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# The Decision to Import Capital Goods in India: Firms' Financial Factors Matter



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**Published on:** 01 Jan 2012 - The World Bank Economic Review (Oxford University Press)

**Topics:** Financial capital, Physical capital, Capital good, Factors of production and Economic capital

# The Decision to Import Capital Goods in India: Firms' Financial Factors Matter

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Are financial constraints preventing firms from importing capital goods? Sourcing capital goods from foreign countries is costly and requires internal or external financial resources. A simple model of foreign technology adoption shows that credit constraints act as a barrier to importing capital goods under imperfect financial markets. In our study, we investigate this prediction using detailed balance-sheet data from Indian manufacturing firms having reported information on financial statements and imports by type of good over the period 1997–2006. Our empirical findings shed new light on the micro determinants of firms' choices to import capital goods. Baseline estimation results show that firms with a lower leverage and higher liquidity are more likely to source their capital goods from foreign countries. Quantitatively, a 10 percentage point improvement of the leverage or liquidity ratio increases the probability of importing capital goods by 11 percent to 13 percent respectively. Different robustness tests demonstrate that these results are not driven by omitted variable bias related to changes in firm observable characteristics as well as ownership status. These findings are also robust to alternative specifications dealing with the potential reverse causality issues. JEL codes: F10, F14, D92

Globalization is characterized by a significant increase in world imports of capital goods and intermediate inputs. In developing countries, a number of firms rely on capital goods and inputs from abroad since they are more advanced in terms of technology relative to the domestic goods. While the literature on endogenous growth provides theoretical grounds for the role of foreign technology to enhance economic growth, recent firm-level studies confirm that firm performance depends critically on the access to inputs used

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The authors thank Amélie Maingault for her excellent research assistance. We have benefited from discussions with Jens Arnold, Agnès Bénassy-Quéré, Matthieu Crozet, Joze Damijan, Joep Konings, Tibor Besedes, Ben Li, Kalina Manova, Bruno Merlevede, Sandra Poncet, Romain Ranciere and Elisabeth Sadoulet. We also thank three anonymous referees for their valuable comments to the manuscript and their constructive suggestions. This research was carried out while Antoine Berthou was an economist at CEPII, and does not reflect the views of the Banque de France.

THE WORLD BANK ECONOMIC REVIEW, VOL. 26, NO. 3, pp. 486–513 doi:10.1093/wber/lhs002
Advance Access Publication February 8, 2012

in the production of final goods.[1] Amiti and Konings (2007) find that input-trade liberalization in Indonesia boosts firm productivity up-to 12 percent, while Khandelwal and Topalova (2010) show that it improved firm productivity by 4.8 percent in India. Goldberg and others (2010) demonstrate that input-tariff cuts in India account on average for 31 percent of the new products introduced by domestic firms. Using firm-level data from Argentina, Bas (2011) finds that input tariff reductions are associated with 8 percent increase in the probability of exporting.[2]

While the use of foreign technology is expected to increase firm efficiency, foreign technology adoption is conditioned by the access to financial resources. Importing capital goods implies incurring fixed costs associated with gathering information on foreign markets, establishing linkages with foreign suppliers, learning the new technology or adapting the production process, which requires external financing.[3] In our study, we argue that financial constraints represent an important barrier to firms' imports of capital goods, thereby limiting their opportunities to benefit from technological spillovers of foreign countries.

First, we present a simple theoretical framework to rationalize the main mechanisms through which financial access affects firms' foreign technology choice. In this framework, using foreign capital goods increases the efficiency to produce final goods, but requires paying an additional fixed cost. In the presence of financial constraints wealthier firms have a better access to external finance and are more likely to use the foreign technology by importing capital goods. Second, we test this relationship between firms' financial statements and their decision to import capital goods using a detailed Indian firm-level dataset, Prowess. This data was collected by the Centre for Monitoring the Indian Economy (CMIE) for the period 1997–2006.[4] During this period, about 75 percent of imports of capital goods in India are originated from high income OECD countries.[5] The Prowess data provides information on financial characteristics of firms as well as imports distinguished by type of goods (capital equipment, intermediate goods, or final goods). This information allows us to compute the liquidity and leverage ratios that are used throughout the paper to measure firms' financial factors. These balance sheet statements are expected to

1. Ethier (1982), Markusen (1989), Grossman and Helpman (1991), Rivera-Batiz and Romer (1991) develop theoretical models where foreign technology acts as a driver of economic growth.

2. Kasahara and Rodrigue (2008), Halpern and others (2009), Schor (2004), Kugler and Verhoogen (2009), Bas and Strauss-Kahn (2011) find empirical evidence that the use of foreign inputs enhances firms' total factor productivity, the quality of final goods, and the number of products exported by firms.

3. See Eaton and Kortum (2001), who quantify that about 25 percent of cross-country productivity differences can be explained by the relative price of equipment, half of it being due to barriers to trade in equipment.

4. We focus on the period 1997–2006 in order to maximize the number of firms each year.

5. This number is obtained by using the HS6 product-level bilateral trade BACI dataset from CEPII, combined with the Broad Economic Product Classification provided by the United Nations.

be positively related to the borrowing capacity in the presence of financial constraints. Our empirical strategy disentangles the impact of the liquidity and leverage ratios of the firm on the decision to invest in foreign capital goods.

Our empirical findings confirm the theoretical prediction that those firms that are ex-ante more liquid and less leveraged are more likely to import capital goods. In our baseline estimations, a 10 percentage point decrease in the leverage ratio or an equivalent increase in the liquidity ratio for the average firm increases the likelihood of importing capital goods by 11 percent and by more than 13 percent, respectively. These results are robust to changes in firm observable characteristics such as firm size, capital and skill-intensity. We carry out different tests that demonstrate that our results are not influenced by omitted variable bias related to India's trade liberalization. Our results remain also robust to the exclusion of multinational firms, state-owned firms, and local business groups.

We provide robustness tests to account for the possibility that using foreign capital goods may improve financial factors of firms ex-post. First, we focus on the sample of firms that have started importing foreign capital goods, by considering in the empirical analysis only those firms that did not import capital goods in the previous two to four years. As an additional related test, we include in the baseline specification the past importer status to take into account previous import experience. Second, we use the measure of external dependence proposed by Rajan and Zingales (1998) to test whether financial factors are more important in industries where firms rely more on external finance. These results confirm that the leverage (liquidity) of the firm has a strong negative (positive) effect on the probability of importing foreign equipments.

These results complete the existing evidence regarding the determinants of firm performance in the case of the Indian economy. Many of these works have used the Prowess data over a comparable period of time. Alfaro and Chari (2009) show that although the importance of private firms in the Indian economy has been growing after the economic reforms in the early 1990s, state-owned firms still represent an important share of total production and assets in some sectors. Khandelwal and Topalova (2010) and Goldberg and others (2010, 2009) study the micro-economic effects of trade liberalization in India. Input-tariffs cuts have contributed significantly to firm productivity growth (Khandelwal and Topalova 2010), and also to the ability of firms to introduce new products (Goldberg and others 2010, 2009). On the same line, Arnold and others (2010) find that product market reforms in services sectors have an important effect on firm productivity in the manufacturing sector in India. Evidence regarding the importance of financial factors in explaining Indian firm performance is more scarce: Topalova (2004) shows that although Indian firms improved their financial statements during the period of economic reforms, some firms still face problems servicing their debt obligations.

This work also contribute to the literature in finance that connects financial factors and firms' investment decision. In the presence of information asymmetries, uncollateralized external financing becomes more costly than internal financing, thus introducing a positive relation between a firm's net worth and its investment decision. This link has been empirically observed for a number of countries and surveyed by Hubbard (1998). These studies (Fazzari and others, 1988, Whited 1992, Bond and Meghir 1994, Bond and others 2003) use firms' financial indicators such as the cash flow, the debt to assets ratio, or the liquidity ratio as proxies for firms' net worth or collateral. Most of these papers rely on data for OECD economies and show that wealthier firms invest more. Similar evidence is found for Ecuador (Haramillo and others 1996) and Cote d'Ivoire (Harrison and McMillan 2003). In a different setting, Gorodnichenko and Schnitzer (2010) use a survey of firms in Eastern European countries and show that financial constraints decrease investment in innovation by domestic firms. Aghion and others (2008) alternatively use measures of firms' payment incidents for France to analyze the relation between credit constraints and research and development along the business cycle. We build on this literature and provide new evidence that financial constraints are preventing firms located in India to invest in foreign capital equipment.

