Financial constraints and innovation:
Why poor countries don't catch up*

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Abstract

This paper examines micro-level channels of how financial development can affect macroeconomic outcomes such as the level of income and export intensity. Specifically, the paper investigates theoretically and empirically how financial constraints affect a firm's innovation and export activities. Theoretical predictions are tested using unique firm survey data which provides direct measures for innovations and firm-specific financial constraints and information on shocks to firms' internal funds that can serve as firm-level instruments for financial constraints. There is unambiguous evidence that financial constraints strongly adversely affect the ability of domestically owned firms to innovate and to export and hence to catch up to the technological frontiers. Furthermore, the negative effect of financial constraints on productivity is amplified as these constraints force export and innovation activities to become substitutes even when these activities are natural complements. Findings reported in the paper can help explain why poor countries don't catch up, despite increasing globalization.

JEL classification: O3, O16, F1, G3

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1 Introduction

One of the central questions in economic growth and development is why disparities in income and development across countries are large and persistent, despite increasing globalization. Much of empirical and theoretical research has been developed to identify factors that prevent less developed countries from catching up with developed countries. After decades of research, however, the question continues to puzzle the profession. Most of the difference in income across countries is attributed to differences in productivity which, in words of Zvi Griliches, is a measure of our ignorance. In this paper, we attempt to shed more light onto what determines variation in the level of productivity and hence income across countries by better understanding frictions that prevent firms from innovation as well as other productivity enhancing activities and, consequently, from catching up.

Our analysis is motivated by several stylized facts. First, in emerging markets and transition economies foreign owned firms tend to be more productive than domestically owned firms and these productivity differences between domestically and foreign owned firms do not seem to diminish over time (see e.g. Blomstrom (1988), Haddad and Harrison (1993), Aitken and Harrison (1999), Arnold and Javorcik (2009), Estrin et al. (2009)).[1] To the extent that foreign owned firms embody the technological frontier, one can interpret this fact as suggesting that some forces prevent domestically owned firms from emulating the best practices and techniques. Second, there is ample macroeconomic evidence (see Levine (2005) for a survey) that development of financial markets is strongly correlated with the development of a country. Although microeconomic channels for this relationship are an area of active research, many aspects of micro-level determinants remain unclear. Third, financial frictions affect investment as well as research and development (R&D) spending made by firms at the microeconomic level (see Hall (2002) and Hall and Lerner (2009) for surveys). Fourth, recent research documents that exporting firms are more productive than non-exporting firms (e.g. Bernard and Jensen (1999)) which in part could be attributed to export stimulating productivity enhancements (e.g. Van Biesebroeck (2005) and De Loecker (2007)) thus suggesting that trade liberalization should foster productivity growth. Furthermore, financial frictions tend to adversely affect firm's ability to export (e.g., Greenaway et al. (2007)).

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[1]A part of the discrepancy in the levels of productivity of domestically and foreign owned firms could be due to selection effects when only most productive firms establish subsidiaries abroad or when foreign owners purchase only most productive domestically owned firms. However, even after controlling for such effects (Estrin et al. (2009)), the difference between domestically and foreign owned firms remains large and persistent.

We reconcile these facts in a stylized theoretical framework where firms make decisions about whether to innovate and/or to export given financial constraints faced by the firms. We show that a firm's decision to invest into innovative and exporting activities is sensitive to financial frictions which can prevent firms from developing and adopting better technologies. Furthermore, we demonstrate that in a world without financial frictions, innovation and exporting goods are complementary activities. Thus, easing financial frictions can have an amplified effect on firms' innovation effort and consequently the level of productivity. However, as financial frictions become increasingly severe, these activities become effectively substitutes since both exporting and innovation rely on internal financing of firms.

We test predictions of our model using Business Environment and Enterprise Performance Surveys (BEEPS) which covers a broad array of sectors and countries in Eastern Europe and Commonwealth of Independent States (CIS). As we argue below, this data set has a number of advantages relative to data sets used in previous research. Most importantly, BEEPS collects direct measures of innovation and financial constraints so that we do not have to rely on indirect proxies for the key variables in our analysis. In addition, BEEPS provides information on shocks to firms' cash flow and internal funds which we can use as firm-level instrumental variables for our measures of financial constraints.We document that these self-reported measures are strongly correlated with more objective macroeconomic indicators of financial development.

Our preferred econometric results based on instrumental variable estimates unambiguously suggest that innovative activities of firms are strongly influenced by financial frictions. Moreover, we show that domestically owned firms are more likely to be affected by financial constraints than foreign firms, which helps explain why domestically owned firms do not catch up. We also find that financial frictions affect export status and, consistent with our theoretical predictions, the joint incidence of export and innovation activities decreases in the severity of financial constraints. This may explain why the integration of product markets does not necessarily help domestically owned firms to catch up. Finally, we document that financial frictions measured at the firm level are strongly negatively correlated with macroeconomic measures for productivity and trade intensity. Thus, our analysis suggests financial frictions adversely affecting innovation as one potential microeconomic channel affecting macroeconomic productivity and growth.

These findings point to clear policy prescriptions. To boost productivity at micro and macro levels, policymakers should focus on developing financial markets that ensure access to external funding for a broad array of firms. Reducing the cost of as well as enhancing access to external finance is likely to lead to more intensive innovation and

exporting activities which, in turn, are likely to yield a rapid development of new goods and technologies and adoption of frontier technologies and practices. Otherwise, costly external funding due to poor access or excessively high interest rates may significantly hamper convergence to the technological frontier.

Our analysis builds on and contributes to three broad strands of previous research. First, we contribute to a large literature documenting effects of financial frictions on R&D expenditures.[2] More recently this literature has started to shift focus on direct measures of innovation rather than indirect ones such as R&D spending. Ayyagari et al. (2007), which is the closest to our analysis, study the determinants of broadly defined innovation (i.e., innovation is not only product and process innovation, but also closing plants, entering a joint venture, obtaining a new licensing agreement and others) using survey data from 47 developing countries. Similar to our results, Ayyagari et al. (2007) find a positive relationship between the use of external finance and the extent of innovation. Apart from considering the interplay between export and innovation, our analysis differs from Ayyagari et al. (2007) by employing finer definitions of innovation so that we can provide a more nuanced view on the effects of financial frictions on different types of innovation. Furthermore, we use a direct measure of financial constraints based on reported difficulties in access to external finance rather than the actual use of external finance which does not adequately reflect how firms intended to finance their investment. Finally, we use firm-level rather than country level instrumental variables to address potential endogeneity of access to external finance. The latter is important for two reasons. First, using country-level instruments is vulnerable to shocks affecting access to external finance at the country level. Second, firm-level variation dwarfs variation at the country level and hence using country-level instruments may capture only a small fraction of variation. Correspondingly, estimates may be imprecise and may measure the causal effect only due to country-level variation rather than quantitatively more important firm-level variation. Finally, we also provide a theoretical rationale why access to external

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[2]Early papers in this literature exploited the idea that a change in available internal funds should not affect investment or R&D expenditure, if firms are not limited in their access to external funds. This hypothesis was tested by examining the sensitivity of investment and R&D spending to cash flow variables in the standard Euler-type investment regressions (The rationale of this approach has been challenged by Kaplan and Zingales (2000)). Himmelberg and Petersen (1994) were the first to find an economically large and statistically significant relationship between R&D expenditure and internal finance for a panel of small high-tech firms. Similarly, Mulkay et al. (2001) compare the cash flow sensitivity of both R&D expenditure and capital investment for US and French firms. They report that cash flow has a much larger impact on both R&D and investment in the US than in France. They also find no significant difference between the sensitivity of investment and R&D expenditure to measures of financial constraints. Bond et al. (2003) compare firm level panel data from the UK and Germany providing evidence that suggests that financial constraints are more relevant for British firms than for German firms. See Hall and Lerner (2009) for a review.

finance may matter for innovation, even though most firms report to rely exclusively on internal finance for their innovation activities.

The second strand reports that financial frictions influence a firm's ability to export. For example, Chaney (2005) introduces financial constraints into Melitz (2003) model and predicts that financially constrained firms are less likely to cover the fixed costs of exporting and hence less likely to export. In line with Chaney's predictions, data on bilateral export flows imply that financially more developed countries are more likely to export and that the effect is more pronounced in financially vulnerable sectors (Manova (2008)). Micro-level data studies, which typically rely on firms' balance sheets and income statements to capture financial constraints, also broadly support these predictions. For instance, Bellone et al. (2008) find that export starters enjoy better financial conditions while Greenaway et al. (2007) and Buch et al. (2009) report that financially healthy firms are more likely to export.[3]

The final strand is the nascent literature investigating the interaction between export and innovation. Most of this literature is theoretical (e.g., Atkeson and Burstein (2007), Constantini and Melitz (2008)) and aimed to show that adoption of new technologies in a country is more likely to occur after trade liberalization. Consistent with these theoretical models, Bustos (2007) finds that new entrants in the export market upgraded technology faster than other firms after trade and capital account liberalization in the early 1990s in Argentina. The dearth of empirical evidence in this literature makes our results particularly valuable, even more so as the impact of financial constraints has not yet been taken into account in this literature. We also emphasize in our theoretical model that if financial constraints are severe, innovation and export activities are less likely to be complements and may become substitutes instead.

The paper is organized as follows. Section 2 lays out a stylized model of a firm's decision to innovate and to export when faced with financial constraints. Section 3 describes the data and Section 4 presents the econometric specification. In Section 5 we report the main empirical findings. Section 6 discusses the interaction of export and innovation. Section 7 discusses how one can use our findings to reconcile the stylized facts presented above. Section 8 presents policy implications and concluding remarks.

