in magnitude compared to the baseline estimates in Table 5 and is significant at 10 percent, implying that the firms choose to invest more in foreign capital goods in a given year if the tariff rates on capital goods are lowered during that year. On the other hand, the coefficient on the lagged capital tariff measure is positive, albeit not significant. This result suggests that firms facing high tariff rates in the past year might have postponed purchasing foreign capital goods and that they increase their investment in these goods in the following period when the tariffs are lowered.

Next, we investigate whether trade liberalization has impacted total investment and investment in domestic capital goods similarly. Column (3) of Table 6 presents the results for estimating equation (15) for total investment, and column (4) presents the results for investment in domestic capital goods. We would expect the input and output tariffs to have the same effect on investment in domestic capital goods and on foreign capital goods, since both tariff measures affect the marginal profitability of capital (see equation (8)), which would matter for investment decisions in both types of capital goods. However, how capital goods tariffs affect investment in domestic capital goods is a priori ambiguous. If domestic and foreign capital goods are substitutes, a reduction in capital goods tariffs should lower investment in domestic capital goods, as the reduction makes foreign capital goods relatively cheaper. If they are

complements, however, cheaper foreign capital goods could also make the firm purchase more domestic capital goods.

While the signs of the coefficients on output and capital tariff measures in columns (3) and (4) are the same as the signs on the estimates for investment in foreign capital goods in Table 5, they are not statistically significant. Contrary to our expectations, the coefficient on input tariff measure is positive, but not significant, in both specifications. It is not surprising that the results for total investment resemble the results for investment in domestic capital goods, since investment in domestic capital goods makes up an average of 87 percent of total investment expenditures. These results imply that an important benefit of trade liberalization accrues from the enhanced ability of firms to invest in foreign capital goods.

6.3 Mark-ups and Quality Ladder

In this subsection, we analyze the roles of market power, degree of competition, and the product market's scope for quality differentiation in mediating the impact of output tariffs on firm investment in foreign capital goods. The theoretical framework in Section 3 illustrates how the effect of output tariffs can be increasing in the size of the firm's mark-up. A firm with higher market power, i.e., with a higher mark-up, can be affected more adversely by lower output tariffs because of the heightened import competition that erodes the marginal profitability of the firm. To check for this, we include an interaction term between the average mark-up of the firm and the output tariff measure in our main specification.

The results are presented in column (1) of Table 7. As expected, the interaction term between the average mark-up of the firm and the output tariff is positive with a coefficient of 0.190 and is highly significant. Unlike the interaction term, the coefficient on the output tariff measure is negative (-.092) and significant. The coefficients jointly suggest that a 10 percentage point reduction in output tariffs at the sample mean (the mean mark-up in the sample is .618) leads to a 7.06 percent decrease in investment in imported capital goods. The positive interaction term implies that a firm with a mark-up one standard deviation higher than the mean reduced investment in imported capital goods by 11.71 percent due to intensified foreign competition. In this extended specification, the coefficient on capital goods tariffs increases in magnitude and is significant at the 1 percent level, and the coefficient on input tariffs is similar to the baseline specification.

In column (2) of Table 7, we analyze the role of product differentiation and quality upgrading on investment in foreign capital goods. To that end, we augment the baseline specification with an interaction term between the quality ladder index constructed by Khandelwal (2010) and output tariffs (capturing foreign competition), in addition to an interaction term between

the quality ladder index and a Herfindahl index of domestic competition at the four digit industry level.[26] The quality ladder index, which is time-invariant, measures the scope for quality differentiation in the industry. The adverse effects of both domestic and foreign competition on investment should be lower in industries with "long" quality ladders, since it is more feasible for the firms to upgrade the quality of their products in order to not lose marginal profitability. As in the baseline specification, the coefficient on output tariffs is positive and significant, while its interaction with the quality ladder index is negative and significant at 10 percent. The two coefficients jointly imply that a 10 percentage point reduction in the output tariffs leads to a 5.8 percent decline in the investment in foreign capital goods given the quality ladder's sample mean of 2.283. A similar 10 percentage point reduction in output tariffs in an industry with a bigger scope for quality upgrading (one standard deviation above the mean) leads to a smaller decline in investment of 3.74 percent. When we turn our attention to domestic competition, we find that enhanced competition increases investment in foreign capital goods for industries at the mean of the quality ladder distribution. Specifically, we find that a one standard deviation reduction in the Herfindahl index (corresponding to higher levels of competition) leads to a 6.24 percent increase in investment in foreign capital goods. The positive interaction shows that as the scope for quality differentiation increases, investment in foreign capital goods increases also for less competitive industries.

6.4 Importers of Intermediate Inputs and Exporters

In this subsection, we provide some sub-sample analysis with respect to the importing and exporting status of the firms. Equation (8) in Section 3 illustrates how a reduction in input tariffs, τ_t^I, can increase investment by lowering the cost of imported inputs, and thereby raising the marginal profitability of capital. Hence, a firm requiring the use of imported inputs should benefit more from a reduction in input tariffs. Moreover, firms that use imported intermediate inputs that are complements to imported capital goods in the production process might invest more when capital becomes cheaper as a result of lower capital goods tariffs. To test whether importing intermediate goods matters for foreign capital investment decisions, we estimate the comprehensive specification in column (6) of Table 5 on firms that are importers of intermediate inputs, and exclude non-importers from the sample. We classify a firm as an importer of foreign intermediate inputs if it has imported intermediate inputs for at least two years between 1989-1997. This lowers the number of firms in the sample from 2,512 to 1,911. The results are reported in the first column of Table 8. The coefficient on output tariffs remains similar to the baseline estimates and is significant at the 5 percent level, while the coefficient on capital goods tariff increases slightly in magnitude to -0.037 and is significant at the 1 percent level.