Previous empirical studies have investigated whether financial constraints influence the export decisions of firms in the United Kingdom (Greenaway and others 2007) and in several developing economies (Berman and Héricourt 2010). The negative effect of financial constraints on export decisions is observed for the sample of developing countries, but not in the case of the UK. These studies, however, elude the question of financial constraints as a determinant of foreign technology adoption through the imports of foreign capital goods. This is the focus of our study.

In the next section, we present a simple theoretical framework of import decision and credit constraints. Section II describes the data and introduces the estimation strategy. In Section III we present the baseline empirical results. Section IV presents several robustness checks. In the last section, we present our conclusion.

## I. Theoretical Motivation

The aim of this section is to motivate our empirical analysis by introducing a simple model of endogenous adoption of foreign technology. The theory rationalizes the mechanisms through which credit constraints affect firms' decision to upgrade foreign technology. The model is based on firm heterogeneity in terms of productivity à la Melitz (2003). Firms are also characterized by their initial wealth as in Chaney (2005).[6] They use this wealth as a collateral to get

6. Previous models of heterogeneous firms and credit constraints have also used this framework to explain the determinants of export decision. See Manova (2008) and Muûls (2008).

external finance in the presence of financial constraints. The representative household allocates consumption from among the range of domestic goods ($j$) produced using domestic-low technology ($\Omega_d$) and those produced using foreign-high technology ($\Omega_f$).[7]

### *Production*

There is a continuum of firms, which are all different in terms of their initial productivity ($\varphi$). This productivity draw is derived from a common distribution density $g(\varphi)$, after firms decide to enter the market. Each firm produces its own variety in a monopolistic competition market structure. In order to produce the final good ($y$) firms must pay a fixed production cost ($F$) and they need to combine two inputs: labor ($l$) and physical capital ($k$). There are two types of capital equipment goods: domestic ($z$) and imported ($m$).[8] However, only those firms that are productive enough to adopt the foreign technology are able to produce with imported capital goods. Heterogeneous firms in terms of different productivity levels ($\varphi$) are introduced. Technology is represented by the following Cobb-Douglas production function that combines labor ($l$) and capital goods ($k$) to produce output with factor shares $\eta$ and $1-\eta$:

$$y_i = \varphi\gamma_i \left(\frac{k_i}{\eta}\right)^{\eta} \left(\frac{l_i}{1-\eta}\right)^{1-\eta} \qquad i = \{d, f\} \tag{1}$$

The subscript $d$ corresponds to firms producing with domestic technology and $f$ to those producing with foreign technology embodied in imported capital goods. The coefficient $\gamma$ represents the efficiency of imported capital goods relative to domestic ones. Firms using only domestic capital goods ($i = d$) have $\gamma = 1$ and $k_d = z$. Firms producing with foreign technology ($i = f$) combine both types of capital goods by a Cobb-Douglas function: $k_f = \left(\frac{z}{\alpha}\right)^{\alpha}\left(\frac{m}{1-\alpha}\right)^{1-\alpha}$. Firms that decide to adopt foreign technology increase their productivity level by a factor $\gamma > 1$. To access imported capital goods firms must pay a fixed foreign technology acquisition cost ($F_T$). The fixed technology costs are associated with gathering information on foreign markets, learning about the foreign technology and establishing linkages with foreign suppliers of this technology. To keep the model simple, we assume that the fixed cost for domestic capital goods is included in the fixed production cost. These assumptions reflect the fact that for a developing country like India, foreign capital goods

7. The standard CES utility function (C) represents the consumer preferences $C^{\frac{\varphi-1}{\varphi}} = \int_{j\in\Omega_d} C_{dj}^{\frac{\varphi-1}{\varphi}} dj + \int_{j\in\Omega_f} C_{fj}^{\frac{\varphi-1}{\varphi}} dj$. The elasticity of substitution between both types of goods is given by $\phi > 1$. The optimal relative demand functions are: $C_i = \left(\frac{P}{p_i}\right)^{\varphi} C$, where $P$ represents the price index, $C$ the global consumption and $p_i$ the price set by a firm.

8. To keep the model simple, we assume that one unit of domestic capital good is produced using one unit of labor, which is elastically supplied and the wage is normalized to one.

are more advanced in terms of technology relative to domestic goods, but they are also associated with ahigher initial investment.[9]

The first-order condition of monopolistic firms is such that prices reflect a constant mark-up, $\rho = \left(\frac{\varphi-1}{\varphi}\right)$, over marginal costs: $p_i = \frac{c_i}{\rho\varphi}$. $c_i$ represents the per unit cost of production, which is different among firms depending on whether or not they have adopted the foreign imported technology: $c_d = p_z^{\eta}$ and $c_f = \frac{(p_z)^{\alpha\eta}(\tau_m p_z)^{(1-\alpha)\eta}}{\gamma}$. The price of domestic capital good is $p_z$ and the price of imported capital takes into account transport costs and tariffs ($\tau_m$): $p_m = \tau_m p_z$ . The relative per unit cost is equal to $\frac{c_f}{c_d} = \frac{\tau_m^{\eta(1-\alpha)}}{\gamma}$. We assume that the efficiency parameter of imported capital goods ($\gamma$) is higher than its additional variable cost ($\tau_m$) relative to domestic ones.[10]

Combining the demand faced by each firm, $q_i(\varphi) = \left(\frac{P}{p_i(\varphi)}\right)^{\varphi} C$, and the price function, $p_i(\varphi) = \frac{c_i}{\rho A_i}$, revenues are given by $r_i(\varphi) = q_i(\varphi)p_i(\varphi) = \left(\frac{P}{p_i}\right)^{\varphi-1} R$, where $R = PC$ is the aggregate revenue of the industry exogenous to the firm. Firm profit is then $\pi_i = \frac{r_i}{\varphi} - F$, where $F$ is the fixed production cost.

### *Firm's Decision under Perfect Financial Market Conditions*

Only those firms with enough profits to afford the fixed production ($F$) cost will be able to survive and produce. Profits of the marginal firm are equal to zero. The zero cutoff condition is given by: $\frac{r_d(\varphi_d^*)}{\varphi} = F$. The value $\varphi_d^*$ represents the productivity cutoff to produce in the domestic market.

Once a firm has received its productivity draw, it may also decide to adopt a foreign technology to reduce its marginal costs on the basis of its profitability. Only a subset of the most productive firms will switch to foreign technology since the fixed importing cost is higher than the fixed production cost. The condition to acquire the foreign technology is given by: $\pi_f(\varphi_f*) = 0$. The value $\varphi_f^*$ represents the productivity cutoff to import foreign goods: $\frac{r_f(\varphi_f*)}{\varphi} = F + F_T$.

### *Firm's Decision under Imperfect Financial Market Conditions*

Importing technology embodied in foreign capital goods implies a sunk cost of investment ($F_T$). In the presence of financial constraints, firms cannot use their future expected revenues $r_f(\varphi)$ to get external finance ex-ante. In this context,

9. Using product-level imports for India (from the BACI data), we find that about 75 percent of imports of capital goods in India during the 1997-2006 period are sourced from high income OECD economies. This confirms that capital goods are mostly imported from countries that are more advanced in terms of technology.

10. Note that the relative per unit cost is a function of tariffs on capital goods and the efficiency parameter. A reduction of import tariffs on capital goods reduces the relative per unit costs of foreign technology. Similar results hold in the case of an increase in the efficiency parameter of foreign technology ($\gamma$).

firms can make use of two sources of cash to finance the extra fixed cost $F_T$. First, firms are able to borrow up to $r_d(\varphi)$, which corresponds to the sales of the final good for firms using the domestic technology. Financial intermediaries have perfect information about firms' profitability in the case where they produce with the domestic technology, and will be willing to provide cash in advance up to $r_d(\varphi)$. Second, firms can use their exogenous wealth $A$ as a collateral to borrow additional liquidity $\lambda A$, where $\lambda$ corresponds to the credit multiplier and is inversely related to the extent of credit constraints in the economy, as in Aghion and others (1999).