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[3]The micro-level evidence however is not unanimous. Stiebale (2008) finds no effect of financial constraints on a firm's export decision once observed and unobserved financial firm heterogeneity is accounted for.

2 Theoretical Framework

In this section we develop a stylized model to highlight the interaction between financial constraints, innovation and exporting activities. We abstract from many details to present a clear picture of how these three phenomena are interconnected. We will use this prototypical model to derive a series of falsifiable implications which we will test later in the empirical sections of the paper.

2.1 Basic Setup

Consider an investor who has the opportunity to invest in innovation activities, at a fixed cost F_I, before engaging in production.[4] Since the focus of our analysis is the impact of financial constraints on the investor's innovation activities, we need to specify in some detail how innovation and production are financed. In principle, the investor can use either internal funds resulting from previous cash flows or external funding obtained from creditors to finance current expenditures. We assume that external funding is more expensive than internal due to asymmetric information problems. Specifically, to finance one unit of credit the investor has to pay $\gamma > 0$ for external financing while the opportunity cost of internal financing is normalized to 0.[5]

Consistent with the empirical evidence (e.g. Hall and Lerner (2009), Ughetto (2008)), we assume that to finance innovation at stage 1, the investor has to rely on internal funds from positive cash flows. Intuitively, innovation is an activity which is particularly prone to asymmetric information problems and that cannot be easily collateralized. This rules out using external finance for innovation.

At stage 2, production needs to be financed. The firm prefers to use internal finance for production, if possible, but needs to turn to external sources if internal funds are not sufficient. We assume that a priori, sufficient internal funds for production will be available with probability q, while external finance needs to be used with probability $(1-q)$.

We capture financial constraints by the likelihood with which the firm needs to rely on external financing. There are two kinds of events that can increase the likelihood of the need to rely on external finance. First of all, the investor may spend internal funds on innovation activities at stage 1, which leaves less internal funds for production

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[4]In principle, the innovation can take two forms: product innovation and process innovation. For the purpose of our analysis, however, it is not necessary to distinguish these two forms: to fix ideas, we assume that both forms of innovation increase the firm's profit potential by the same amount.

[5]The cost γ absorbs not only the direct cost of credit from external sources but also indirect costs associated with external credit being unavailable.

at stage 2. In this case, the likelihood of having sufficient internal funds is lowered by δ_I. Furthermore, the investor may experience a shock to liquidity, due to late payments by customers, for instance. This lowers the likelihood of having sufficient internal funds by $\delta_L \in \{0, \overline{\delta_L}\}$. While the investor can influence the first kind of events, by choosing whether or not to innovate, he has no influence on the second kind of events.

Both cases imply that the investor has to rely on external finance with larger probability. It is in these cases that the investor will feel financially constrained, because he realizes that he needs external finance which may be difficult or very costly to obtain.[6] Since innovation reduces the amount of internal funds, it increases the probability of hitting financial constraints and thus one may observe in the data that incidences of innovations and reported severity of financial constraints are positively correlated. Exogenous shocks to internal funds, on the other hand, are unaffected by innovation activities and hence this source of variation can be used later as an instrumental variable.

In summary, the sequence of events is as follows. In stage 0, the potential exogenous shock to liquidity, $\delta_L \in \{0, \overline{\delta_L}\}$, is realized. In stage 1, the investor considers whether or not to innovate. Let π_i denote the profit if no innovation takes place where $i = 0$ if production is financed with internal funds and $i = \gamma$ if it is financed externally, with $\pi_0 > \pi_\gamma$. Similarly, let π_i^I denote the profit if the investor has carried out an innovation, with $\pi_i^I > \pi_i$. Without loss of generality, we assume that the increase in profit resulting from innovation decreases as the cost of financing increases, i.e.

Assumption 1

$$\frac{d(\pi_\gamma^I - \pi_\gamma)}{d\gamma} < 0 \tag{1}$$

In the appendix, we illustrate this assumption to hold for a standard model of monopolistic competition.

Ex ante, the investor's expected payoff if he does not innovate is

$$E(\pi) = (q - \delta_L)\pi_0 + (1 - q + \delta_L)\pi_\gamma \tag{2}$$

If the investor spends on innovation at stage 1, production can be financed internally at stage 2 with probability $q - \delta_L - \delta_I$, while with probability $(1 - q + \delta_L + \delta_I)$ external finance has to be used. In case of innovation, the ex ante expected profit is

$$E(\pi|I) = (q - \delta_L - \delta_I)\pi_0^I + (1 - q + \delta_L + \delta_I)\pi_\gamma^I - F_I. \tag{3}$$

At stage 2, production takes place and profits are realized.

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[6]It is straightforward to extend our theoretical analysis to including the case where a negative liquidity shock δ_L has a positive impact on the cost γ at which external finance can be attracted. This reinforces the negative impact of a negative liquidity shock on the incentive to innovate.

We can now determine the investor's incentive to innovate at stage 1 and how this is affected by potential financial constraints arising from negative liquidity shocks at stage 0. His incentive to innovate is given by the difference in expected profits, $\Delta_\pi = E(\pi|I) - E(\pi)$.

$$
\begin{aligned}
\Delta_\pi &= E(\pi|I) - E(\pi) \\
&= (q - \delta_L)(\pi_0^I - \pi_0) + (1 - q + \delta_L)(\pi_\gamma^I - \pi_\gamma) - \delta_I(\Pi_0^I - \pi_\gamma^I) - F_I.
\end{aligned}
\tag{4}
$$

Naturally, a firm decides to innovate if and only if $\Delta_\pi > 0$. To determine the impact of exogenous liquidity shocks, we take the first derivative of Δ_π with respect to δ_L.

$$
\frac{d\Delta_\pi}{d\delta_L} = -(\pi_0^I - \pi_0) + (\pi_\gamma^I - \pi_\gamma) < 0.
\tag{5}
$$

which follows from Assumption 1. Thus, the more severely the firm is hit by an exogenous liquidity shock, the less likely it is to innovate.

In the next step we examine how the impact of financial constraints is affected by the cost of external finance. We find that

$$
\frac{d^2\Delta_\pi}{d\delta_L d\gamma} = \frac{d(\pi_\gamma^I - \pi_\gamma)}{d\gamma} < 0.
\tag{6}
$$

Thus, the larger γ, i.e. the larger the cost of external finance, the more damaging is the effect of a negative liquidity shock on the incentive to innovate. Note that although innovation is always financed internally, the cost of external finance matters for the innovation incentive. This is due to the fact that external finance may play a role for the production cost and hence for the overall profitability of the firm. Thus, the larger the cost of external finance, i.e. the smaller $(\pi_\gamma^I - \pi_\gamma)$, the more detrimental it is to rely on external finance and hence the more negative the impact of a negative liquidity shock is on the firm's innovation activities.

Although in this section we focus on innovation as a productivity enhancing activity which cannot be collateralized, we can extend our analysis to other types of activities which cannot be easily collateralized yet lead to improvements in measured productivity. A prominent example of such alternative activities is exporting goods. The sunk and flow cost of exporting goods often do not have a significant material component (e.g., a building or machine) and thus is similar to innovation in this respect. Likewise, exporting goods expands the market size so that overhead costs can be spread more widely and hence an exporting firm can be more productive. Therefore, one may reasonably use our model to study exporting as well and it is straightforward to repeat our analysis from

above to show that the incentive to engage in exporting decreases as the availability of internal funds decreases, i.e. δ_L increases.[7]

2.2   Interaction of export and innovation

In the this section we investigate how financial constraints affect the interaction of a firm's activities that draw on scarce financial resources. For this purpose, consider the entry to a foreign market as a second activity the firm may be interested in. As in Melitz (2003), setting up exporting facilities requires an upfront investment F_E.[8] Let π_i^{IE} denote the profit if both activities are carried out and π_i^E denote the profit if only exporting is chosen as a new activity, with $i = \{0, \gamma\}$, depending on how production is financed.

Since returns to innovation increase in the size of the market, exporting (i.e., entering a new market) makes innovation more attractive. On the other hand, a more productive firm (i.e., a firm which has innovated successfully) gains more from exporting than a less productive firm. Hence, innovation and entering a new market are complements. To capture this pattern, we assume that $\pi_i^{IE} - \pi_i^I > \pi_i^E - \pi_i$, i.e. the incentive to invest in starting export activities is larger if the firm invests in innovation activities as well. Likewise, we assume $\pi_i^{IE} - \pi_i^E > \pi_i^I - \pi_i$. In the appendix, we illustrate that these assumptions hold for a standard model of monopolistic competition.

Consider now the investor's incentive to invest in both, innovation and export. If both activities need to be financed with internal funds, it is even less likely to have internal funds left to finance production than if only one activity is financed. Thus, the expected payoff is given by

$$E(\pi|IE) = (q - \delta_L - \delta_{IE})\pi_0^{IE} + (1 - q + \delta_L + \delta_{IE})\pi_\gamma^{IE} - F_I - F_E \qquad (7)$$

with $\delta_{IE} > \delta_I$. The incentive to engage in both activities is captured by the following

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[7]Although our partial equilibrium analysis provides a number of useful insights, it may miss some general equilibrium effects which can amplify or attenuate factors highlighted in our analysis. We leave analysis of these general equilibrium effects to future research.