[26] We construct the Herfindahl index as the sum of squared sales share of firms in each four digit NIC industry.

Moreover, the coefficient on input tariffs increases in magnitude and becomes significant at the 5 percent level. The estimate of -0.030 suggests that a 10 percentage point reduction in input tariffs increases investment in foreign capital by 7.32 percent for firms that import intermediate inputs. These results are consistent with Bas and Berthou (2017), who find that the reduction in input tariffs between 1999-2006 in India (12 percentage points) led to an increase in the probability of importing capital goods of 2.6 percent for the average firm, and almost 4 percent for the average firm importing intermediate goods.

Next, we consider the exporting status of the firms. Firms that export can have higher investment profiles, since such firms are typically more productive and are larger in size, and therefore might respond more to reductions in tariffs. Columns (2) and (3) of Table 8 present the results from estimating our main specification for exporters and non-exporters separately. We categorize a firm as an exporter if the firm exported for at least two years between 1990 and 1997. The estimates of both the input and capital tariffs are negative for the exporters, and they are significant at the 5 and 10 percent levels, respectively. In column (2), the coefficient on the capital tariff measure is the same size as the one obtained for the full sample (-0.034, see column (6) of Table 5), whereas the coefficient on the input tariff measure is much larger at -0.038. These estimates suggest that a 10 percentage point reduction in tariffs on capital goods increases investment in foreign capital goods by 8.5 percent, and a 10 percentage point reduction in tariffs on inputs increases investment in foreign capital goods by 9.5 percent.[27] The estimate of the effect of output tariffs is also similar in size to the one obtained using the full sample; however, it is not statistically significant. We present the results for non-exporters in column (3). Unlike the impacts we uncover for exporters, we do not find statistically significant effects of lower tariffs on investment in foreign capital goods for non-exporters.

6.5 Heterogeneity in the Impact of Lower Tariffs

In this subsection, we analyze the heterogeneity in the impact of lower tariffs on investment in imported capital goods. Building on the work of Melitz (2003), theoretical and empirical studies such as Bustos (2011) and Bas and Berthou (2017) have shown that faced with lower tariffs, firms will have an incentive to upgrade technology, due to the expanded export opportunities and/or the cheaper inputs. Both studies suggest that this incentive is not the same for all firms— it varies with productivity, and that only firms in the middle-range productivity are impacted by the changes in tariffs. Similar effects of the trade liberalization in India on firm-level investment are also likely to exist. For example, as capital goods or input tariffs fall, firms in the middle of the productivity distribution are most likely to experience the largest

[27]The mean foreign capital goods investment rate is higher for exporters at 0.040, compared to the 0.0361 for the full sample.

investment incentive due to the lower prices of imported capital goods and intermediate inputs. Lower tariffs can spur investment for these firms, which were likely on the margin in investing in imported or domestic capital goods. On the other hand, the incentives of cheaper capital goods and imported intermediate goods might not be large enough for the least efficient firms, for which the marginal profitability of capital would be quite low before and after the fall in tariffs. Similarly, the most productive establishments might not increase their investment by much because they had likely already achieved a high investment rate based on the high expected level of sales before the trade liberalization.

To empirically test for heterogeneity in the impact of India's trade liberalization on firm-level investment, we divide all firms into four groups— the four quartiles of productivity distribution. We then estimate the following expanded version of our baseline specification (15):

$$\frac{I_{ijt}}{K_{ijt-1}} = \alpha_1 \frac{I_{ijt-1}}{K_{ijt-2}} + \alpha_2 \frac{S_{ijt}}{K_{ijt-1}} + \alpha_3 \frac{S_{ijt-1}}{K_{ijt-2}} + \alpha_4 \frac{C_{ijt}}{K_{ijt-1}} + \alpha_5 \frac{C_{ijt-1}}{K_{ijt-2}} + \\ + \sum_{r=1}^{4} \gamma^r_{\tau^{KT}} (\tau^{KT}_{jt} \times Q^r_{ij}) + \sum_{r=1}^{4} \gamma^r_{\tau^{IT}} (\tau^{IT}_{jt} \times Q^r_{ij}) + \sum_{r=1}^{4} \gamma^r_{\tau^{OT}} (\tau^{OT}_{jt} \times Q^r_{ij}) + \upsilon_i + \eta_t + \varepsilon_{ijt}, \qquad (16)$$

where r indexes the four quartiles of the productivity distribution and Q_{ij} is the indicator variable equal to one when firm i belongs to quartile r. We classify firms into the four quartiles using two alternate measures of productivity. The first measure we use is total factor productivity (TFP). We estimate the Cobb Douglas production function using a control function approach in the spirit of Olley and Pakes (1996), Levinsohn and Petrin (2003) and Ackerberg et al. (2006) using material inputs as a proxy for unobserved productivity. We use the mean TFP levels of the firms to classify them into the four quartiles and present the estimates in column (1) of Table 9. The second measure we use is firm size based on mean sales to classify firms into the four quartiles and present the estimates in column (2) of Table 9.