We assume that the productivity and the exogenous collateral distributions are independent. The total liquidity that is available to the firm is equal to $\pi_d(\varphi) + \lambda A$. Importing foreign capital goods relates to the liquidity constraint condition (LCC) given by

$$\pi_d(\varphi) + \lambda A \geq F_T \tag{2}$$

We can define the lowest productivity level below which firms with an exogenous wealth $A$, $\overline{\varphi}(A)$, are liquidity constrained. $\overline{\varphi}(A)$ is given by $\pi_d(\overline{\varphi}(A)) + \lambda A = F_T$. Firms that face liquidity constraints have a productivity level below $\overline{\varphi}(A)$. They are not able to import capital goods due to financial constraints.

Following Chaney (2005), we set $\varphi_d^* = g(F)$ and use the zero cutoff profit conditions and the liquidity constraint condition, equation (2), to define two productivity cutoffs[11]:

$$\varphi_f^* = \left(\frac{F + F_T}{F}\right)^{\frac{1}{\varphi - 1}} \left(\frac{\tau_m^{\eta(1-\alpha)}}{\gamma}\right) \varphi_d^*; \overline{\varphi}(A) = \left(\frac{F_T + F - \lambda A}{F}\right)^{\frac{1}{\varphi - 1}} \varphi_d^*$$

All the firms with a productivity level between $max\{\varphi_f^*, \overline{\varphi}(A)\} > \varphi > \varphi_d^*$ produce with domestic technology. Only those firms with a productivity $\varphi > max\{\varphi_f^*, \overline{\varphi}(A)\}$ are able to finance the fixed technological cost of importing and thus they use both types of capital goods.

Which are the firms that face credit constraints to import capital goods? There is a subset of firms that are profitable enough to be viable importers, but prevented from accessing foreign capital goods because of liquidity constraints. Firms that have a productivity level $\varphi$ below $\overline{\varphi}(A)$ are liquidity constrained, and are not able to source imported inputs from abroad no matter how profitable they could be by importing more efficient foreign capital goods. All firms with a productivity level above $\varphi_f^*$ could profitably import, if they had sufficient liquidity. Hence, there is a subset of liquidity constrained firms with a

11. For tractability purposes we assume, as in Chaney (2005), that the price index only depends on local firms' prices. In the Appendix we define the price index approximation.

productivity level above $\varphi_f*$, but below $\overline{\varphi}(A)$. In the appendix we demonstrate the existence of liquidity constrained importers.

### *Testable Prediction*

Firms' import decision is determined by domestic revenues and by the exogenous collateral. These two sources of finance allow firms to afford the fixed technology cost of importing. Using equation (2) we can define the probability that a firm $i$ imports capital goods at time $t$:

$$(3) \qquad Pr(\pi_d+\lambda A-F_T>0)=Pr(\varphi^{\phi-1}\frac{1}{\varphi}\left(\frac{\rho}{c_d}\right)^{\phi-1}RP^{\varphi-1}+\lambda A-F-F_T)>0$$

The probability of importing is directly determined by the two sources of finance. On the one hand, in this monopolistic competition framework with heterogeneous firms, the most productive firms set lower prices and have larger domestic revenues to finance the fixed importing cost. On the other hand the higher the exogenous collateral, the greater the financial resources of the firm to afford the fixed foreign technology cost.

**Testable prediction:** *In the presence of financial constraints, wealthier firms are more likely to import foreign equipment and upgrade foreign technology.*

## II. Data and Empirical Methodology

In the empirical part of the paper, we present a test of the prediction that is derived from the theoretical model. The empirical strategy is based on the estimation of an equation where the import decision of a firm is explained by its financial factors such as the liquidity or leverage ratios. Estimations are performed using information for a sample of 3,500 Indian listed companies (Prowess data) over the period 1997–2006.

### *Data*

The Indian firm-level dataset is compiled from the Prowess database by the Centre for Monitoring the Indian Economy (CMIE). This database contains information from the income statements and balance sheets of listed companies comprising more than 70 percent of the economic activity in the organized industrial sector of India. Collectively, the companies covered in Prowess account for 75 percent of all corporate taxes collected by the Government of India. The database is thus representative of large and medium-sized Indian firms.[12]

The dataset covers the period 1997–2006 and the information varies by year. It provides quantitative information on sales, capital stock, income from

12. Since firms are under no legal obligation to report to the data collecting agency, the Prowess data do not allow properly identifying entry and exit of firms.

financial and non financial sources, consumption of raw material and energy, compensation to employees and ownership group.

The Prowess database provides detailed information on imports by category of goods: finished goods, intermediate goods and capital goods. In our main empirical specification, we use imports of capital goods (machinery and equipment) as a proxy of foreign technology. Although we are not able to test directly for the impact of imported capital goods depending on the countryof origin (e.g developed vs. developing countries), one realistic assumption for the case of a developing country like India is that most imports of capital goods are sourced from more advanced economies.

The dataset contains also comprehensive information about the financial statements of firms such as total assets, current assets, total debt and liabilities. We construct two financial variables: (1) the leverage ratio and (2) the liquidity ratio. Leverage is the ratio of borrowing over total assets and liquidity ratio is measured by the ratio of current assets over total liabilities of the firm.

Summary statistics are provided in the Appendix Table. Our sample contains information for 3,500 firms on average each year in organized industrial activities from manufacturing sector for the period 1997–2006. The total number of observations firm-year pairs is 34,735. In order to keep a constant sample throughout the paper and to establish the stability of the point estimates, we keep firms that report information on all the firm and industry level control variables. On average 32 percent of firms import capital goods in a year and 62 percent of firms import intermediate goods. Firms are categorized by industry according to the 4-digit 1998 NIC code (116 industries). Most of the firms in our sample are private-owned firms (81 percent). 39 percent of firms are largest firms belonging to local business groups and only 7 percent are multinational firms. Although our panel of firms is unbalanced, there is no statistical difference in the average firm characteristics presented in the Appendix Table between the initial year (1997) and the final year (2006) of our sample.

Two industry-level controls are included in the empirical specifications to control for competitive pressures. Since the period under analysis covers trade liberalization process started in the early 1990s, we introduce effectively applied output tariffs (collected rates) at the 4-digit NIC code level obtained from the World Bank (WITS).[13] In order to capture domestic competition we use an Herfindhal index computed at the 2-digit NIC industry level. The Herfindahl index measures the concentration of sales for each industry within 2-digit industry categories.

13. Tariffs data provided by WITS are at the industry level ISIC rev 2 4-digit level. We use correspondence tables to convert tariffs into ISIC rev 3.1. that match almost perfectly with NIC 4-digit classification.

*Empirical Methodology*

A unique feature of our database is that firms report imports by type of products: finished goods, capital goods and intermediate goods. Keeping in line with our theoretical framework, the baseline econometric analysis is therefore performed on capital goods. The rationale for this is that importing capital goods implies incurring fixed costs associated with gathering information on foreign markets, establishing linkages with foreign suppliers, and learning about the new foreign technology. In the case of a developing economy like India, firms' importing capital goods decision can be interpreted as foreign technology adoption.

We estimate a linear probability model, where the decision of a firm $i$ to import capital goods from abroad in year $t$ is explained by its financial factors and additional control variables. Our preferred specification estimates the following equation using the following model:

$$\text{(I)} \quad Importer_{(is)(t)} = \beta_0 + \beta_1 Finance_{(i)(t-1)} + \beta_2 Z_{(i)(t-1)} + \beta_3 X_{(s)(t)} + \upsilon_t + \mu_i + \nu_{it}$$

where $Importer_{(is)(t)}$ is a dummy variable equal to one if the firm $i$ producing in 4-digit NIC code industry $s$, has positive imports of capital goods in year $t$ and zero otherwise. Finance measures firms' financial statements. The financial variables of interest that we use to proxy the financial factors (the empirical counterpart of the exogenous collateral in the model) are the liquidity ratio and the leverage ratio. The liquidity ratio is the share of firms' current assets over total liabilities. The liquidity ratio is related to the firm's ability to pay off its short-terms debts obligations. The leverage ratio indicates the proportion of borrowing over total assets of the firm. A higher level of leverage decreases, everything else equals, the net worth of the firm. According to the model's predictions, an improvement of the firm's wealth (measured by a higher liquidity ratio or a lower leverage), increases the access to external finance. Since the access to external finance determines the decision to source capital goods from abroad, we expect a positive coefficient for the liquidity ratio and a negative coefficient for the leverage ratio.