[8]These fixed cost of entering a foreign market are the reason why only the most productive firms are internationally active, because only the most productive firms are able to shoulder the fixed cost of market entry.

difference in profits:

$$
\begin{aligned}
E(\pi|IE) - E(\pi) \quad = \quad & (q - \delta_L)[\pi_0^{IE} - \pi_0] + (1 - q + \delta_L)[\pi_\gamma^{IE} - \pi_\gamma] - \delta_{IE}[\pi_0^{IE} - \pi_\gamma^{IE}] - F_I - F_E \\
= \quad & (q - \delta_L)[\pi_0^{IE} - \pi_0^I] + (1 - q + \delta_L)[\pi_\gamma^{IE} - \pi_\gamma^I] - F_E \\
& + (q - \delta_L)[\pi_0^I - \pi_0] + (1 - q + \delta_L)[\pi_\gamma^I - \pi_\gamma] - F_I - \delta_{IE}[\pi_0^{IE} - \pi_\gamma^{IE}] \\
> \quad & (q - \delta_L)[\pi_0^E - \pi_0] + (1 - q + \delta_L)[\pi_\gamma^E - \pi_\gamma] - F_E \\
& + (q - \delta_L)[\pi_0^I - \pi_0] + (1 - q + \delta_L)[\pi_\gamma^I - \pi_\gamma] - F_I - \delta_{IE}[\pi_0^{IE} - \pi_\gamma^{IE}] \quad (8)
\end{aligned}
$$

where the last inequality holds if the two activities are complementary. However, note that the larger are the cost of external finance, i.e. the larger γ, or the more internal fund absorbing are the two activities, i.e. the larger δ_{IE}, the larger is the negative impact of $(\pi_0^{IE} - \pi_\gamma^{IE})$. Thus, it is theoretically possible to have

$$
E(\pi|IE) - E(\pi) < (E(\pi|I) - E(\pi)) + (E(\pi|E) - E(\pi)) \quad (9)
$$

Hence, not only is the complementary effect reduced in case of financial constraints, but it is also possible that if the negative impact of financial constraints is sufficiently large, observed innovation and export could behave as substitutes.

2.3 Empirical predictions

We can now turn to the predictions implied by our theoretical framework. From equation (5) above, we can establish the following hypothesis.

Hypothesis 1 *The more severe the financial constraints, as captured by the negative liquidity shock (larger δ_L), the less likely it is that the firm engages in innovation or exporting activities.*

Hypothesis 1 is the central prediction of our model. Effectively it states that a drain of internal funds is likely to make other activities (e.g. production or purchases of new machines) more expensive and, therefore, firms may choose to do less innovation and exporting.

From equation (6) we derive the next hypothesis.

Hypothesis 2 *The larger are the cost of external finance (larger γ), the more negative is the impact of financial constraints on the firm's innovation activities.*

Hypothesis 2 suggests that financial constraints are likely to be more detrimental, the more expensive it is to finance externally.

Finally, taking into account the firm's decision to enter foreign markets, we derive the following hypothesis.

Hypothesis 3 *The more severe the financial constraints experienced by a firm, the less complementary are the observed innovation and export activities, i.e. the relatively less the firm chooses both types of activities rather than only one of them.*

According to Hypothesis 3, activities competing for the same internal funds become substitutes as internal funds become scarcer even when these activities are complements in absence of frictions.

3 Data

To test the predictions outlined in the previous section, we use data from the 2002 and 2005 Business Environment and Enterprise Performance Survey (BEEPS), a joint initiative of the European Bank for Reconstruction and Development (EBRD) and the World Bank Group. These are large surveys of 6,500 firms in 2002 and 7,900 firms in 2005 in 27 transition countries.[9] An important feature of this data set is the inclusion of firms in the service sector, which is the new dynamic (yet understudied) sector in these economies. The surveys relied on the same sampling frames and used identical questionnaires in all countries. To ensure that the samples are representative of the relevant population of firms, the surveys used stratified random sampling. For example, in each country, the sectoral composition of the sample in terms of manufacturing versus services was determined by their relative contribution to GDP.[10] Firms that operate in sectors subject to government price regulation and prudential supervision, such as banking, electric power, rail transport, and water and waste water, were excluded from the sample. The sample includes very small firms with as few as two employees and firms with up to 10,000 employees. Moreover, the data include firms in the rural areas as well as large cities. Hence these data enable us to analyze diverse firms in a large number of countries. In addition, the data set contains a panel component, where 1,443 firms

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[9]In both years the surveys were administered to 15 countries from Central and Eastern Europe (Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Serbia and Montenegro, Macedonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovak Republic, and Slovenia), 11 countries from the former Soviet Union (Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Ukraine and Uzbekistan) and Turkey. In neither year could the survey be administered in Turkmenistan. Our estimation sample includes only about 11,500 firms due to missing observations on variables on interest.

[10]Manufacturing includes: manufacturing and agro-processing. We do not include mining, quarrying and construction into manufacturing. Services includes: Transportation, storage and communications; wholesale, retail, repairs; real estate, business services; hotels and restaurants; other community, social and personal activities; and commerce.

that were surveyed in 2002 were surveyed again in 2005.[11] While we use these panel data for robustness checks, our analysis relies primarily on the pooled 2002 and 2005 data since many variables of interest have a retrospective component in each survey date and because it is hard to detect robust relationships with a small panel of heterogeneous firms, especially when we use many control variables.

In addition to basic information about firm characteristics such as age, employment size and composition, and degree of competition, BEEPS collects information on self-reported measures of access to finance. Specifically, firms are asked to report on a 1 ("No obstacle") to 4 ("Major obstacle") scale how problematic access to financing (e.g., collateral required or financing not available from banks) is for the operation and growth of the firm's business, hereafter *Difficulty of Access to External Finance*. Similar information is collected for the cost of financing (e.g., interest rates and charges), hereafter *Cost of External Finance.*

Since the self-reported measures of financial constraints may be distorted due to subjective or cultural biases, it is important to check whether these measures are correlated with alternative indicators especially at the macroeconomic level given our interest to explain cross-country differences in macroeconomic outcomes. Figure 1 plots the average score of reported difficulties with the cost of and access to external finance against indicators of financial development (private credit to GDP ratio and the net interest rate margin). The self-reported measures are clearly positively correlated with more objective macroeconomic indicators of financial development. Thus, our measures of financial constraints are meaningful indicators of financial development at the country level and by explaining effects of variation in our measures of financial constraints we can shed new light on the sources of cross-country variation of income and productivity.

Finally, BEEPS asks firms to report various types of innovation activity. Hence, we are able to define innovation broadly as the development and upgrading of new products or adoption of new technologies. Specifically, we use binary variables based on answers to the question about whether firms have undertaken any of the following initiatives in the last three years: Developed successfully a major new product line or upgraded an existing product line - hereafter *New Product*; acquired new production technology – hereafter *New Technology*. These measures of innovation are an improvement over the more commonly used measures of patents and R&D expenditures. Patents are generally viewed as having three weaknesses: 1) they measure inventions rather than innovations;

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[11]The relatively small size of the panel should not be associated with intensive exit of firms in these countries. The exit rate was about 8% (average across countries). The size of the panel is mainly brought about by a refusal of firms to participate in the new wave of the survey (42%) and inability to reach eligible responders within firms (25%).

2) the tendency to patent varies across countries, industries and processes; and 3) firms often protect their innovations by using methods other than patents (maintaining technological complexity, industrial secrecy, and lead time over competitors). Using R&D expenditures may also be inappropriate because not all innovations are generated by R&D expenditures, R&D does not necessarily lead to innovation (it is an input rather than output), and formal R&D measures are biased against small firms (see e.g. Michie (1998), Archibugi and Sirilli (2001)). More important from the point of view of this paper is that these types of innovations are less likely to be observed in emerging market economies. Domestically owned firms are expected to engage more in imitation and adaptation of already created and tested technologies, rather than generating new inventions or expending resources on R&D. This is substantiated in our data where the majority (70%) of firms who answered that they acquired a new technology said that it was embodied in new machinery or equipment that was purchased or licensed from other sources. Perhaps most importantly, the measures we use capture management innovations, which can be argued to be more important than inventions for improving a firm's competitiveness and efficiency.

To complement our analysis of innovation, we also consider two additional measures of innovation. First, we construct a dummy variable equal to one if a firm reports positive R&D spending and zero otherwise. We prefer using this measure of innovation to the volume of R&D spending because the distribution of R&D spending is highly skewed with a large mass of firms reporting zero R&D expenditures. Unfortunately, few firms answer the question about R&D spending so that the sample size with non-missing responses shrinks by approximately 50%.

Second, we construct a measure of total factor productivity (TFP) which captures the *derived* effect of innovations. We compute TFP using the cost shares for labor, material and capital (computed for each firm and aggregated for a given industry in each country and year) and adjust it for capacity utilization (CU):

$$logTFP_{isct} = logY_{isct} - s_{sc}^L logL_{isct} - s_{sc}^M logM_{isct} - s_{sc}^K logK_{isct} - logCU_{isct} \qquad (10)$$

where i, s, c, and t index firms, industries, countries and time, $s_{sc}^L, s_{sc}^M, s_{sc}^K$ are labor, materials and capital cost shares, Y is sales, L is number of employees, M is the value of materials and K is the replacement value of capital.[12] Since only about one-half of the firms report sales revenue and even fewer report capital, the TFP-measure is available for less than 5,000 firms.

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[12]The interpretation of the measured productivity given by equation 10 should be careful. As argued by Gorodnichenko (2007) and others, measured productivity captures the revenue generating ability of firms (which includes both market power and technology level) rather than the technology level of firms.

Because we lose so many observations with the R&D dummy and TFP-based measure of innovation, we use these alternative measures only as a robustness check. However, we can use TFP measures to check if self-reported measures of innovation are correlated with objectively measured productivity. Table 1 shows that self-reported measures of innovation are indeed positively related to measured productivity and thus they are meaningful indicators of innovative activities.