In general, the results are consistent with expectations and imply that the impact of lower capital goods tariffs is the highest for the middle quartiles. The impact of the reduction of capital goods tariffs on investment in imported capital goods is largest for firms in the third quartile. The magnitudes of the estimates at -0.075 (column 1) and -0.044 (column 2) are larger than the average impact of -0.034 that we estimate for all firms in our baseline specification (15) (see Table 5). The four estimates of the capital goods tariffs are significant at the 5 percent level under the alternate ways of classifying firms into the four quartiles. The effects of lower input tariffs and output tariffs are less precisely estimated. The coefficients on output tariffs suggest that the smaller and less productive firms (in the first and second quartiles) were largely unaffected by foreign competition. On the other hand, the larger and more productive firms faced stiffer foreign competition and thus reduced their investment. These results show that

not all firms responded to changes in tariffs in a similar way and this highlights the importance of controlling for heterogeneity in uncovering the impact of trade liberalization on investment in foreign capital goods.

6.6 Overall Impact of the Trade Liberalization on the Investment in Foreign Capital Goods in India's Manufacturing Sector

Finally, in this subsection, we evaluate the overall impact of India's trade liberalization between 1990 and 1997 on the investment rate in foreign capital goods $\left(\frac{I_{Mijt}}{K_{ijt-1}}\right)$ in the manufacturing sector. We also separate and compare the respective contributions of the three major trade barriers— tariffs on capital goods, intermediate inputs, and final output— which declined substantially as part of the trade liberalization process. In 1990, the average output, intermediate input, and capital goods tariffs were 95, 85, and 94 percent, respectively. By the end of our sample period in 1997, the three average tariff rates had dropped to 39, 34, and 33 percent, respectively.

Given the overall decrease in these trade barriers, our baseline estimates in column (6) of Table 5 imply that the 61-percentage-point decline in capital goods tariffs led to a 57.58 percent increase in the average investment in foreign capital goods. On the other hand, the 56-percentage-point decline in output tariffs led to a 26.43 percent decline in the average investment in foreign capital goods. Combining these two opposing effects, we get a net positive effect of 31.15 percent increase in the average investment in foreign capital. If we add the impact of the 51-percentage-point decline in the intermediate input tariffs, which resulted in a 31.16 percent increase in investment, we find an overall net increase of 62.31 percent.[28] Given the average investment rate $\left(\frac{I_M}{K}\right)$ of 0.036 over the sample period, our results imply that the trade liberalization led to an increase in the investment rate of 0.022, or 2.2 percentage points. Between the beginning and the end of the sample period, the average investment rate in foreign capital goods grew from 0.022 to 0.080, or 5.8 percentage points.[29] Hence, based on our model estimates, 38 percent of this increase (0.38=0.022/(0.080-0.022)) was due to the decline in tariffs, in particular to the decline in the capital goods tariff. Not surprisingly, the net impact of the trade liberalization on the investment rate differs across the manufacturing industries, driven by the differences in the decline in three tariff measures and the average foreign capital investment rate in each of the industries. In Table 10, we report the initial and the final average tariff

[28] As we discussed earlier, the estimated coefficients on the three tariffs are jointly statistically significant at the 5 percent level.

[29] To evaluate the overall increase in the average investment rate throughout the sample period, we use 1990 as a beginning date and 1996 as the end date. We do so to avoid the decline in the average investment rate in 1997 that came as a result of the Asian Financial Crisis.

rates for the two-digit NIC-industries in our sample, along with the change in the investment in foreign capital goods caused by the reduction in each tariff measure. The last column presents the combined effect of the reductions in output, input, and capital goods measures. While the net impact is positive for all of the industries, there is substantial variation in the net gains. Among the industries that witnessed the largest net increase in their investment in foreign capital goods are "Coke and Petroleum Products" (167 percent increase), "Beverages" (159 percent increase), and "Food Products" (156 percent increase). These are also the industries that benefitted most from the reduction in capital goods tariffs. On the other hand, the net increase in foreign capital investment in the "Motor Vehicles and Trailers" (13 percent), "Furniture" (10 percent), and "Recorded Media" (4 percent) industries are relatively small, despite the substantial reduction in tariffs, due to the fact that these industries had relatively large foreign capital investment rates to begin with.

7 Conclusion

Using firm-level data from the Indian manufacturing sector, we evaluate the impact of lower capital tariffs, as well as input and output tariffs, on firms' investment in foreign capital goods. Our study improves upon previous work along two dimensions. First, it distinguishes investment in imported capital goods from other investment and shows that trade liberalization contributed to capital accumulation through its impact on investment in foreign equipment, rather than domestic capital goods. Second, employing input-output tables, we construct capital goods tariffs that are distinct from tariffs on intermediate inputs and final consumption goods. This allows us to estimate the price elasticity of investment in foreign capital goods.