Unobserved firm characteristics could lead to inconsistent estimates. For this reason, all estimations include firm-level fixed effects ($\mu_i$). The introduction of firm fixed effects is important to control for unobservable firm characteristics that do not vary over time. Our specification shows how improvements in firms' financial factors over time affects firms' decisions to import.

Estimates also include controls for firm and industry characteristics that vary over time. First, we introduce a set of firm level variables ($Z_{(i)(t-1)}$) expressed in logarithm in year (t-1) that control for observable firm characteristics that

mightaffect firms' import choices. We use the value added to measure firms' size (the number of employees is not available in the Prowess data). In alternative specifications, we use firm total factor productivity (TFP) computed using Levinsohn and Petrin (2003) methodology, by relying on wage bill rather than labor.[14] Since larger firms tend to be more skill intensive and to pay higher wages, we also control for the wage-bill. As we focus on the import decision of capital equipment goods, we also include the past capital intensity of the firm measured as total capital stock over the wage-bill. We expect a positive coefficient of capital intensity. The more firms rely on capital goods in the production process, the more likely they are to import capital goods from abroad.

Second, we introduce a set of industry level variables $X_{(st)}$ that control for observable industry characteristics that might affect firms' import choices of capital goods. Several studies show that competition might enhance firm efficiency and create incentives for firms to invest in R&D activities and in foreign technology (Aghion and others 2005). We construct a Herfindahl index at the 2-digit NIC industry level to control for competition in the domestic market. We also control for foreign competition pressures associated with the trade liberalization process experienced by India at the beginning of the 1990s, by including the average effective applied import tariffs for final goods at the 4-digit NIC industry level.

All explanatory variables are expressed in logarithm and they are lagged by one period. We also introduce year fixed effects to control for macroeconomic shocks ($\upsilon_t$). This is an important control since India was affected by the Asian financial crisis in 1997-1998. The introduction of year fixed effects allows us to control for the effects of this crisis on both financial statements of firms and their import decisions. In the last section we deal explicitly with the potential reversecausality between financial factors and firms' investment decision in imported capital goods.

## III. Estimation Results

The estimation results of the import decision equation are presented in this third section of the article. All estimations are performed using the above mentioned firm-level data for India (Prowess). The testable prediction from the model states that "*in the presence of financial constraints, wealthier firms are more likely to import foreign equipment and upgrade foreign technology.*"

### *Baseline Results*

*Are Financial Factors Related to Firms' Decision of Sourcing Foreign Capital Goods?* Estimation results of the linear probability model (equation I) are provided in Table (1). The estimation includes firm and year fixed effects. The effect of the leverage ratio lagged of one period on firms' decision to import

14. Because our dataset does not contain the number of employees, we can not rely on the extension of Olley and Pakes (1996) and Levinsohn and Petrin (2003) developed by Ackerberg and others (2007) to estimate total factor productivity.

TABLE 1. Access to External Finance and Import of Capital Goods Decision (1997–2006)

| | Dummy equal one if firm(i) imports capital goods in t | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Dependent variable | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Leverage(i)(t−1) | −0.156*** | −0.132*** | −0.114*** | −0.114*** | | | | |
| | (0.016) | (0.016) | (0.016) | (0.016) | | | | |
| Liquidity ratio (i)(t−1) | | | | | 0.166*** | 0.109*** | 0.126*** | 0.126*** |
| | | | | | (0.026) | (0.026) | (0.026) | (0.026) |
| Log value added(i)(t−1) | | 0.029*** | 0.016*** | 0.016*** | | 0.030*** | 0.015*** | 0.015*** |
| | | (0.003) | (0.003) | (0.003) | | (0.003) | (0.003) | (0.003) |
| Capital intensity(i)(t−1) | | | 0.036*** | 0.036*** | | | 0.044*** | 0.044*** |
| | | | (0.005) | (0.005) | | | (0.005) | (0.005) |
| Log wage(i)(t−1) | | | 0.055*** | 0.055*** | | | 0.060*** | 0.060*** |
| | | | (0.007) | (0.007) | | | (0.006) | (0.006) |
| Output tariffs(s)(t−1) | | | | 0.026 | | | | 0.020 |
| | | | | (0.036) | | | | (0.036) |
| Herfindahl index(s)(t−1) | | | | 0.001 | | | | 0.000 |
| | | | | (0.003) | | | | (0.003) |
| Firm fixed effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 34,735 | 34,735 | 34,735 | 34,735 | 34,735 | 34,735 | 34,735 | 34,735 |
| $R^2$ | 0.016 | 0.021 | 0.025 | 0.025 | 0.013 | 0.018 | 0.024 | 0.024 |

*Notes*: The table reports estimates from linear probability estimations of Equation (I). The dependent variable is a dummy equal to one if the firm *i* imports capital goods in *t*. All explanatory variables are lag of one period. Firms' capital intensity is the ratio of capital over the wage-bill. The financial variables that we use are leverage(i) and liquidity ratio(i). Leverage(i) is the ratio of borrowings over total assets and liquidity ratio(i) is the ratio of current assets over total liabilities of the firm. The output tariffs are at the 4-digit NIC industry level and the Herfindahl index is at the 2-digit NIC industry level. In parentheses we report heteroskedasticity-robust standards errors. ***,**, and * indicate significance at the 1, 5 and 10 percent levels respectively.

*Source*: Authors' estimations using Prowess data.

capital goods is negative and significant at the 1 percent level: firms having a higher ratio of borrowing over total assets are less likely to import their capital goods from the foreign market (column 1). Next, we include firm level variables to control for firm characteristics that vary over time and that could be picking up the effect of firms' financial factors. As expected, bigger firms are more likely to import capital goods from abroad (column 2). We next introduce two additional firm-level controls: capital intensity and wage-bill in column (3). More capital and skill-intensive firms (paying higher wages) have a higher probability of upgrading foreign technology. The coefficient of interest remains robust and also stable when we control for firm observable characteristics.

Moreover, firms producing in industries growing faster might be less credit constrained. If this is the case, changes in firms' financial statements might be capturing the effects of industry characteristics. We address this issue by introducing in column (4) additional controls at the industry level. Concerning the time variant industry characteristics, both coefficients of output tariff and Herfindahl index are not significant. More importantly, the negative effect of leverage on firms' foreign technology decision remains unchanged and robust to the inclusion of this set of industry controls. The estimated coefficients imply that a 10 percentage point fall in the leverage ratio leads to an 11 percent to 15 percent increase in the likelihood of importing capital goods for the average firm.

We test how a firm's liquidity ratio affects its probability to upgrade foreign technology embodied in imported capital goods in columns (5) to (8). The lagged liquidity ratio is subsequently introduced. The coefficient of the liquidity ratio is positive and significant at the 1 percent level, indicating that more liquid firms are more likely to import their capital goods from abroad (column 5). Results on the liquidity ratio remain robust to the inclusion of firm size, capital and skill-intensity in column (6) and (7) and also to the inclusion of industry-level characteristics in column (8). Moreover, the point estimates of the liquidity ratio are stable under different specifications. The estimated coefficients imply that a 10 percentage point increase in the liquidity ratio leads to a 13 percent to 17 percent increase in the likelihood of importing capital goods for the average firm.

Based on these estimations, we use the standard deviation of the leverage and liquidity ratios within firms to have a quantification of their economic impact on the import decision of capital goods by the average firm. We find that a one standard deviation reduction of the leverage ratio, corresponding to a decrease of leverage of the average firm by 32 percent, increases the probability of sourcing capital goods from abroad by 3.6 percent. A one standard deviation increase of the liquidity ratio, corresponding to an increase of the liquidity of the average firm by 17 percent, improves the probability of

importing capital goods by 2.1 percent. These results confirm that firms financial factors are important determinants of the decision to import capital goods.[15]

*Are Imports of Intermediate Inputs also Affected by Financial Constraints ?* In order to disentangle the mechanisms through which financial access affect firms' foreign technology upgrading, we consider separately the special case of intermediate goods imports. This test allows us to determine whether financial factors affect differently imports of intermediate goods relative to capital goods.