4 Econometric Specification

We estimate the following baseline probit specification with the pooled data in the 2002 and 2005 BEEPS for private domestically owned firms (i.e., with no foreign or state ownership):

$$
\begin{aligned}
I_{isct} = \Phi\{\alpha_0 FC_{isct} \quad &+ \quad \beta_1 logL_{isc,t-3} + \beta_2 (logL_{isc,t-3})^2 + \beta_3 Edu_{isc,t-3} \\
&+ \quad \beta_4 Skill_{isc,t-3} + \beta_5 Age_{isct} + \beta_6 CMN_{isct} + \beta_7 Markup_{isct} \\
&+ \quad \beta_8 SMNE_{isct} + \beta_9 Import_{isct} + \beta_{10} CU_{isct} \\
&+ \quad \gamma Loc_{isct} + \lambda_s + \eta_c + \psi_t + error\}
\end{aligned}
\tag{11}
$$

where I is a dummy variable equal to one if the firm reported an innovation, and zero otherwise; Φ denotes c.d.f. of a standard normal random variable; i, s, c, and t index firms, industry, country, and time, respectively. For continuous measures of innovation such as TFP we estimate the linear analogue of specification (11) with the same set of regressors. Variables dated with period are taken from retrospective questions about the firm's performance three years prior to the current date. In addition to industry (λ_s), country (η_c) and year (ψ_t) fixed effects, the following variables are included to control for a number of firm-specific factors deemed to be important in the literature:

FC, the main variable of our analysis, is a measure of financial constraints faced by firms. Our theory predicts that α_0 should be negative. To measure FC we will employ two variables, *Difficulty of Access to External Finance* and *Cost of External Finance.*

L (the number of employees) measures the size of the firm. The argument for including size is that large companies have more resources to innovate and can benefit from economies of scale in R&D production and marketing.

EDU (the share of workers with a university education) and $SKILL$ (the share of skilled workers) capture human capital in the firm. These variables might be expected to be positively correlated with innovation if EDU reflects the involvement

of workers in R&D and more skilled workers ($SKILL$) are able to give feedback to the firm on how to improve a product.

Age of the firm is the log of the number of years since the firm began operations in the country. Two hypotheses are plausible: one suggesting that older firms developed routines that are resistant to innovation and another suggesting that older firms will accumulate the knowledge necessary to innovate. There is evidence for both hypotheses.

Variables CNM and $Markup$ capture competitive pressures. CNM is a dummy equal to one if the firm competes in the national markets and zero otherwise (e.g., when a firm only competes in a regional or local market). We expect CNM to have a positive effect on innovation, given that the firm operates in a larger market. $Markup$ (the price to cost ratio) is used as a proxy to estimate the effect of competition faced by each firm (see e.g., Nickell (1996); Aghion et al. (2005)). Gorodnichenko et al. (2009) show that both $Markup$ and CNM are positively related to the incidence of innovations.

$SMNE$ (the share of sales to multinational enterprises) and $Import$ (the share of imported inputs) capture vertical linkages or transfer of capabilities. Presumably exposure to foreign firms and markets is likely to stimulate more innovation as foreign firms and markets are likely to have better technologies, practices and products.

Location (Loc) is a set of dummies for size of population where the firm is operating or headquartered. This will control for potential differences in knowledge available in larger v. smaller cities.

Capacity Utilization (CU) is the percentage of a firm's output relative to maximum possible output. Although capacity utilization has been found to be a strong predictor of innovations (e.g. Becheikh et al. (2006)), the effect of CU on innovation is a priori indeterminate. If firms are too busy filling demand, they may be more interested in extending their current capacity than finding new ways of producing goods and services. At the same time, if firms are at capacity they may need to innovate.

Appendix Tables A1-A3 provide summary statistics for variables used in our analyses.

Estimating specification (11) by ordinary least squares or probit may lead to biased estimates of the key parameter α_0. For example, Canepa and Stoneman (2008) report

that firms from high tech industries and small firms in the U.K. are more likely to report a project being abandoned or delayed due to financial constraints. In other words, consistent with our model, firms that intend to innovate are more likely to hit a financial constraint than firms that do not even try. Hajivassiliou and Savignac (2007) make a similar observation based on French survey data. They illustrate the issue by estimating the sensitivity of innovation to financial constraints for two samples of firms: the full sample, which includes all firms, and a restricted sample. In the restricted sample, they include firms that are likely innovators and exclude firms that show no innovation activity despite being not financially constrained. Hajivassiliou and Savignac (2007) find that innovation and financial constraints are positively correlated in the full sample and negatively in the restricted sample. In summary, innovating firms are more likely to hit financial constraints and therefore one may find a positive relationship between financial constraints and incidence of successful innovations.

To correct for this endogeneity bias, we propose using instrumental variables which affect financial constraints but do not (directly) influence the intensity of innovative activities. Exogenous shocks to cash receipts of a firm appear to be a natural candidate since they can be interpreted as δ_L in our model. Such shocks affect the amount of internal funds as well as attractiveness of firms to external creditors but do not influence innovations directly. This approach contrasts with previous analyses which use split-sample estimation (e.g., Hajivassiliou and Savignac (2007)).

Fortunately, BEEPS collects information about the structure of revenues as well as timeliness of payments from customers and to suppliers. We focus on variables which are most likely to be observed by external creditors and thus are likely to influence access to external finance. Specifically, we will use three variables. The first variable *Overdue* is the dummy variable equal to one if a firm has overdue payments to suppliers. Presumably, overdue payments to suppliers strongly signal that a firm experiences a financial difficulty. Since external creditors may be unable (e.g., due to asymmetric information) to differentiate insolvent vs. illiquid (but solvent) firms, availability of external financing is likely to fall for firms with overdue payments. The second variable *NTPcustomer* is the share of payments from customers settled by debt swaps or offsets and exchange of goods for goods (barter). The third variable *NTPsupplier* is the share of payments to suppliers settled by debt swaps or offsets and exchange of goods for goods (barter). Since debt swaps and barter are less likely to provide liquidity, firms engaged in these types of payment settlements are more likely to experience financial constraints.[13]

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[13]As Marin and Schnitzer (2002) and Marin and Schnitzer (2005) show for transition economies, firms resort to barter if they are considered not creditworthy. But there is an additional mechanism which

We also consider alternative instrumental variables (e.g. whether firms took non-paying customers to court) in the robustness checks.[14]

5 Empirical analysis of innovation

5.1 Productivity gap

We begin our empirical analysis by documenting that foreign owned firms are more productive than domestically owned firms in BEEPS. Table 2 shows that domestically owned firms are significantly (10 to 20 percent) less productive than companies under foreign ownership and that this productivity gap appears to widen over time, which is consistent with previous studies (see e.g. Sabirianova Peter et al. (2005), Sabirianova Peter et al. (2009)). Likewise we observe that foreign owned firms innovate more intensively than domestically owned firms. We also find that the gap is not eliminated after we control for the initial level of firm's total factor productivity.

Although our data do not permit us to properly control for possible selection of productive firms into foreign ownership ("cherry picking"), we can check the quantitative importance of such effects by assessing the gap for de novo firms which were founded after 1991 and were never in state ownership. Importantly, in contrast to privatized firms, de novo private firms are unlikely to be purchased by foreign owners. Thus, we effectively compare "greenfield" domestically and foreign owned firms. Our results are very similar to the results we obtain for the baseline sample and hence the selection effects should not distort our results to any significant extent.[15]

The large and persistent gap in measured productivity and innovation intensity is

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can make these types of payments exacerbate financial constraints. As discussed in Gorodnichenko and Grygorenko (2008), debt swaps or offsets and exchange of goods for goods were often employed by management to channel resources away from stakeholders. Since external creditors are particularly vulnerable to these types of looting, they may be more reluctant to provide credit to firms that engage in these forms of settling payments to suppliers and payments from customers.

[14] An additional source of discrepancy between regular and IV probits could be measurement errors in self-reported measures of financial constraints. Using instrumental variables could correct the attenuation bias as well.

[15] This finding is consistent with Estrin et al. (2009) documenting that the productivity gap between domestically and foreign owned firms does not shrink considerably after controlling for selection into foreign ownership. It is possible that foreign owned firms reported more intensive innovations because they can "import" new technologies and goods from parent companies. Although it is true that foreign owned companies report greater incidence of transfers of new technologies from parent companies, the frequency of such transfers is quite modest. In the 2005 wave of BEEPS when the relevant data were collected, less than ten percent of foreign owned firms that reported developing or acquiring a new technology indicated that the technology was transferred from parent companies. Thus a vast majority of innovations of foreign owned firms is likely to be produced locally and hence the comparison with domestically owned firms is meaningful.

hard to reconcile with extensive reforms taken by BEEPS countries to accelerate growth and catching up with the technological frontier. As we conjecture above, a part of the gap could be explained by differential access of foreign and domestically owned firms to external credit. In particular, foreign firms may face milder financial frictions because they can more often borrow in internal markets (e.g. from a mother company) than private domestically owned companies. In the rest of the section, we attempt to test this conjecture.

5.2 Main findings

In this section, we present estimates of equation (11), which tests the main hypotheses described in Section 2. Our baseline specification for each measure of innovation is reported in Table 3. In addition to estimated coefficients and standard errors, we also report the elasticity of innovation with respect to financial constraints: $(\partial I / \partial FC)(\overline{FC}/\overline{I})$ where $(\partial I / \partial FC)$ is the marginal effect of financial constraint FC on a measure of innovation I (evaluated at mean values), and $\overline{FC}$ and $\overline{I}$ are mean values of reported severity of financial constraint and reported innovation respectively. The advantage of using elasticity is that it makes the sensitivity of innovation to financial constraints comparable across regressions since mean innovation rates vary across samples and definitions. Our baseline sample includes only private domestically owned firms.