In the case of investment in foreign capital goods, theory suggests three mechanisms through which trade liberalization can affect investment in foreign capital goods. Lower capital goods tariffs have a direct positive effect of investment decisions, as they lower the price of foreign capital goods. Lower input tariffs increase firms' profitability and therefore investment as they improve access to cheaper inputs. Lower output tariffs bring about more intense import competition, which results in lower profits and investment. This is exactly what our analysis finds. Employing data that cover a period of broad trade liberalization in India in the 1990s, we find that a 10 percentage point decrease in the capital goods tariffs led to a 9.44 percent increase in the average firm's investment rate in foreign capital goods. A similar 10 percentage point reduction in input tariffs led to a 6.11 percent increase in investment in foreign capital. Also as predicted by theory, we find that the reductions in output tariffs affect investment adversely. When we combine the effects of the three types of tariffs, we find that the trade liberalization in India resulted in a net increase of 62.31 percent in the manufacturing sector

investment rate in foreign capital over the course of the sample period (1990-1997). Based on our model estimates, about 38 percent of the actual increase in the investment rate over the sample period was due to the decline in tariffs, in particular, to the decline in the capital goods tariff. Our findings imply that trade policy in India during this period had a substantial positive impact on investment in foreign capital goods, which potentially contributed to overall industrial growth.

8 Appendix: Taylor Expansion and Structural Parameters

The fully-parameterized non-linear investment equation we obtain when we substitute equation the partial derivatives of the adjustment cost function in equation (11), the marginal profitability of capital in equation (8), and the demand for imported capital goods in equation (2) into the Euler equation in (5) is:

$$\theta_1 \left(\tau_t^K P_{Mt}\right)^{\omega} \frac{I_{Mit}}{K_{it-1}} = E_t\Bigg[\frac{x_{it+1}p_{it+1}}{\psi_i K_{it}} - \frac{w_{t+1}L_{it+1}}{K_{it}} - \frac{\tau_{t+1}^I w_{t+1}^* L_{it+1}^*}{K_{it}} + \theta_2 \left(\tau_{t+1}^K P_{Mt+1}\right)^{2\omega} \left(\frac{I_{Mit+1}}{K_{it}}\right)^2 + \theta_3 \left(\tau_{t+1}^K P_{Mt+1}\right)^{\omega} \left(\frac{I_{Mit+1}}{K_{it}}\right) + \theta_4\Bigg], \tag{17}$$

where the coefficients are defined as: $\theta_1 = \frac{\gamma_0}{\beta\mu}$; $\theta_2 = \frac{\gamma_0}{2\mu^2}$; $\theta_3 = \frac{(1-\delta)\gamma_0}{\mu}$
$\theta_4 = \frac{\gamma_0\gamma_1 - 1}{\beta} - \frac{\gamma_0\gamma_1^2}{2} + (1-\delta) - (1-\delta)\gamma_0\gamma_1$.

First we take a first-order Taylor approximation of the non-linear equation above around the steady state values of the variables. Second we define total sales as S_{it}=$x_{it+1}p_{it+1}$; total costs as $Z_{it+1} = w_{t+1}L_{it+1}$; and the cost of imported inputs as $Z_{it+1}^* = \tau_{t+1}^I w_{t+1}^* L_{it+1}^*$. Rewriting the sales and the cost variables in terms of S_{it}, Z_{it+1} and Z_{it+1}^*, we obtain equation (12) in the text:

$$\frac{I_{Mit}}{K_{it-1}} = E_t\left[\phi_0 + \phi_1\frac{I_{Mit+1}}{K_{it}} + \phi_2\frac{S_{it+1}}{K_{it}} - \phi_3\frac{Z_{it+1}}{K_{it}} - \phi_4\frac{Z_{it+1}^*}{K_{it}} + \phi_5\left(\tau_{t+1}^K P_{Mt+1}\right) - \phi_6\left(\tau_t^K P_{Mt}\right)\right]$$

The expressions for the coefficients in terms of the structural parameters and the steady-state values of the variables are:
$\phi_0 = \left[\frac{\omega}{\tau^K P_M} - \frac{\theta_3}{\theta_1}\omega\right]\frac{I_M}{K} - \frac{\theta_2}{\theta_1}(2\omega+1)\left(\tau^K P_M\right)^{\omega}\left(\frac{I_M}{K}\right)^2 + \frac{\theta_4}{\theta_1\tau^K P_M}$
$\phi_1 = 2\frac{\theta_2}{\theta_1}\left(\tau^K P_M\right)^{\omega}\frac{I_M}{K}$
$\phi_2 = \frac{1}{\theta_1\psi}\left(\tau^K P_M\right)^{-\omega}$
$\phi_3 = \phi_4 = \frac{1}{\theta_1}\left(\tau^K P_M\right)^{-\omega}$
$\phi_5 = 2\omega\frac{\theta_2}{\theta_1}\left(\tau^K P_M\right)^{\omega-1}\left(\frac{I_M}{K}\right)^2 + \frac{\theta_3\omega}{\theta_1}\left(\tau^K P_M\right)^{-1}\frac{I_M}{K}$
$\phi_6 = \omega\left(\tau^K P_M\right)^{-1}\frac{I_M}{K}$.