First, we estimate equation (I) for the subsample of firms using foreign intermediate goods. Results are reported in Table 2. Once we control for firm and industry characteristics, the leverage ratio has a negative but not significant effect on firms' import decision to use foreign intermediate goods (column (1)). Next, we investigate whether the decision to import intermediate goods is associated to the decision of upgrading foreign technology embodied in capital goods. If such a complementarity exists, the effect of financial factors on imports of intermediates may arise because of its effect through capital goods. To isolate the effect of capital goods decision from foreign input decision, we restrict our sample to firms that have never imported capital goods in the period (columns 2). The results are similar to the previous ones. These findings indicate that credit constraints are not crucial for importing foreign inputs.

In the next columns, we reproduce the same specifications using the liquidity ratio. The effect is positive and significant in both cases for the full sample (column 3) and the sample of firms that have never imported capital goods in the period (column 4). The higher the current assets over total liabilities ratio of the firm, the more likely firms are to import their inputs from abroad.

Given that firms tend to import intermediates on a regular basis, the positive effect of the liquidity of the firm may not be specifically related to the decision to start importing intermediates. Indeed, 62 percent of firms in our sample report importing intermediates, whereas 32 percent import capital goods (Appendix Table). This evidence suggests that firms find it more difficult to import capital goods than intermediates due to a larger fixed cost. In order to explore the effect of financial health of firms on their decision to start sourcing inputs from abroad, we carry out an additional test focusing on firms that have not imported intermediate goods in the previous two years. These results are reported in columns (5) and (6). As can be seen when we focus on the decision to start importing intermediate inputs, not only the leverage ratio is not significant but now the liquidity ratio is no longer significant. Firm size, capital and

15. These results are also robust to alternative econometric specifications, available upon request, such as Conditional Logit estimations with firm fixed effects. We only report the linear probability model estimations since the parameters are easier to interpret and their stability easier to establish.

TABLE 2. Decision to import intermediates

| | Dummy equal one if firm(i) imports intermediates in t | | | | | |
|---|---|---|---|---|---|---|
| | | | | | (5) | (6) |
| Dependent variable | (1) | (2) | (3) | (4) | Firms that have not imported inputs in the past 2 years | |
| Leverage(i)(t-1) | −0.025 | −0.024 | | | −0.008 | |
| | (0.017) | (0.025) | | | (0.021) | |
| Liquidity ratio (i)(t−1) | | | 0.069*** | 0.124*** | | 0.003 |
| | | | (0.026) | (0.034) | | (0.034) |
| Log value added(i)(t−1) | 0.021*** | 0.018*** | 0.020*** | 0.016*** | 0.015*** | 0.015*** |
| | (0.003) | (0.004) | (0.003) | (0.004) | (0.003) | (0.003) |
| Capital intensity(i)(t−1) | 0.042*** | 0.037*** | 0.045*** | 0.039*** | 0.041*** | 0.041*** |
| | (0.005) | (0.007) | (0.005) | (0.007) | (0.007) | (0.007) |
| Log wage(i)(t−1) | 0.086*** | 0.073*** | 0.087*** | 0.073*** | 0.085*** | 0.086*** |
| | (0.007) | (0.010) | (0.007) | (0.009) | (0.009) | (0.009) |
| Output tariffs(s)(t−1) | 0.039 | 0.095* | 0.038 | 0.092* | −0.012 | −0.012 |
| | (0.042) | (0.051) | (0.042) | (0.051) | (0.048) | (0.048) |
| Herfindhal index(s)(t−1) | 0.003 | 0.005 | 0.003 | 0.005 | 0.002 | 0.002 |
| | (0.002) | (0.004) | (0.002) | (0.004) | (0.004) | (0.004) |
| Firm fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 34,735 | 18,477 | 34,735 | 18,477 | 16,190 | 16,190 |
| $R^2$ | 0.033 | 0.027 | 0.034 | 0.028 | 0.036 | 0.036 |

*Notes*: The table reports estimates from linear probability estimations of Equation (I). The dependent variable is a dummy equal to one if the firm *i* imports capital goods in *t*. All explanatory variables are lag of one period. Firms' capital intensity is the ratio of capital over the wage-bill. The financial variables that we use are leverage(i) and liquidity ratio(i). Leverage(i) is the ratio of borrowings over total assets and liquidity ratio(i) is the ratio of current assets over total liabilities of the firm. The output tariffs are at the 4-digit NIC industry level and the Herfindahl index is at the 2-digit NIC industry level. In parentheses we report heteroskedasticity-robust standards errors. *** , ** and * indicate significance at the 1, 5 and 10 percent levels respectively.

*Source*: Authors' estimations using Prowess data.

skill intensity are positive, significant and more over their coefficients remain stable relative to the previous estimations.[16]

These results suggest that credit constraints are more binding for importing capital goods than intermediate goods. One of the main differences between the decision of importing capital goods and the decision of using foreign intermediate inputsis related to the nature of this choice and the way these production factors enter into the production process. While intermediate goods are variable inputs that firms have to buy on a regular basis, capital goods are fixed investments (machines and capital equipment) used in the production process that are not renewed every year. As discussed above, the fact that less firms import capital goods than intermediates suggests that the barriers to start importing are larger in the case of capital goods. Moreover, the evidence that most foreign capital goods in India are sourced from developed economies reinforces this idea that importing capital goods is associated with a higher fixed cost. This may be due to a larger up-front cost in the case of foreign technology upgrading, and also to additional sunk costs related to learning about foreign technologies, finding foreign suppliers, and the adaptation period of the production process. In the theoretical part of the paper, the model shows that the larger thefixed cost, the more binding are credit constraints. This reasonably explains why firms' financial factors play a higher role for starting importing capital goods than intermediates.

*Financial Constraints Versus Tariffs on Capital Goods*. In a context of trade liberalization, firms could upgrade foreign technology easily thanks to the removal of import barriers on capital equipment goods. Thereby, the effect of better financial access on foreign technology adoption might just be picking up the effects of lower tariffs on capital equipment goods.

In the previous specifications, we include tariffs on final goods at the 4 digit industry level to capture the impact of India's trade liberalization that took place at the beginning of the nineties. We now explore the robustness of our results when we take into account tariff reductions on capital goods over the period. The average yearly reduction of import tariffs on machinery and equipment goods is 2.3 percent during the period. Since trade liberalization in India in the early 90s consisted in a unilateral trade reform, we use effectively applied tariff rates at the HS6 product level set by India to the rest of the world for the period 1997 to 2006. This is possible thanks to the match of the firm level data with the average import tariff data of products corresponding to HS6 codes between 840000 and 859999 (machinery and mechanical appliances) from the World Bank (WITS). The results including the variation of the average import tariffs on capital equipment goods are presented in Table 3.

As expected, a reduction of import barriers on capital goods increases the likelihood of firms to upgrade foreign technology. Most importantly, our

16. The results are similar when we use as an alternative specification, available upon request, the previous import status of intermediate goods as a control variable relying on the full sample of firms.