For all measures of innovation, we consistently find that a binding financial constraint is strongly negatively related to the incidence of innovations, as predicted by Hypothesis 1, according to instrumental variable estimates. At the same, in the regular probit, we do not find any significant relationship between innovations and access to external finance.[16] This pattern sharply contrasts with results in Ayyagari et al. (2007) who find very similar least squares and instrumental variable estimates. However, our estimates are in agreement with our theoretical prediction that endogeneity of innovation and financial constraints will bias estimates upward since more innovative firms are more likely to need external funding and hence more likely to hit financial constraints. Once the endogeneity bias is corrected, we find a strong negative causal effect of financial constraints on innovation. Specifically, the bottom panel of Table 3 shows that the elasticity of innovations with respect to financial constraints implied by estimates in the top panel of Table 3 is in -1.5 to -1 range for developing a new good or adopting a new technology, approximately -2 for the R&D spending, and -0.5 for TFP. These are economically significant magnitudes. For example, an one-standard deviation increase

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[16]We find similar results for linear probability models. Results are available upon request.

in the severity of financial constraints lowers the probability of a successful innovation by 18 percentage points for developing a new good, 24 percentage points for adopting a new technology, 28 percentage points for positive R&D spending, and 25 percentage points for TFP.

Note that our instrumental variables have desirable properties such as being strong predictors of the endogenous variable (the F-statistics for the first stage fit is well above 10, a value commonly suggested as a sign of variables to be good instruments) and orthogonality to the error term (the p-value of the over-identifying restriction test is routinely above any standard significance level). We report first stage estimates in Appendix Table A4. Consistent with predictions of economic theory, positive $Overdue$, $NTPcustomer$ and $NTPsupplier$ raise the severity of financial constraints. However, $Overdue$ appears to be the strongest predictor of financial constraints.[17]

There are a number of interesting findings with respect to the control variables in Table 3. First, larger firms tend to innovate more than smaller firms, which is consistent with the finding in the vast majority of studies on innovation (see e.g., Becheikh et al. (2006) and the Schumpeter (1943)) hypothesis. The size effect is concave for both types of innovations. Second, the effect of human capital varies by how it is measured. Having a higher share of skilled workers does not affect the probability of developing a new product and acquiring new technology. On the other hand, as the share of workers with a university education rises, all types of innovation are boosted. These findings stress the need for a highly educated labor force to improve the capabilities of the product or service. Third, older (more mature) firms are not as likely to innovate with respect to product and technology as new firms. Fourth, firms that compete/operate in national markets are more likely to innovate in any of the three areas than firms that only compete/operate in a local or regional market. This may reflect both the capability of the firms operating in the larger national market, as well as the characteristics of the national as opposed to local environment. Fifth, lower competition, proxied by markup, has a positive effect on innovation, which is consistent with the results in Carlin et al. (2006) and Gorodnichenko et al. (2009) who use a similar econometric framework. Sixth, consistent with Gorodnichenko et al. (2009), linkages to foreign firms ($SMNE$ and $Import$) are positively associated with the success of innovation. Finally, more intensive capacity utilization is associated with less intensive innovative activities.

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[17]Interestingly, after conditioning on industry/country dummies, observable characteristics of firms other than those related to liquidity and capacity utilization (and as we discuss later initial levels of debt and productivity) are not strong predictors of reported financial constraints.

5.3 Analysis of subsamples

To investigate possible heterogeneity of causal effects of financial constraints on innovation across types of firms, we re-estimate specification (11) for a series of sub-samples. In these sample splits, we focus only on the incidence of acquiring new technology and developing a new good since for these two measures of innovation we have the largest number of observations. For two other measures of innovation (TFP and positive R&D spending), we have too few observations for certain cells which makes statistical analysis imprecise and sensitive to a handful of observations. Table 4 reports our results for various sub-samples which differentiate firms by sector, age, size, ownership, region and time period.

First, by and large the strength of the causal effect is somewhat larger for service than for manufacturing, although in many cases we cannot reject the null of equality for these two sectors. The stronger responses for services probably reflect the fact that it is easier for firms in the manufacturing sector to collateralize (e.g., pledge a new piece of equipment as collateral for a loan) borrowing from external creditors than for firms in the service sector which tends to be more intensive in labor and possibly intangible assets such as loyalty of customers and customer base. According to this interpretation, the stronger response of the service sector to financial constraints may reflect higher cost of external finance due to lower collateralization, as suggested by Hypothesis 2.

Second, we also find that new firms are more sensitive to financial constraints than old firms. This finding is consistent with the idea that new firms may have shorter credit history which makes access to external financing harder and that they have had less opportunities to accumulate internal funds and hence need to rely more on external finance. Our finding is consistent with previous studies (e.g., Brown et al. (2009)) reporting that R&D spending of mature firms is much less sensitive to cash flow and external equity than that of young firms.

Third, the strength of the response strongly varies with the firm size. Small firms (2 to 10 employees) have the elasticity of innovation with respect to financial constraints two to three times larger than the elasticity of large firms (100 and more employees). This result is consistent with many previous studies documenting that small firms are more likely to experience lack of external funds and several informational frictions than large firms (see e.g. Harhoff (1998), Canepa and Stoneman (2008) and Ughetto (2008)).

Fourth, the sensitivity can also vary with the level of development of financial markets. Generally, more developed financial markets are more likely to overcome asymmetric information and other impediments for access to external credit. To examine this

hypothesis, we split countries into four regions commonly used in the analysis of Eastern European and CIS countries: Central European and Baltic countries which became new EU members; South-East European (SEE) countries (mainly Balkans); Western CIS (WCIS) countries (Belarus, Russia, Ukraine); Eastern CIS (ECIS) countries (Caucasus and Central Asia). The ranking of financial market development as an indicator of accessability of external finance typically runs from new EU members (most developed) to SEE to WCIS to ECIS (least developed). Therefore, according to Hypothesis 2, we should expect that the sensitivity of innovation to financial constraints should be the lowest in new EU member countries and the highest in the Eastern CIS countries. Our results strongly support this prediction. We find a relatively monotonous increase in sensitivity as we move from more to less financially developed economies.[18]

Fifth, we re-estimate specification (11) for state owned and foreign owned firms. Both types of firms are less likely to experience financial constraints since they can borrow funds internally either from an appropriate level of government (directly or indirectly using loan guarantees from the government) or from a mother company. Thus, they are less likely to be forced to rely on costly external finance, even in case of negative liquidity shocks and hence we should expect a weaker (if any) effect of financial constraints on innovation.[19] This conjecture is supported by our results: only state owned firms exhibit some sensitivity to financial constraints when we measure innovation as the incidence of acquiring a new technology; in all other cases, we find no significant sensitivity. In particular, foreign owned firms do not appear to be financially constrained in their innovation activities. Thus, we can identify financial constraints as one important reason for why domestically owned firms innovate less than foreign firms do, why domestically owned firms are less productive than foreign firms and why they do not catch up over time. In short, our analysis suggests that one important channel leading from financial constraints to unsatisfactory firm performance is the lack of innovation activity.

Finally, we explore the sensitivity of our results to different time samples and we find similar results for 2002 and 2005 waves of BEEPS.

5.4   Robustness checks

Financial constraints can have many dimensions. Typically, financial constraints are measured along (i) whether firms have access to external credit and (ii) the price firms

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[18]Our ranking of the countries is also consistent with the ranking of venture capital deals across countries, as documented by e.g. VentureXpert. Specifically, new EU member countries have the largest number of venture capital deals while ECIS countries have the lowest.

[19]For example, Harrison and Mcmillan (2003) report for firms in Côte d'Ivoire that domestically owned firms are more credit constrained in their investment than foreign firms.

have to pay for external credit if they have access to it. We have focused on whether firms have access to credit. In Table 5, we examine if our results also extend to the price of credit which we measure with the *cost of external credit* variable. We use the self-reported measure of the cost of financing which runs on 1 ("No obstacle") to 4 ("Major obstacle") scale. We find that results are largely the same as for the access to credit and thus we do not report all sample splits to preserve space.

In another robustness check, we examine if additional instrumental variables affect our estimate of innovation sensitivity to financial constraints. Specifically, we use a dummy variable which is equal to one if a firm had to resolve non-payment from customers in court. As shown in Table 5, we find results similar to our baseline.

It is possible that our results may be driven by initial levels of productivity and debt as these variables could affect the access to external finance and the incentives to innovate. To assess the quantitative importance of these factors, we augment the set of regressors with the level of labor productivity and level of debt as a fraction of total assets three years before the the current year in the survey wave.[20] Although these additional controls do affect our measures of financial constraints in the first stage regressions, we find estimates of the causal effect of financial constraints on innovation similar to our baseline set of estimates. Hence, we can rule out alternative explanations based on initial conditions.

To check for possible selection effects into foreign ownership, we explore the sensitivity of estimates to restricting the sample only to de novo firms and again find similar results. Likewise our results do not change substantively when we recode the ordinal self-reported measure of financial constraints into dummy variables equal to one if firms indicate severe constraints and zero otherwise.

Finally, our theory predicts that innovations are increasingly sensitive in their ability to be collateralized, as higher collateralization lowers the cost of external finance. To test this prediction, we use information (contained in the 2005 wave of BEEPS) about how new technology was implemented. Specifically, we construct two measures of new technology: i) machine-based when firms report that their new technology was mainly embodied in new equipment; ii) non-machine-based when new technology was primarily a result of research efforts. Consistent with our theory, we find that non-machine-based

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[20]This information is taken from retrospective questions. In this exercise we prefer labor productivity to total factor productivity because with labor productivity we have more observations than with total factor productivity. Results are similar when we use total factor productivity although the precision of TFP-based estimates is smaller. Information on the level of debt was collected only in the 2002 wave of BEEPS. We do not include these additional regressors in the baseline specification because these variables have many missing values which would substantially reduce the sample size available for estimation.

new technology is more sensitive to financial constraints than machine-based acquisition of new technology.[21]

6 Interaction of export and innovation

Previous research documents that financial constraints affect the export status of firms (see Berman and Héricourt (2008), Buch et al. (2009), Bellone et al. (2008), Greenaway et al. (2007)). It is also firmly established that exporting firms are more productive and innovate more than non-exporting firms (see e.g. Aw and Hwang (1995), Bernard and Jensen (1995), Bernard and Jensen (2004)), Bernard and Wagner (1997)).[22] However, the interplay between how exporting firms acquire these advantages over non-exporters is less clear. Importantly, causation may flow from export status to productivity (see e.g. Grossman and Helpman (1991), World Bank (1991), World Bank (1993), Van Biesebroeck (2005), and De Loecker (2007) for theoretical arguments and empirical evidence). In this section, we try to tie together effects of financial constraints on export status and productivity differences.