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Figure 1: Average Tariff Rates (In Percent)

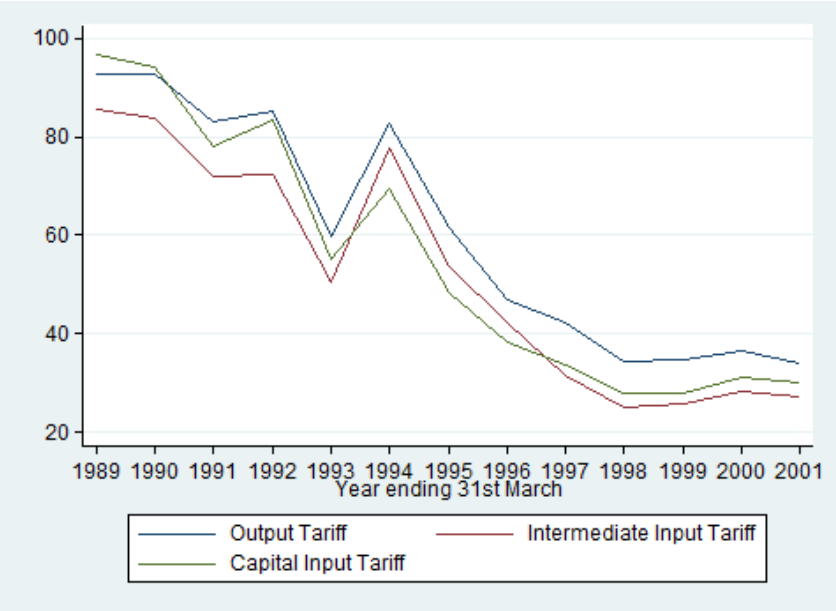

Figure 2: Standard Deviation of Tariffs

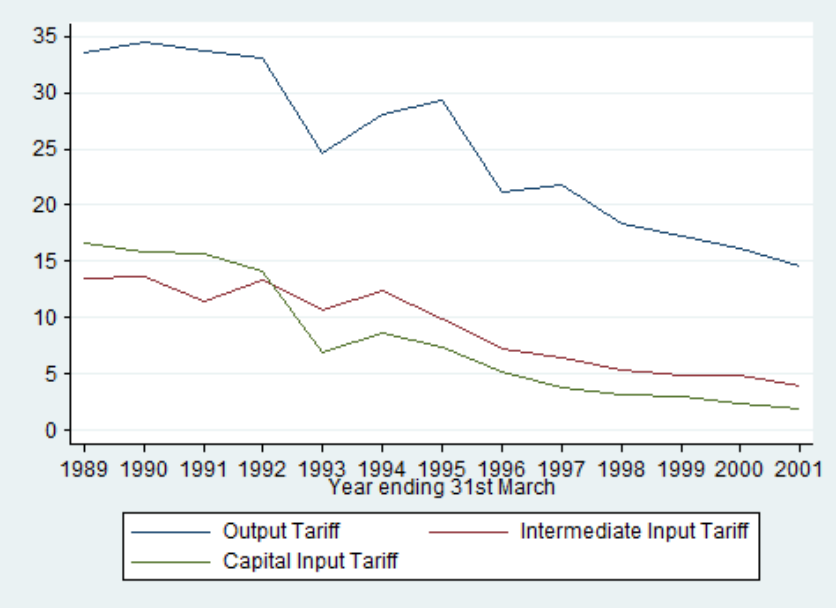

Table 1: Trading partner share of total imported capital

Rank	Trading Partner	Imported Capital (Percent of Total)
1	U.S.	20.14
2	Japan	16.80
3	Germany	16.73
4	U.K.	6.60
5	Singapore	4.98
6	France	4.96
7	Italy	4.63
8	Switzerland	3.10
9	Korea	2.18
10	Taiwan	1.91
	All Other	17.98
	Total	100.00

Note: The data on trading partner share of total imported capital goods are from the World Bank Trade, Production and Protection (1976-2004) database. Average percentages of total (over the sample period from 1990 to 1997) capital goods imports are reported.

Table 2: Trade Policy Endogeneity: Current Trade Policy and Past Investment

	(1)	(2)	(3)
Dependent Variable	Output Tariff	Intermediate Input Tariff	Capital Input Tariff
Panel A			
Investment in Foreign Capital Goods	-0.744	0.358	0.488
	(1.261)	(0.719)	(0.505)
Number of observations	1498	1498	1498
R-squared	0.808	0.863	0.935
Panel B			
Investment in Domestic Capital Goods	-0.077	-0.007	0.154*
	(0.225)	(0.216)	(0.083)
Number of observations	1491	1498	1498
R-squared	0.814	0.903	0.945

Notes: Panel A presents the panel regressions of current trade policy tool on lagged investment rate in foreign capital goods. Panel B presents the regressions of current trade policy tool on lagged investment rate in domestic capital goods. Estimations include year and five-digit industry fixed effects and are weighted by the number of firms in each five-digit industry in each particular year. Standard errors are robust and they are clustered at the five-digit industry level.

Table 3: Combined Tariffs, Intermediate-Input and Capital-Input Tariffs

Dependent Variable: Combined Input Tariffs	(1)	(2)
Capital Tariffs	0.096***	0.065***
	(0.013)	(0.007)
Intermediate Tariffs	0.909***	0.927***
	(0.014)	(0.009)
Industry Effects	No	Yes
Observations	2,496	2,496
R-squared	0.983	0.995

Notes: The combined input tariffs are regressed on the capital-input tariffs and intermediate-input tariffs. Robust standard errors clustered at the 5 digit NIC level are in parenthesis.