TABLE 3. Trade liberalization and imports of capital goods

| | Dummy equal one if firm(i) imports of capital goods | | | | |
|---|---|---|---|---|---|
| Dependent variable | (1) | (2) | (3) | (4) | (5) |
| Δ tariffs capital goods | −0.321*** | −0.295*** | −0.309*** | −0.297*** | −0.311*** |
| | (0.052) | (0.051) | (0.050) | (0.052) | (0.051) |
| Leverage(i)(t−1) | | −0.133*** | −0.133*** | | |
| | | (0.016) | (0.016) | | |
| Liquidity ratio (i)(t−1) | | | | 0.162*** | 0.161*** |
| | | | | (0.026) | (0.026) |
| Log value added(i)(t−1) | | 0.019*** | 0.019*** | 0.018*** | 0.018*** |
| | | (0.003) | (0.003) | (0.003) | (0.003) |
| Capital intensity(i)(t−1) | | 0.042*** | 0.042*** | 0.052*** | 0.052*** |
| | | (0.005) | (0.005) | (0.005) | (0.005) |
| Log wage(i)(t−1) | | 0.046*** | 0.047*** | 0.052*** | 0.053*** |
| | | (0.007) | (0.007) | (0.007) | (0.007) |
| Output tariffs(s)(t−1) | | | 0.027 | | 0.027 |
| | | | (0.029) | | (0.029) |
| Herfindahl index(s)(t−1) | | | 0.001 | | 0.001 |
| | | | (0.003) | | (0.003) |
| Firm fixed effects | Yes | Yes | Yes | Yes | Yes |
| Observations | 34,735 | 34,735 | 34,735 | 34,735 | 34,735 |
| $R^2$ | 0.001 | 0.017 | 0.017 | 0.015 | 0.015 |

*Notes*: The table reports estimates from linear probability estimations of Equation (I). The dependent variable is a dummy equal to one if the firm *i* imports capital goods in *t*. All explanatory variables are lag of one period. Firms' capital intensity is the ratio of capital over the wage-bill. The financial variables that we use are leverage(i) and liquidity ratio(i). Leverage(i) is the ratio of borrowings over total assets and liquidity ratio(i) is the ratio of current assets over total liabilities of the firm. The output tariffs are at the 4-digit NIC industry level and the Herfindahl index is at the 2-digit NIC industry level. In parentheses we report heteroskedasticity-robust standards errors. *** , ** and * indicate significance at the 1, 5 and 10 percent levels respectively.

*Source*: Authors' estimations using Prowess data.

results remain unaffected by the introduction of import tariffs on capital goods. Once we take into account directly the effects of trade reform, a reduction of the leverage ratio and an increase in the liquidity of the firm have both a positive impact on the probability of adopting a foreign technology. Comparing the point estimates of the coefficients of the leverage and liquidity ratios with those reported in baseline estimations (Table 1) reveals that the coefficients on the variables of interest remain stable. Estimation results in Table 3 show that a 10 percentage point reduction of the leverage ratio increases the probability of upgrading foreign technology by 13 percent. Similarly, a 10 percentage point increase in the liquidity ratio is associated with an increase in the likelihood of importing capital goods of 16 percent in this specification. These effects are very comparable to the baseline specification.

*Additional firm characteristics*. This section presents alternative sensitivity tests related to other firm-characteristics that might be driving our results.

In the previous estimations, firm controls include the wage bill, value added and capital intensity. Although value added is positively correlated with firm productivity, it is a raw measure for efficiency gains. As an additional test we use firm total factor productivity measured by Levinsohn and Petrin (2003) methodology, using wage bill as a proxy for firms' labor utilization. Our findings show that most productive firms have a higher probability of upgrading foreign technology (columns (1) and (2) of Table (4)). The inclusion of firms' total factor productivity does not modify the results as compared with the baseline specification. The point estimates suggest that a reduction of leverage ratio of 10 percentage points or an analogous increase in the liquidity ratio increases the probability of sourcing capital goods from abroad by 14 and 15 percent, respectively.

Next we address whether firms' ownership is driving our results. Previous studies on multinational firms show that foreign firms in developing countries tend to use more advanced technologies and be more productive relative to domestic firms (Javorcik 2004). One reason may be that foreign multinationals have a better access to finance, and are more likely to source capital goods from abroad. Javorcik and Spatareanu (2009) also show that the suppliers of multinationals are less credit constrained.[17] In general, the fact that foreign companies are wealthier firms and use more advanced technology could potentially explain our results. In order to address this issue, we exclude from our sample multinational firms in columns (3) and (4) of Table (4). Our coefficients of interest on financial variables remain robust and stable when we restrict the sample to domestic firms, implying that financial factors matter when considering the sample of domestic firms.[18]

17. Manova and others (2009) also show that in the case of China, multinationals have a better propensity to export in sectors where firms are typically more financially vulnerable.

18. We thank anonymous referees for having pointed out this channel.

TABLE 4. Additional firm characteristics

| | dummy = 1 if firm imports capital goods$_{it}$ = 1 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Controlling for TFP | | Subsample Non-MNF | | Subsample Private firms | | Subsample Non-Business groups | |
| Dependent variable | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Leverage(i)(t-1) | −0.141*** | | −0.119*** | | −0.118*** | | −0.120*** | |
| | (0.018) | | (0.017) | | (0.017) | | (0.020) | |
| Liquidity ratio (i)(t−1) | | 0.148*** | | 0.132*** | | 0.119*** | | 0.094*** |
| | | (0.028) | | (0.027) | | (0.029) | | (0.030) |
| TFP(i)(t−1) | 0.026*** | 0.028*** | | | | | | |
| | (0.009) | (0.009) | | | | | | |
| Log value added(i)(t−1) | | | 0.016*** | 0.015*** | 0.015*** | 0.015*** | 0.011*** | 0.011*** |
| | | | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) |
| Capital intensity(i)(t−1) | 0.038*** | 0.048*** | 0.035*** | 0.043*** | 0.034*** | 0.042*** | 0.032*** | 0.040*** |
| | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.006) | (0.006) |
| Log wage(i)(t−1) | 0.082*** | 0.087*** | 0.052*** | 0.057*** | 0.051*** | 0.056*** | 0.058*** | 0.063*** |
| | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) | (0.008) | (0.008) |
| Output tariffs(s)(t−1) | 0.025 | 0.018 | 0.042 | 0.037 | 0.012 | 0.006 | −0.006 | −0.011 |
| | (0.038) | (0.038) | (0.037) | (0.038) | (0.040) | (0.040) | (0.044) | (0.044) |
| Herfindahl index(s)(t−1) | 0.002 | 0.002 | 0.001 | 0.001 | 0.002 | 0.001 | 0.002 | 0.001 |
| | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) |
| Firm fixed effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 32,936 | 32,936 | 32,275 | 32,275 | 28,301 | 28,301 | 21,321 | 21,321 |
| $R^2$ | 0.026 | 0.024 | 0.025 | 0.023 | 0.023 | 0.021 | 0.024 | 0.021 |

*Notes*: The table reports estimates from linear probability estimations of Equation (I). The dependent variable is a dummy equal to one if the firm *i* imports capital goods in *t*. All explanatory variables are lag of one period. Firms' capital intensity is the ratio of capital over the wage-bill. The financial variables that we use are leverage(i) and liquidity ratio(i). Leverage(i) is the ratio of borrowings over total assets and liquidity ratio(i) is the ratio of current assets over total liabilities of the firm. The output tariffs are at the 4-digit NIC industry level and the Herfindahl index is at the 2-digit NIC industry level. In parentheses we report heteroskedasticity-robust standards errors. *** ,** , and * indicate significance at the 1, 5 and 10 percent levels respectively.

*Source*: Authors' estimations using Prowess data.

Besides, previous works using the same firm-level dataset have emphasized the role of state-owned firms in India (Topalova 2004, Alfaro and Chari 2009). State-owned firms might benefit from special access to credit from State-owed banks. In order to address this issue, we restrict the sample to private firms (columns 5 and 6). The point estimates of leverage and liquidity ratio remain robust and stable. Finally, the largest domestic firms belonging to the Indian business groups in India could also benefit from a better access to finance. Our results are robust to the exclusion of these groups from the estimation sample (columns 7 and 8). These tests confirm that different firm ownership characteristics are not picking up our results.

### *Robustness Analysis*

One of the challenges when investigating the relationship between the access to external finance and firms' technology adoption decisions is the potential reverse causality. In the medium or long run, importing foreign capital goods is expected to increase the profitability of the firm and therefore its financial statements (reduce the leverage or increase the liquidity ratio). This mechanism would result in a positive bias in the relation between imports and financial factors of the firm. In the short run, the cost associated with the imports of a new technology is expected to increase the leverage of the firm, or decrease its liquidity. This mechanism would result in a negative bias. We perform two robustness checks to address this potential reverse causality issue.[19]

*Decision to Start Importing Capital Goods.* We explore the robustness of our baseline specification when we restrict our sample to firms that have not imported capital goods in the previous years. We investigate whether an increase in the access to external finance is associated with the decision to start sourcing capital goods from abroad. By focusing on firms that have not imported capital goods in the previous period, this specification deals with the possible endogeneity issues between financial access and foreign technology adoption that the previous specifications might suffer.