Our theoretical model suggests that measured productivity and innovation are jointly determined with export status. Furthermore, export status and innovation depend on whether a firm faces financial constraints. Specifically, for mild financial constraints, it is always optimal for firms to engage in both exporting and innovation since both activities are complementary. However, for sufficiently binding financial constraints, the activities become substitutes. Intuitively, both activities must rely on internal financing since neither activity can be collateralized. With mild financial constraints, both activities can be funded with internal resources and since one activity reinforces the other it is optimal for firms to do both activities. With a binding financial constraint, only one activity can be funded and, hence, export and innovation become substitutes. In what follows, we examine formally this testable implication of our theoretical model.

Table 6 reports the estimates for specification (11) where we replace the innovation dummy with an export dummy. In our analysis we consider two measures of export status. The first is the dummy variable (*Export*) equal to one if a firm exports any of its goods directly or indirectly and zero otherwise. The second is the dummy variable

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[21]We also experimented with including firm fixed effects to control for time-invariant factors. Although the signs of the estimated coefficients in fixed effect regressions were in line with the estimates we report for specifications without firm fixed effects, the sample size in fixed effect regressions was too small (about 700 firms) to have precise estimates given the amount of heterogeneity we have in the data. These results are available upon request.

[22]For a survey of empirical studies on this issue see Wagner (2007)

($NewExport$) equal to one if a firm has started to export in the last 3 years and zero otherwise. Consistent with the fact that starting new export involves larger expenses than maintaining export status (Das et al. (2007)), we find that $NewExport$ is more sensitive to financial constraints than $Export$. Thus, strengthening previous findings, we confirm that exporting is affected by financial constraints.

To study the interplay between export and innovation, we construct two additional variables. The first variable ($E\&I$) is the dummy variable equal to one if a firm both exports and innovates. The second variable ($EorI$) is the dummy equal to one if a firm either export or innovates but does not do both activities. $E\&I$ captures the complementary nature of export and innovation. $EorI$ reflects the substitutable nature of export and innovation. As we discussed above, the incidence of $E\&I$ relative to $EorI$ should be a decreasing function in the severity of financial constraints. This means, in practice, that if we use specification (11) with $E\&I$ and $EorI$ as the dependent variables, the elasticity of $E\&I$ with respect to financial constraint should be greater than the elasticity of $EorI$ with respect to financial constraint. We look for this pattern by estimating the $E\&I$ and $EorI$ regressions separately (i.e. IV probit for each regression) and as a multinomial IV probit. The advantage of the latter approach is that we can explicitly take into account the correlation across outcomes. We find that the elasticity for $E\&I$ is statistically and economically significantly larger in the $E\&I$ regression than it is for $EorI$ in the $EorI$ regression, thus confirming Hypothesis 3.

This finding clearly indicates that firms may be forced to a suboptimal behavior when financial frictions are severe. In particular, firms may fail to fully materialize gains from complementary export and innovation activities. Inability to jointly innovate and export can considerably slow down technological catching up to the frontier and thus can lead to persistent gaps between domestically and foreign owned firms.

7   Reconciling the stylized facts

We started our analysis with the stylized fact that in developing and transition economies, foreign owned firms are more productive than domestically owned firms and that this productivity gap is not decreasing over time. The evidence from BEEPS is consistent with this observation. As documented in Section 5.1, domestically owned firms in our sample are significantly and robustly less productive than companies under foreign ownership and foreign owned firms innovate more intensively than domestically owned firms. In other words, domestically owned firms fall behind the technological frontier often represented by foreign owned firms.

We conjectured that this gap in productivity and innovation may be due to domestically owned firms being more financially constrained than foreign firms because, as highlighted by other stylized facts, financial constraints at the firm level may be responsible for missed innovation and export activities which could enhance the productivity of domestically owned firms. Our findings support this conjecture: domestically owned firms are strongly hampered in their innovation and export activities by financial constraints, in particular small and young firms, while foreign owned firms do not seem to be affected. Furthermore, because of financial frictions, domestically owned firms cannot exploit potential complementarities between innovation and export activities which further widens the productivity gap.

Since our analysis can explain the effect of financial constraints on export and innovation (and more generally productivity) at the micro level, we can explore if the average size of the frictions reported at the country level is correlated with macroeconomic outcomes and thus can reconcile the macroeconomic evidence that the development of financial markets is strongly correlated with the development of a country. Figure 2 confirms that reported financial constraints at the firm level show a strong negative correlation with macro-level measures for productivity and export intensity, which is consistent with previous studies based on macroeconomic data (see Levine (2005), Lane (2009)). Our analysis can provide micro-foundations for this correlation so that one can interpret this relationship between financial and economic development at the macroeconomic level as a causal one.

8   Policy implications and concluding remarks

There are a number of policy implications to be drawn from our analysis. First of all, evidence presented in this paper may help to understand why the productivity of domestically owned firms in emerging economies catches up slowly to the technological frontier. Specifically, we argue that domestically firms may find it difficult to finance the innovation necessary to increase their productivity. We also offer a more detailed perspective for policymakers. We document that financial frictions are particularly detrimental for small or young firms. Policies aimed to help these types of firms are likely to have the biggest effect. We also find that firms in the service sector are more sensitive to financial constraints probably because it is harder to collateralize investment and innovation in this sector. Since the service sector has been underdeveloped in emerging market economies and, consequently, there is an acute need to expand the size and quality of the service sector, public policy should provide support to firms in the service sector so

that they can overcome financial frictions and catch up faster to world standards. Transition and emerging market economies can benefit from emulating policies (e.g., Small Business Innovation Research grants in the U.S.A.) that support innovations of firms most sensitive to financial frictions.

More broadly, our cross-country analysis of firms' behavior at the micro level strongly indicates that the severity of financial frictions faced by firms is decreasing in the level of development of financial markets. Since financial frictions slow down improvements in technology and the welfare costs of delayed productivity catch up are probably enormous, policy should also be directed toward establishing a framework for deep credit markets and a strong banking sector willing to provide access to external financing for a broad range of firms. In support of this policy prescription, Figure 3 shows that the self-reported measures of financial constraints are strongly negatively correlated with the EBRD's indexes of reforms in the financial and banking sectors. Hence, deeper reforms in these sectors are likely to alleviate the adverse effects of financial frictions and, consequently, to stimulate the growth of the economies in our sample.

Our findings also suggest that financial constraints may force firms to choose between innovation and internationalization strategies, thus losing out on the complementary effects of both strategies. This could explain why domestically owned firms in emerging economies benefit less from trade liberalization than should a priori be expected. The problem may be that they lack the finance to take advantage of new export opportunities, while being confronted with increased import competition. Thus, the integration of international product markets does not have the desired effects of pushing domestically owned firms towards the technology frontier if it is not accompanied by complementary financial market reforms.

Foreign multinationals may ease local credit constraints by bringing foreign capital into the economy which is consistent with the negative correlation between foreign presence and self-reported financial constraints (see Figure 3). However, to the extent that foreign firms borrow locally, they can also crowd out domestic borrowers and exacerbate financial constraints faced by domestically owned firms (see Marin and Schnitzer (2006) and Harrison and Mcmillan (2003) for further discussion and evidence). Deeper understanding globalization trade-offs as well as establishing exact mechanisms of how foreign presence affects financial frictions in developing economies is an important task for future studies.

9 Mathematical Appendix

Basic Setup

Consider the following example of a firm that is competing in a monopolistic competition environment à la Dixit Stiglitz. Consumers have a preference for variety and hence there are total expenditures Y on a diversified bundle of goods. Solving the utility maximization problem of a representative consumer, we can derive derive the demand function for the firm as

$$x = \frac{Yp^{-\sigma}}{P^{1-\sigma}}, \tag{12}$$

where p is the price charged by the firm, P is the price index of all varieties' prices, and σ is the elasticity of substitution.

Firms produce at a constant marginal cost c. If the firm innovates, it reduces this marginal cost to $\alpha c < c$, with $\alpha < 1$. If production is financed with external funds, the cost of each unit is increased by a factor of γ, with $\gamma > 1$. Profits are given by

$$\pi_0 = px - cx - F_I \tag{13}$$

if internal funds are used and no innovation is carried out. Firms set prices to maximize their profits. Consider the first order condition

$$\frac{d\pi_0}{dp} = x + (p - c)\frac{dx}{dp} = 0 \tag{14}$$

From 12 we can derive

$$\frac{dx}{dp} = -\sigma\frac{Yp^{-\sigma-1}}{P^{1-\sigma}} \tag{15}$$

using the fact that the price index does not change if a single firm changes its price, due to the continuum of firms.