Table 4: Summary Statistics

Variable	Mean	St. Dev.	Min	Max
Investment in Foreign Capital Goods $\left(\frac{I_{Fijt}}{K_{ijt-1}}\right)$	0.036	0.187	0	10.05
Investment in Domestic Capital Goods $\left(\frac{I_{Dijt}}{K_{ijt-1}}\right)$	0.243	0.669	0	22.62
Sales $\left(\frac{S_{ijt}}{K_{ijt-1}}\right)$	3.298	6.114	0.004	409.9
Cash-Flow $\left(\frac{C_{ijt}}{K_{ijt-1}}\right)$	-0.248	0.869	-32.62	3.956
Average Markup (ψ_i)	0.618	0.088	0	1.128
Output Tariff $\left(\frac{\tau^O_{jt}}{100}\right)$	0.594	0.244	0.088	3.263
Intermediate Input Tariff $\left(\frac{\tau^I_{jt}}{100}\right)$	0.543	0.182	0.142	1.115
Capital Input Tariff $\left(\frac{\tau^K_{jt}}{100}\right)$	0.532	0.198	0.260	1.274
License	0.113	0.273	0	1
FDI	0.579	0.419	0	1
Quality ladder	2.283	0.299	1.219	3.325
Herfindahl index	0.141	0.149	0.016	1

Notes: The number of observations is $9,486$ and the number of firms is $2,512$.

Table 5: Main Effects of Trade Liberalization on Investment in Foreign Capital Goods

Dependent Variable: $\frac{I_{Mijt}}{K_{ijt-1}}$	(1)	(2)	(3)	(4)	(5)	(6)
Lagged foreign capital investment $\left(\frac{I_{Mijt-1}}{K_{ijt-2}}\right)$	0.086***	0.086***	0.086***	0.086***	0.088***	0.087***
	(0.009)	(0.009)	(0.009)	(0.010)	(0.008)	(0.010)
Sales $\left(\frac{S_{ijt}}{K_{ijt-1}}\right)$	0.003	0.003	0.003	0.003	0.003	0.003
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Lagged sales $\left(\frac{S_{ijt-1}}{K_{ijt-2}}\right)$	0.002*	0.002*	0.002	0.002*	0.001*	0.002*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Cash-flow $\left(\frac{C_{ijt}}{K_{ijt-1}}\right)$	0.013	0.013	0.013	0.013	0.016	0.016
	(0.021)	(0.021)	(0.021)	(0.021)	(0.019)	(0.020)
Lagged cash-flow $\left(\frac{C_{ijt-1}}{K_{ijt-2}}\right)$	0.015*	0.015*	0.015*	0.015*	0.011	0.012
	(0.008)	(0.009)	(0.009)	(0.009)	(0.008)	(0.009)
Output tariff $\left(\frac{\tau^O_{jt}}{100}\right)$	0.010	0.015	0.017	0.014	0.016*	0.017*
	(0.010)	(0.012)	(0.011)	(0.011)	(0.008)	(0.009)
Input tariff $\left(\frac{\tau^I_{jt}}{100}\right)$		-0.017	-0.015	-0.017	-0.016	-0.022
		(0.015)	(0.012)	(0.014)	(0.010)	(0.015)
Capital goods tariff $\left(\frac{\tau^K_{jt}}{100}\right)$			-0.032***	-0.028**	-0.030***	-0.034**
			(0.012)	(0.012)	(0.008)	(0.014)
License				-0.011*	-0.011*	-0.013**
				(0.006)	(0.006)	(0.006)
FDI				-0.013	-0.012	-0.011
				(0.009)	(0.010)	(0.009)
Lagged domestic capital investment $\left(\frac{I_{Dijt-1}}{K_{ijt-2}}\right)$						-0.007*
						(0.004)
Regional time trends	no	no	no	no	yes	yes
Number of observations	9,486	9,486	9,486	9,486	9,486	9,486
Number of firms	2,512	2,512	2,512	2,512	2,512	2,512
Hansen-Sargan test (p-value)	0.638	0.585	0.654	0.513	0.642	0.715
1st order serial correlation test (p-value)	0.007	0.007	0.007	0.007	0.007	0.007
2nd order serial correlation test (p-value)	0.251	0.252	0.250	0.245	0.225	0.209

Notes: The estimates and standard errors are obtained from the two-step system GMM. Standard errors are clustered at the 5 digit NIC level, and are in parentheses. All firm-specific regressors are treated as endogenous. A set of year effects and industry-specific time trends are included in all specifications. The p-values for the Hansen over-identification test and the second order serial correlation tests are reported. ***, **, * denote significance at the 1, 5, and 10% level, respectively. Lags 2 and 3 of the investment rate, sales and cash-flow intermediate input costs and other operating costs are included as GMM-type instruments. All industry-level variables are included as IV-type instruments.