The estimates from linear probability estimations of equation (I) with firm and year fixed effects for the restricted sample of firms that have not imported capital goods in the last two years are reported in columns (1) to (2) of Table 5. In this case, the coefficients of the financial variables are smaller compared to the baseline specification due to the reduction of the sample size from 34,735 observations to almost 21,000. The point estimates indicate that a 10 percentage point reduction of the leverage ratio increases the probability to

19. In estimations available upon request, we also carry out a two-stage least square (2SLS) linear probability model where the liquidity ratio, the leverage ratio, and the capital intensity are instrumented with lagged values (three to four years) and the mean capital intensity of the industry. The results remain robust for the leverage ratio under the instrumental variable specification, while the liquidity ratio is no longer significant. However, this last result should be interpretedwith caution, given the reduction of the sample size due to the use of lagged instruments. This restriction leaves us with half of the sample under the IV relative to the baseline estimations.

TABLE 5. Decision to start importing capital goods

| | dummy = 1 if firm imports capital goods$_{it}$ = 1 | | | |
|---|---|---|---|---|
| | Firms that do not import capital goods in the previous | | | |
| | Two years | | Four years | |
| Dependent variable | (1) | (2) | (3) | (4) |
| Leverage(i)(t−1) | −0.058*** | | −0.052*** | |
| | (0.012) | | (0.012) | |
| Liquidity ratio (i)(t−1) | | 0.050** | | 0.022 |
| | | (0.021) | | (0.020) |
| Log value added(i)(t−1) | 0.004* | 0.004* | 0.000 | 0.001 |
| | (0.002) | (0.002) | (0.002) | (0.002) |
| Capital intensity(i)(t−1) | 0.012*** | 0.016*** | 0.013*** | 0.017*** |
| | (0.004) | (0.004) | (0.004) | (0.003) |
| Log wage(i)(t−1) | 0.029*** | 0.032*** | 0.038*** | 0.040*** |
| | (0.006) | (0.005) | (0.005) | (0.005) |
| Output tariffs(s)(t−1) | −0.055* | −0.058** | −0.069*** | −0.072*** |
| | (0.028) | (0.029) | (0.027) | (0.027) |
| Herfindahl index(s)(t−1) | −0.002 | −0.003 | −0.001 | −0.001 |
| | (0.002) | (0.002) | (0.002) | (0.002) |
| Firm fixed effects | Yes | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes | Yes |
| Observations | 20,993 | 20,993 | 18,600 | 18,600 |
| $R^2$ | 0.014 | 0.013 | 0.024 | 0.022 |

*Notes*: The dependent variable is a dummy equal to one if the firm *i* imports capital goods in *t* and have not imported in the previous two years (columns 1 and 2) or four years (columns 3 and 4). We use the same control variables as in Table 1. ***, **, and * indicate significance at the 1, 5 and 10 percent levels respectively.

*Source*: Authors' estimations using Prowess data.

start importing capital goods by 6 percent (column (1)). Similarly, a 10 percentage point increase in the amount of liquidity increases the probability to upgrade foreign technology for the first time by 5 percent (column (2)). When we restrict our sample to firms that have not imported capital goods in the last four years, the effect of the leverage ratio is still negative, significant and stable, while the liquidity ratio is no longer significant (columns (3) and (4)).

As an alternative test we include the past import experience in the baseline estimations. In this case, we keep the full sample of firms and include the lagged importer status of the firm measured by a dummy variable that is equal to one if the firm has been an importer of capital goods in the previous years. This specification allows us to take into account the past experience of importing capital goods that can reduce the fixed costs in the present.[20] These results are reported in Table 6. As expected the previous import status has a positive effect on the decision of importing capital goods in year *t*. The point estimates

20. We thank an anonymous referee for having pointed out this channel.

TABLE 6. Controlling for past import experience

| | dummy = 1 if firm imports capital goods$_{it}$ = 1 | | | |
|---|---|---|---|---|
| Dependent variable | (1) | (2) | (3) | (4) |
| Importer status(i)(t−1) | 0.121*** | 0.110*** | 0.124*** | 0.111*** |
| | (0.009) | (0.009) | (0.009) | (0.009) |
| Leverage(i)(t−1) | −0.143*** | −0.109*** | | |
| | (0.015) | (0.015) | | |
| Liquidity ratio (i)(t−1) | | | 0.167*** | 0.132*** |
| | | | (0.024) | (0.024) |
| Log value added(i)(t−1) | | 0.014*** | | 0.013*** |
| | | (0.003) | | (0.003) |
| Capital intensity(i)(t−1) | | 0.029*** | | 0.036*** |
| | | (0.005) | | (0.005) |
| Log wage(i)(t−1) | | 0.044*** | | 0.049*** |
| | | (0.006) | | (0.006) |
| Output tariffs(s)(t−1) | | 0.020 | | 0.014 |
| | | (0.034) | | (0.035) |
| Herfindahl index(s)(t−1) | | 0.000 | | 0.000 |
| | | (0.003) | | (0.003) |
| Firm fixed effects | Yes | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes | Yes |
| Observations | 34,735 | 34,735 | 34,735 | 34,735 |
| $R^2$ | 0.031 | 0.037 | 0.029 | 0.036 |

*Notes*: The table reports estimates from linear probability estimations of Equation (I). The dependent variable is a dummy equal to one if the firm *i* imports capital goods in *t*. All explanatory variables are lag of one period. Firms' capital intensity is the ratio of capital over the wage-bill. The financial variables that we use are leverage(i) and liquidity ratio(i). Leverage(i) is the ratio of borrowings over total assets and liquidity ratio(i) is the ratio of current assets over total liabilities of the firm. The output tariffs are at the 4-digit NIC industry level and the Herfindahl index is at the 2-digit NIC industry level. In parentheses we report heteroskedasticity-robust standards errors. ***, ** and * indicate significance at the 1, 5 and 10 percent levels respectively.

*Source*: Authors' estimations using Prowess data.

of leverage and liquidity ratio remain almost unchanged relative to the ones presented in the baseline specifications in Table 1. These findings confirm the importance of financial access to start sourcing capital goods from abroad.

*Dependence with Respect to External Finance*. As a final exercise, we use the measure of firms' dependence on external finance ("external dependence"), proposed by Rajan and Zingales (1998) and updated by Braun (2002) and Braun and Larrain (2005), to identify an exogenous effect of financial constraints on capital goods imports across different industries. In the presence of financial constraints, the borrowing capacity of a firm is closely related to its financial statement. Financial constraints are therefore expected to affect more the investment decision in sectors where firms rely more on the use of external finance.

TABLE 7. Imports of capital goods - dependence on external finance in the industry

| | dummy = 1 if firm imports capital goods$_{it}$ = 1 | | | |
|---|---|---|---|---|
| Dependent variable | (1) | (2) | (3) | (4) |
| Leverage(i)(t−1) | −0.077*** | −0.098* | | |
| | (0.024) | (0.051) | | |
| Leverage(i)(t−1) × Ext.Dep.(s) | −0.124* | −0.121* | | |
| | (0.069) | (0.070) | | |
| Leverage(i)(t−1) × Cap.Int(s) | | 0.258 | | |
| | | (0.537) | | |
| Liquidity ratio (i)(t−1) | | | 0.048 | −0.033 |
| | | | (0.036) | (0.066) |
| Liquidity(i)(t−1) × Ext.Dep.(s) | | | 0.241*** | 0.255*** |
| | | | (0.087) | (0.089) |
| Liquidity(i)(t−1) × Cap.Int.(s) | | | | 1.016 |
| | | | | (0.650) |
| Log value added(i)(t−1) | 0.016*** | 0.016*** | 0.015*** | 0.015*** |
| | (0.003) | (0.003) | (0.003) | (0.003) |
| Capital intensity(i)(t−1) | 0.036*** | 0.036*** | 0.044*** | 0.044*** |
| | (0.005) | (0.005) | (0.005) | (0.005) |
| Log wage(i)(t−1) | 0.055*** | 0.055*** | 0.060*** | 0.060*** |
| | (0.007) | (0.007) | (0.007) | (0.007) |
| Herfindahl index(s)(t−1) | 0.001 | 0.001 | 0.001 | 0.001 |
| | (0.003) | (0.003) | (0.003) | (0.003) |
| Output tariffs(s)(t−1) | 0.018 | 0.019 | 0.014 | 0.017 |
| | (0.037) | (0.037) | (0.037) | (0.037) |
| Firm fixed effects | Yes | Yes | yes | Yes |
| Year fixed effects | Yes | Yes | Yes | Yes |
| Observations | 33,773 | 33,773 | 33,773 | 33,773 |
| $R^2$ | 0.026 | 0.026 | 0.024 | 0.025 |