Plugging 15 and 12 into 14, we can solve for the optimal price

$$p = c\frac{\sigma}{\sigma - 1} \tag{16}$$

Now, using 26 and 12, we can determine the profit as

$$\pi_0 = \frac{Y}{\sigma}\left(\frac{p}{P}\right)^{1-\sigma} \tag{17}$$

Consider next the case where external finance is used. The only difference with respect to π_0 is that now the constant marginal cost is multiplied by γ and so is the optimal price set by the firm. Hence

$$\pi_\gamma = \gamma^{(1-\sigma)}\pi_0 \tag{18}$$

Similarly, we can determine

$$\pi_0^I = \alpha^{(1-\sigma)}\pi_0 \tag{19}$$

and

$$\pi_\gamma^I = (\alpha\gamma)^{(1-\sigma)}\pi_0 \tag{20}$$

Thus, assumption 1 is confirmed by

$$\frac{d(\pi_\gamma^I - \pi_\gamma)}{d\gamma} = (1-\sigma)\gamma^{(-\sigma)}(\alpha^{1-\sigma} - 1)\pi_0 < 0 \tag{21}$$

Note that

$$
\begin{aligned}
\frac{d\Delta_\pi}{d\delta_L} &= -(\pi_0^I - \pi_0) + (\pi_\gamma^I - \pi_\gamma) \\
&= -(1-\gamma^{1-\sigma})(\alpha^{1-\sigma} - 1)\frac{Y}{\sigma}\left(\frac{p}{P}\right)^{1-\sigma} < 0 \tag{22}
\end{aligned}
$$

$\gamma > 1$, $\alpha < 1$ and $\sigma > 1$.

Interaction of export and innovation

To see that our assumptions

$$\pi_i^{IE} - \pi_i^I > \pi_i^E - \pi_i \tag{23}$$
$$\pi_i^{IE} - \pi_i^E > \pi_i^I - \pi_i \tag{24}$$

are reasonable, consider again

$$\pi_0 = \frac{Y}{\sigma}\left(\frac{p}{P}\right)^{1-\sigma} \tag{25}$$

as determined above, with

$$p = c\frac{\sigma}{\sigma - 1} \tag{26}$$

and π_γ likewise.

Note that the firm's profit without innovation differs only in the marginal cost and hence the price to be charged by the firm. Let $c = \alpha c < c$. Then we can write

$$
\begin{aligned}
\pi_0^I &= \frac{Y}{\sigma}\left(\frac{\alpha c}{P}\frac{\sigma}{\sigma - 1}\right)^{1-\sigma} \\
&= \frac{Y}{\sigma}\left(\frac{\alpha c}{P}\frac{\sigma}{\sigma - 1}\right)^{1-\sigma} \\
&= \alpha^{1-\sigma}\pi_0 > \pi_0 \tag{27}
\end{aligned}
$$

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Consider next the firm's payoff in case of exporting. To simplify notation, suppose that the foreign market is symmetric to the domestic market, such that the exporting firm is now confronted with an increase in demand, represented by an increase in total expenditures $mE > E$. Thus, we can write

$$\pi_0^E = m\pi_0 = \frac{mY}{\sigma}\left(\frac{c}{P}\frac{\sigma}{\sigma-1}\right)^{1-\sigma} \tag{28}$$

and

$$\pi_0^{IE} = m\pi_0^I = \frac{mY}{\sigma}\left(\frac{\alpha c}{P}\frac{\sigma}{\sigma-1}\right)^{1-\sigma} = m\alpha^{1-\sigma}\pi_0 \tag{29}$$

Then it is straightforward to see that

$$\pi_0^{IE} - \pi_0^I = (m\alpha^{1-\sigma} - \alpha^{1-\sigma})\pi_0 = \alpha^{1-\sigma}(m-1)\pi_0 > (m-1)\pi_0 = \pi_0^E - \pi_0 \tag{30}$$

and similarly

$$\pi_0^{IE} - \pi_0^E = (m\alpha^{1-\sigma} - m)\pi_0 = m(\alpha^{1-\sigma} - 1)\pi_0 > (\alpha^{1-\sigma} - 1)\pi_0 = \pi_0^I - \pi_0 \tag{31}$$

and similarly for π_γ^{IE}, π_γ^E and π_γ^I.

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Figure 1: Measurement of financial constraints.
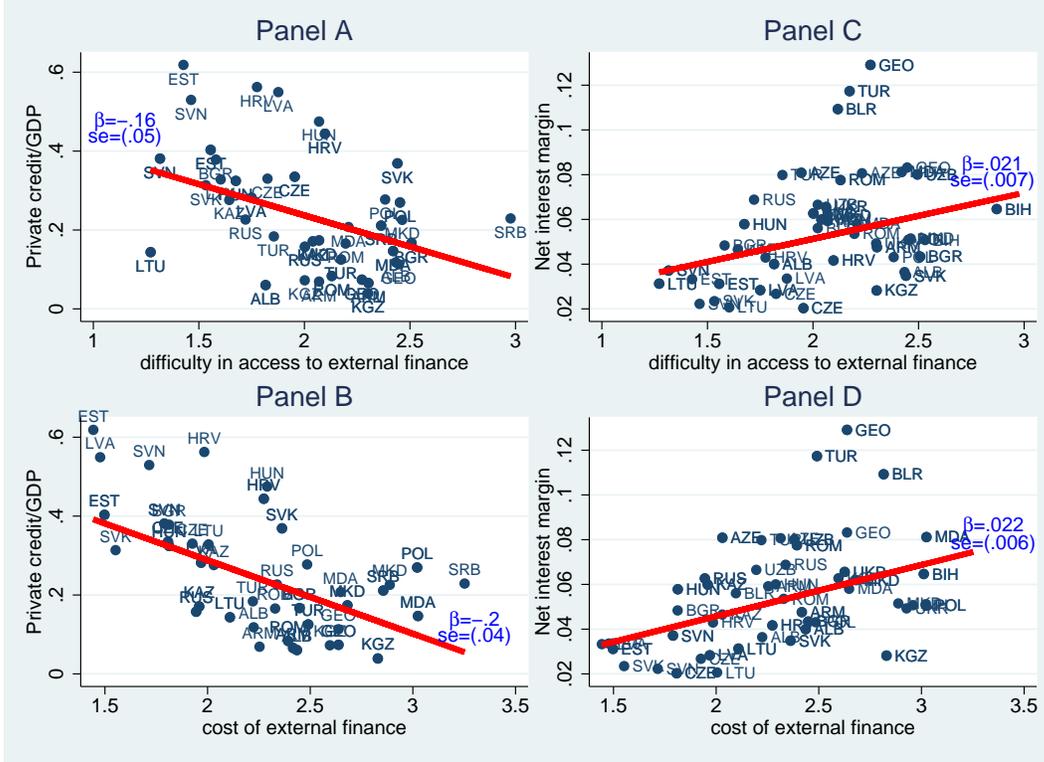
Notes: The figure presents macroeconomic indicators of financial development against the average value (weighted by employment size) of reported severity of access to external finance and cost of access to external finance across all types of firms in a given country and year (2002 and 2005). The ratio of private credit to GDP and the net interest margin (which is the accounting value of bank's net interest revenue as a share of its interest-bearing (total earning) assets) are taken from the World Bank's Database on Financial Development and Structure (updated May 2009). The solid red line is the fitted line from the Huber robust regression with β and *se* showing the estimated slope and the associated standard error. In all panels, the slope is significantly different from zero at 1 percent.

Figure 2: Financial constraints and macroeconomic outcomes.
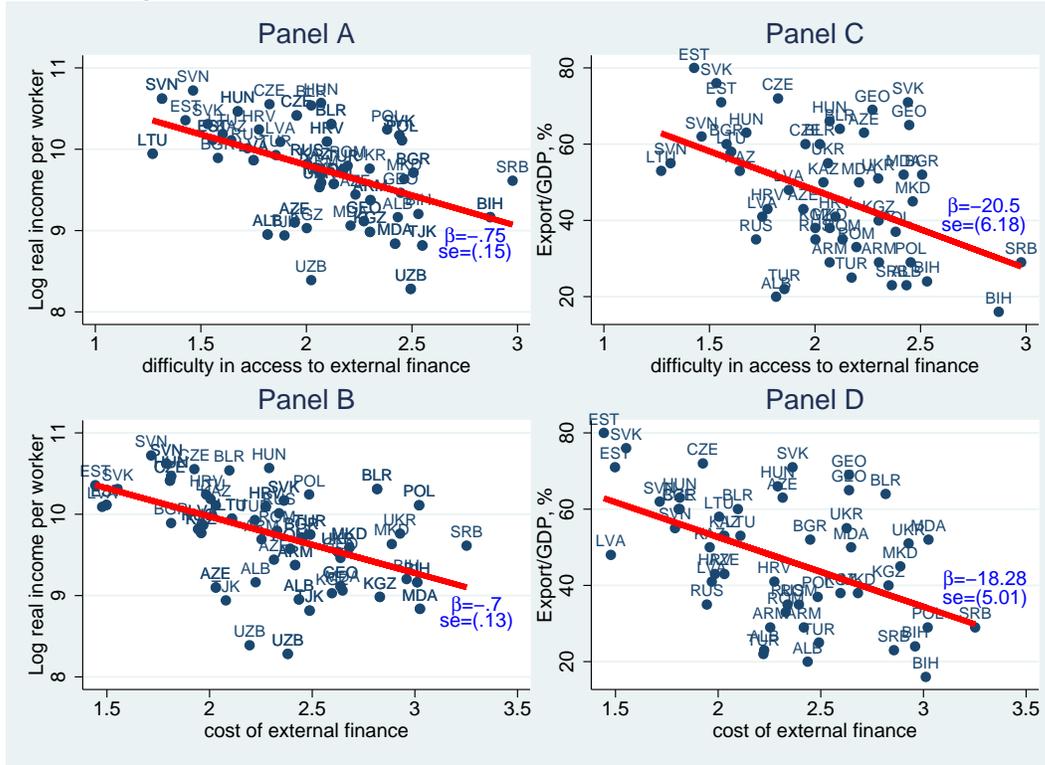
Notes: The figure presents macroeconomic outcomes against the average value (weighted by employment size) of reported severity of access to external finance and cost of access to external finance across all types of firms in a given country and year (2002 and 2005). Log real income per worker data are from the Penn World Tables (version 6.3). The ratio of export to GDP data are from the IMF's IFS database. The solid red line is the fitted line from the Huber robust regression with β and se showing the estimated slope and the associated standard error. In all panels, the slope is significantly different from zero at 1 percent.