Table 6: Alternative Specifications

Dependent Variable– Investment rate:	(1) Foreign capital	(2) Foreign capital	(3) Total capital	(4) Domestic capital
Lagged foreign capital investment $\left(\frac{I_{Mijt-1}}{K_{ijt-2}}\right)$	0.087***	0.089***		
	(0.010)	(0.009)		
Lagged domestic capital investment $\frac{I_{Dijt}}{K_{ijt-1}}$	-0.007*	-0.001		0.040*
	(0.004)	(0.006)		(0.024)
Lagged total investment $\frac{I_{Tijt}}{K_{ijt-1}}$			0.055	
			(0.034)	
Sales $\left(\frac{S_{ijt}}{K_{ijt-1}}\right)$	0.003	0.003	0.023***	0.019***
	(0.002)	(0.002)	(0.006)	(0.005)
Lagged sales $\left(\frac{S_{ijt-1}}{K_{ijt-2}}\right)$	0.002*	0.001	0.014	0.012
	(0.001)	(0.001)	(0.012)	(0.011)
Cash-flow $\left(\frac{C_{ijt}}{K_{ijt-1}}\right)$	0.016	0.016	-0.134	-0.125
	(0.020)	(0.019)	(0.239)	(0.207)
Lagged cash-flow $\left(\frac{C_{ijt-1}}{K_{ijt-2}}\right)$	0.012	0.010	0.231	0.190
	(0.009)	(0.006)	(0.188)	(0.157)
Output tariff $\left(\frac{\tau^O_{jt}}{100}\right)$	0.014	0.014*	0.047	0.027
	(0.009)	(0.008)	(0.058)	(0.062)
Input tariff $\left(\frac{\tau^I_{jt}}{100}\right)$		-0.020	0.125	0.143
		(0.015)	(0.093)	(0.090)
Capital goods tariff $\left(\frac{\tau^K_{jt}}{100}\right)$		-0.048*	-0.065	-0.053
		(0.027)	(0.118)	(0.105)
Lagged capital goods tariff $\left(\frac{\tau^K_{jt-1}}{100}\right)$		0.013		
		(0.025)		
Combined input and capital goods tariffs	-0.024			
	(0.020)			
License	-0.012*	-0.011*	-0.034	-0.023
	(0.007)	(0.006)	(0.033)	(0.029)
FDI	-0.013	-0.011	-0.006	-0.004
	(0.010)	(0.010)	(0.036)	(0.032)
Number of observations	9,486	9,486	9,486	9,486
Number of firms	2,512	2,512	2,512	2,512
Hansen-Sargan test (p-value)	0.503	0.628	0.484	0.547
1st order serial correlation test (p-value)	0.00658	0.00677	7.79e-08	7.38e-08
2nd order serial correlation test (p-value)	0.204	0.230	0.432	0.608

Notes: See Table 5 for notes.

Table 7: Mark-ups and Quality Ladder

Dependent Variable: $\frac{I_{Mijt}}{K_{ijt-1}}$	(1)	(2)
Lagged foreign capital investment $\left(\frac{I_{Mijt-1}}{K_{ijt-2}}\right)$	0.087***	0.087***
	(0.010)	(0.010)
Sales $\left(\frac{S_{ijt}}{K_{ijt-1}}\right)$	0.003	0.003
	(0.002)	(0.002)
Lagged sales $\left(\frac{S_{ijt-1}}{K_{ijt-2}}\right)$	0.002	0.002*
	(0.001)	(0.001)
Cash-flow $\left(\frac{C_{ijt}}{K_{ijt-1}}\right)$	0.017	0.015
	(0.020)	(0.020)
Lagged cash-flow $\left(\frac{C_{ijt-1}}{K_{ijt-2}}\right)$	0.011	0.012
	(0.009)	(0.009)
Output tariff $\left(\frac{\tau^O_{jt}}{100}\right)$	-0.092**	0.078**
	(0.044)	(0.037)
Output tariff*mark-up $\left(\frac{\tau^O_{jt}}{100} * \psi^H_i\right)$	0.190***	
	(0.068)	
Output tariff*Log quality ladder indicator		-0.025*
		(0.014)
Input tariff $\left(\frac{\tau^I_{jt}}{100}\right)$	-0.022	-0.032*
	(0.014)	(0.018)
Capital goods tariff $\left(\frac{\tau^K_{jt}}{100}\right)$	-0.039***	-0.037**
	(0.014)	(0.018)
Herfindahl index		-0.150**
		(0.069)
Herfindahl index*quality ladder indicator		0.059*
		(0.032)
License	-0.013*	-0.012*
	(0.007)	(0.006)
FDI	-0.013	-0.011
	(0.009)	(0.008)
Lagged domestic capital investment $\left(\frac{I_{Dijt-1}}{K_{ijt-2}}\right)$	-0.007*	-0.007*
	(0.004)	(0.004)
Number of observations	9,485	9,486
Number of firms	2,511	2,512
Hansen-Sargan test (p-value)	0.768	0.821
1st order serial correlation test (p-value)	0.007	0.007
2nd order serial correlation test (p-value)	0.211	0.216

Notes: The first column augments the baseline model in column (6) of Table 5 with an interaction term between the output tariff measure with the average mark-up of the firm, ψ^H_i. Column (2) augments the baseline model in column (6) of Table 5 with an interaction term between the output tariff measure with the quality ladder index, the Herfindahl index measuring the competition at the 4-digit NIC industries, and an interaction term between the Herfindahl index and the quality ladder measure. See Table 5 for additional notes.