*Notes*: ***, ** and * indicate significance at the 1, 5 and 10 percent levels respectively. Leverage(i)(t-1)× Ext.Dep. and Liquidity(i)(t-1)× Ext.Dep. are interaction variable between the Leverage ratio and the variable external dependence provided by Braun (2002) and Braun and Larrain (2005). Leverage(i)(t-1)× Cap.Int. is the interaction of the leverage ratio with the capital intensity of the industry, also provided by Braun (2002). External dependence and capital intensity are sector-specific, with ISIC rev. 2 3-digits classification.

*Source*: authors' estimations using Prowess data.

The empirical strategy proposed by Rajan and Zingales (1998) is adapted to the context of our study.[21] The measure of external dependence at the 2-digit industry level updated by Braun (2002) and Braun and Larrain (2005) is interacted with our measures of firms' financial statements. The baseline empirical specification is then augmented with the *Leverage(i)(t-1)× Ext. Dep.(s)* and *Liquidity ratio (i)(t-1)× Ext. Dep.(s)* variables. The coefficient on the interaction variable between the leverage of the firm and the external dependence of the industry is expected to be negative, and the coefficient on the interaction between the liquidity ratio of the firm and the degree of external dependence is expected to be positive: in the presence of financial constraints, the liquidity ratio and leverage of the firm are expected to be more closely related to the imports of foreign capital goods for firms that rely more on the use of external finance.

Estimation results are reported in Table 7. The leverage ratio is interacted with the external dependence variable in column (1). The coefficient on the interaction variable reports a negative sign, confirming that the negative impact of the leverage of the firm, on its probability to import foreign capital goods, is higher in sectors where firms require more external finance. This estimation is replicated in column (2), including as well an interaction between the leverage of the firm and the capital intensity of the industry. The capital intensity of the industry is provided by Braun (2002), and is sector-specific. This new variable allows to control for the possibility that importing capital goods is more likely to affect firms' financial factors in sectors where firms are typically more capital intensive. Since the external dependence of the firm and the capital intensity are positively correlated, reverse causality would bias the coefficient on the Leverage(i)(t-1)× Ext. Dep.(s) variable. Estimation results in column (2), though, confirm that the point estimate of the interaction term, Leverage(i)(t-1)× Ext. Dep.(s), is robust and stable under this specification.

A similar analysis where the liquidity ratio is interacted with the sectoral external dependence and the sectoral capital intensity is provided in columns (3) and (4). The coefficient on the Liquidity ratio(i)(t-1)× Ext. Dep.(s) is positive and significant (column 3) and it remains robust and stable when we introduce the interaction term between the liquidity of the firm and the capital intensity of the industry in column (4). These sensitivity tests therefore provide additional evidence confirming that the liquidity of the firm affects the import decision of capital goods.

21. Rajan and Zingales (1998) propose to identify the effect of financial development on economic growth, using an interaction term between the country's financial development and the industry level of external dependence. The degree of dependence on external finance is a technology parameter (measured using Compustat data for the United States), and is independent of countries' characteristics. The coefficient on the interaction term is therefore expected to be unrelated to countries' characteristics, and unaffected by future economic growth.

## IV. Concluding Remarks

Adopting foreign technology is costly and requires using internal and external financial resources. This paper investigates the influence of firms' financial factors on their decision to source foreign capital goods. We test whether firms that experience an improvement in their financial statements have a higher probability to upgrade foreign technology embodied in imported capital goods. We find strong evidence that this is the case in India. Firms with a lower leverage and a higher liquidity have a higher probability of upgrading foreign technology. Different sensitivity tests demonstrate that these results are not driven by omitted variable bias related to changes in firm observable characteristics (size, capital, and skill intensity) as well as ownership status (multinational, state-owned firms and local Indian business groups). Finally, these findings are also robust to alternative specifications dealing with the potential reverse causality issues between financial factors and foreign technology adoption.

Our findings suggest that financial market imperfections have a negative effect on purchases of foreign technology. This is an important issue for aggregate productivity growth in developing countries, like India, that rely heavily on foreign technology in their production process. One important policy implication of our findings is that the success of trade reforms is closely related to the capacity of the financial intermediaries to provide funding to domestic firms.

## A. Theoretical Appendix

### *A.1. Price index approximation*

Following Chaney (2005), we assume that the price index only depends on local firms'prices and that foreign firms do not face any liquidity constraints. The price index approximation is

$$P \approx \left( \int_{\varphi \geq \varphi_d^*} p_d(\varphi)^{1-\varphi} L dF_\varphi(\varphi) \right)^{\frac{1}{1-\varphi}}$$

We define a function $g(.)$ in the following way:

$$g(.) : \varphi^{*\phi-1} = \left( \frac{\varphi}{\mu} \int_{\varphi \geq \varphi^*} \varphi^{\phi-1} dF_\varphi(\varphi) \right) \times F \Leftrightarrow \varphi* = g(F)$$

### A.2. *Credit constrained firms*

A sufficient condition for the existence of liquidity constraints importers is $\frac{c_f}{c_d} < 1$. This is the assumption that we introduce concerning the relative per unit cost is then equal to $\frac{c_f}{c_d} = \frac{\tau_m^{\eta(1-\alpha)}}{\gamma} < 1$. This condition implies that the efficiency parameter of imported capital goods is higher than its additional variable cost relative to domestic ones ($\gamma > \tau_m^{\eta(1-\alpha)}$).

**Proposition 1:** *Under the assumption that* $\chi < 1$, *there is a subset of firms (denoted* $\Phi$*) subject to liquidity constraints with a productivity level between* $\varphi_f^* < \varphi < \overline{\varphi}(A)$.

## B. Empirical Appendix

Appendix Table: Descriptive statistics of Indian manufacturing firms (1997–2006)

| | Mean | Std. Dev. |
|---|---|---|
| **Number of firms** | | |
| Average number of firms per year | 3,473 | |
| Importers of capital goods (%) | 32 | |
| Importers of intermediate goods (%) | 62 | |
| Private firms (%) | 81 | |
| Local business groups (%) | 39 | |
| Foreign firms | 7 percent | |
| **Financial variables** | | |
| Liquidity ratio | 0.50 | 0.20 |
| Leverage ratio | 0.38 | 0.31 |
| **Firm level characteristics** | | |
| Value added | 50 | 214 |
| Wage bill | 7.65 | 46 |
| Capital stock | 113 | 534 |
| **Industry level controls** | | |
| Effectively applied output tariffs (NIC 4 digit) | 0.30 | 0.13 |
| Herfindahl index (NIC 2 digit) | 0.94 | 0.78 |

*Notes*: Mean values and standard errors in parentheses are reported. Leverage(i) is the ratio of borrowings over total assets and liquidity ratio(i) is the ratio of current assets over total liabilities of the firm.

*Source*: authors calculations based on Prowess data.

**Proof** In order to prove that $\Phi$ is not empty we investigate whether $\overline{\varphi}(0) > \varphi_f*$:

$$\left(\frac{F + F_T - \lambda A}{F}\right)^{\frac{1}{\varphi-1}} \varphi_d* > \left(\frac{F + F_T}{F}\right)^{\frac{1}{\varphi-1}} \left(\frac{c_f}{c_d}\right) \varphi_d*$$

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