Table 8: Intermediate good importers and Exporting

Dependent Variable: $\frac{I_{Mijt}}{K_{ijt-1}}$	(1) Importers	(2) Exporters	(3) Non-exporters
Lagged foreign capital investment $\left(\frac{I_{Mijt-1}}{K_{ijt-2}}\right)$	0.087***	0.089***	0.074***
	(0.008)	(0.008)	(0.012)
Sales $\left(\frac{S_{ijt}}{K_{ijt-1}}\right)$	0.003	0.003	0.001
	(0.002)	(0.002)	(0.002)
Lagged sales $\left(\frac{S_{ijt-1}}{K_{ijt-2}}\right)$	0.002	0.002	-0.000
	(0.001)	(0.001)	(0.002)
Cash-flow $\left(\frac{C_{ijt}}{K_{ijt-1}}\right)$	0.015	0.009	0.010
	(0.019)	(0.013)	(0.014)
Lagged cash-flow $\left(\frac{C_{ijt-1}}{K_{ijt-2}}\right)$	0.012	0.016	0.002
	(0.010)	(0.016)	(0.004)
Output tariff $\left(\frac{\tau^O_{jt}}{100}\right)$	0.017**	0.020	0.012
	(0.007)	(0.015)	(0.098)
Input tariff $\left(\frac{\tau^I_{jt}}{100}\right)$	-0.030**	-0.038**	0.013
	(0.013)	(0.018)	(0.046)
Capital goods tariff $\left(\frac{\tau^K_{jt}}{100}\right)$	-0.037***	-0.034*	-0.036
	(0.012)	(0.020)	(0.151)
License	-0.010**	-0.012*	-0.017
	(0.004)	(0.007)	(0.052)
FDI	-0.003	-0.012	-0.011
	(0.005)	(0.013)	(0.025)
Lagged domestic capital investment $\left(\frac{I_{Dijt-1}}{K_{ijt-2}}\right)$	-0.007*	-0.005	-0.001
	(0.004)	(0.007)	(0.007)
Number of observations	8,016	7,014	2,472
Number of firms	1,911	1,607	905
Hansen-Sargan test (p-value)	0.641	0.376	0.817
1st order serial correlation test (p-value)	0.00767	0.0142	0.0359
2nd order serial correlation test (p-value)	0.214	0.284	0.327

Notes: The first column reports the estimates obtained using a sample of firms that import intermediate inputs for at least for two years between 1989-1997. Column (2) reports the estimates obtained using a sample of firms that export for at least for two years during the sample period. Column (3) reports the estimates obtained using a sample of firms that do not export. See Table 5 for additional notes.

Table 9: Heterogeneity of the impacts across size groups

Dependent Variable: $\frac{I_{Mijt}}{K_{ijt-1}}$	(1)	(2)
	Productivity quartiles	Sales quartiles
Output tariff– First quartile	-0.006	0.005
	(0.013)	(0.108)
Output tariff– Second quartile	0.019	0.001
	(0.018)	(0.011)
Output tariff– Third quartile	0.055*	0.004
	(0.031)	(0.023)
Output tariff– Fourth quartile	0.022	0.030*
	(0.018)	(0.016)
Input tariff– First quartile	0.005	0.017
	(0.028)	(0.050)
Input tariff– Second quartile	-0.019	-0.025
	(0.031)	(0.022)
Input tariff– Third quartile	-0.016	0.003
	(0.031)	(0.022)
Input tariff– Fourth quartile	-0.047	-0.030
	(0.030)	(0.024)
Capital goods tariff– First quartile	-0.033	-0.072
	(0.024)	(0.048)
Capital goods tariff– Second quartile	-0.025	-0.026
	(0.029)	(0.023)
Capital goods tariff– Third quartile	-0.075**	-0.044**
	(0.029)	(0.022)
Capital goods tariff– Fourth quartile	-0.017	-0.032
	(0.026)	(0.021)

Notes: The reported coefficients are the interaction terms between the corresponding tariff measure and the dummy for the four quartiles. The firms are classified into four quartiles based on average total factor productivity (column 1) or average size measured by sales (column 2).

Table 10: Tariff Changes and Impacts By Industry

	Output Tariff			Input Tariff			Capital Goods Tariff			
Industry	1990	1997	impact	1990	1997	impact	1990	1997	impact	net impact
Coke and Petroleum Products	80	30	-47	56	19	44	123	32	170	167
Beverages	155	127	-26	83	37	56	100	32	130	159
Food Products	85	35	-60	73	31	66	93	31	149	156
Non-Metallic Mineral Products	89	47	-37	76	34	48	105	34	127	139
Pharmaceuticals	99	40	-44	93	35	55	100	33	99	109
Wood Products	65	32	-21	72	24	39	96	33	79	97
Fabricated metal Products	100	32	-35	80	30	34	106	32	77	76
Chemicals and Chemical Products	112	39	-34	92	34	35	106	32	70	71
Basic Metals	94	29	-36	74	28	32	98	32	72	69
Machinery and Equipment	74	29	-26	87	32	41	77	31	52	68
Electrical Equipment	83	43	-17	92	33	33	86	35	45	60
Rubber and Plastic Products	108	45	-19	118	35	32	109	33	45	58
Paper Products	81	24	-27	65	21	27	91	32	56	56
Leather Products	82	37	-14	86	25	24	92	36	35	45
Other Transport Equipment	74	43	-11	90	33	27	82	43	29	44
Tobacco Products	100	50	-20	84	35	25	76	30	37	42
Wearing Apparel	100	50	-15	93	46	18	78	31	28	32
Textiles	94	50	-11	88	44	15	84	30	28	31
Computer, Electronic Products	111	32	-18	92	34	17	99	39	27	26
Motor Vehicles, Trailers	97	45	-5	92	33	7	95	42	10	13
Furniture	103	48	-4	94	32	6	88	32	8	10
Recorded Media	58	20	-1	68	20	2	90	34	3	4

Notes: The tariff rates are in percentages. The values recorded under the "impact" columns are calculated using the estimates in column (6) of Table 5, and the sales weighted average foreign capital investment rate in each two digit NIC-industry. See footnote 23 for the details of the tariff change impact calculations. The industries are ranked based on the net effect of the reductions in the three tariff measures.