Figure 3: Financial constraints, reforms in financial and banking sectors, and foreign presence.
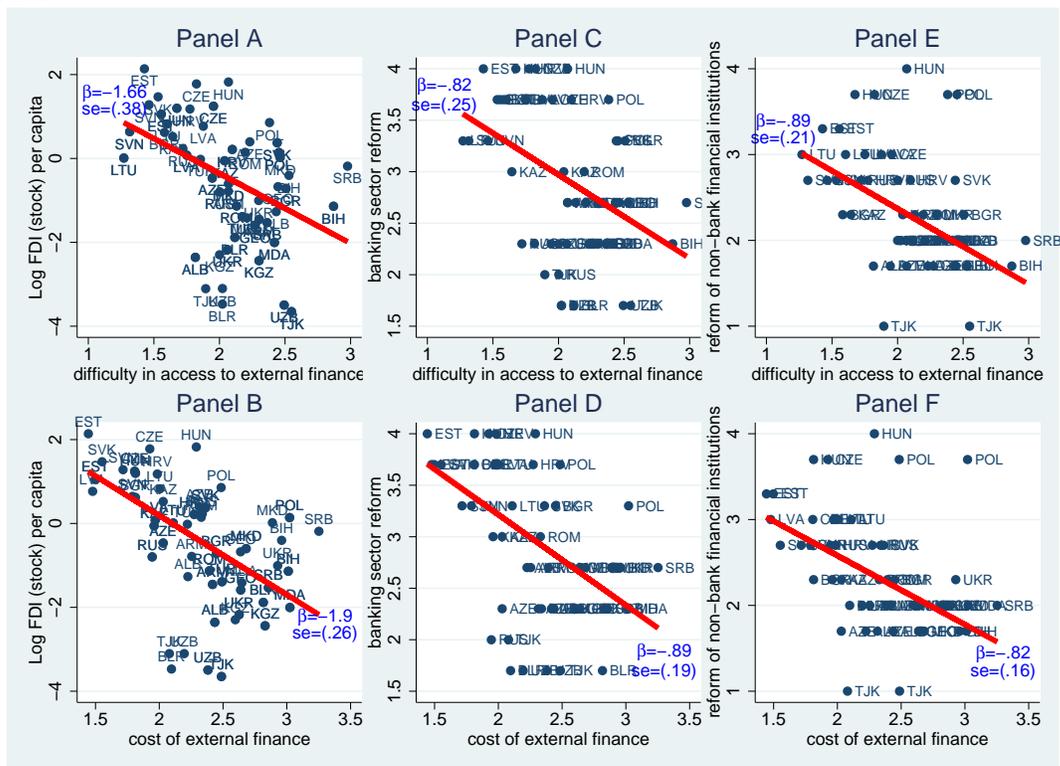
Notes: The figure presents macroeconomic outcomes against the average value (weighted by employment size) of reported severity of access to external finance and cost of access to external finance across all types of firms in a given country and year (2002 and 2005). Indexes of reforms in financial and banking sectors are from the European Bank for Reconstruction and Development (EBRD). Foreign direct investment (FDI) stock data are from UNCTAD. The solid red line is the fitted line from the Huber robust regression with β and *se* showing the estimated slope and the associated standard error. In all panels, the slope is significantly different from zero at 1 percent.

Table 1. The link between Solow residual and innovations.

	Solow residual				
	(1)	(2)	(3)	(4)	(5)
New technology	0.038**			0.032*	0.032
	(0.018)			(0.018)	(0.021)
New good		0.036**		0.033*	0.018
		(0.017)		(0.018)	(0.021)
Positive R&D spending			0.145***		0.119***
			(0.024)		(0.026)
Observations	6,861	6,922	4,733	6,829	4,677
R-squared	0.397	0.388	0.433	0.408	0.455

Notes: *Solow residual* measures log total factor productivity computed as log sales minus log capital, log employment, and log material input weighted by cost shares of each input and adjusted for capacity utilization (see equation (10)). Cost shares are allowed to vary by industry and country. *New technology* is the dummy variable equal to one if the firm reports successful development and/or adaption of new technology and zero otherwise. *New good* is the dummy variable equal to one if the firm reports successful introduction of a new good or service and zero otherwise. *Positive R&D spending* is the dummy variable equal to one if the firm reports positive research and development spending and zero otherwise. Dummy variables for interactions between year, country, and industry are included but not reported. Robust standard errors are in parentheses. ***, **, * denote significance at 0.01, 0.05, and 0.10 levels.

Table 2. Differences in productivity between foreign and domestic private firms.

	all years	2002	2005	De novo firms, all years	Control for productivity at $t-3$, all years
	(1)	(2)	(3)	(4)	(5)
Total factor productivity	0.115***	0.096**	0.135***	0.106***	0.061***
	(0.024)	(0.042)	(0.028)	(0.031)	(0.023)
Observations	6,266	2,236	4,030	3,845	6,010
R-squared	0.158	0.213	0.210	0.136	0.229
Labor productivity	0.258***	0.245***	0.266***	0.231***	0.104***
	(0.022)	(0.038)	(0.027)	(0.028)	(0.012)
Observations	10,587	4,205	6,382	6,681	10,116
R-squared	0.582	0.501	0.621	0.556	0.881
New good	0.072***	0.073***	0.064***	0.069***	0.074***
	(0.011)	(0.016)	(0.015)	(0.013)	(0.014)
Observations	14,513	5,701	8,812	9,430	10,096
R-squared	0.073	0.100	0.073	0.070	0.077
New technology	0.036***	0.029**	0.046***	0.039***	0.030**
	(0.011)	(0.015)	(0.015)	(0.013)	(0.013)
Observations	14,395	5,689	8,688	9,342	9,997
R-squared	0.087	0.095	0.094	0.089	0.100
Positive R&D spending	0.110***	0.047***	0.146***	0.088***	0.108***
	(0.012)	(0.013)	(0.018)	(0.015)	(0.014)
Observations	7,032	2,055	4,977	4,401	6,317
R-squared	0.538	0.561	0.153	0.578	0.507

Notes: Each panel reports the estimated OLS coefficient on the foreign ownership dummy variable for the equation with the dependent variable shown in the left column. A firm is considered foreign owned if foreigners have 50 or more percent ownership. Fixed effects for year, country, and industry are included but not reported. *Solow residual* measures log total factor productivity computed as log sales minus log capital, log employment, and log material input weighted by cost shares of each input and adjusted for capacity utilization (see equation (10)). Cost shares are allowed to vary by industry and country. *Labor productivity* is computed as log of sales to employment ratio. *New technology* is the dummy variable equal to one if the firm reports successful development and/or adaption of new technology and zero otherwise. *New good* is the dummy variable equal to one if the firm reports successful introduction of a new good or service and zero otherwise. *Positive R&D spending* is the dummy variable equal to one if the firm reports positive research and development spending and zero otherwise. *De novo firms* are firms founded after 1991. Robust standard errors are in parentheses. ***, **, * denote significance at 0.01, 0.05, and 0.10 levels.

Table 3. Baseline results.

	New good		New technology		Positive R&D spending		Solow residual	
	IV probit (1)	Probit (2)	IV probit (3)	Probit (4)	IV probit (5)	Probit (6)	IV (7)	OLS (8)
Difficulty of access to external finance	-0.421*** (0.090)	0.019 (0.012)	-0.589*** (0.068)	-0.008 (0.013)	-0.721*** (0.077)	0.010 (0.026)	-0.222*** (0.066)	0.006 (0.007)
Share of sales to MNE	0.130* (0.068)	0.182*** (0.070)	0.090 (0.067)	0.174** (0.071)	0.149 (0.117)	0.310** (0.146)	0.036 (0.047)	0.040 (0.043)
Share of imported inputs	0.256*** (0.037)	0.235*** (0.038)	0.254*** (0.038)	0.241*** (0.041)	0.263*** (0.066)	0.299*** (0.084)	-0.011 (0.028)	-0.038 (0.025)
ln(Labor)	0.204*** (0.038)	0.256*** (0.035)	0.228*** (0.041)	0.328*** (0.038)	0.159** (0.074)	0.333*** (0.097)	0.101*** (0.026)	0.115*** (0.024)
ln(Labor)²	-0.019*** (0.005)	-0.021*** (0.005)	-0.020*** (0.005)	-0.024*** (0.005)	0.006 (0.009)	0.010 (0.013)	-0.008** (0.004)	-0.008** (0.003)
Share of skilled labor	0.032 (0.044)	0.031 (0.047)	0.016 (0.044)	0.020 (0.050)	-0.083 (0.077)	-0.142 (0.102)	0.008 (0.035)	0.036 (0.031)
Share of labor with university degree	0.147*** (0.053)	0.195*** (0.054)	0.120** (0.055)	0.200*** (0.059)	0.022 (0.095)	0.084 (0.128)	0.073* (0.043)	0.094** (0.039)
Markup	0.229** (0.106)	0.246** (0.103)	0.428*** (0.098)	0.523*** (0.103)	0.485*** (0.158)	0.608*** (0.207)	0.023 (0.066)	-0.006 (0.060)
Log(age)	-0.091*** (0.020)	-0.093*** (0.021)	-0.064*** (0.019)	-0.068*** (0.021)	-0.076** (0.033)	-0.088** (0.045)	-0.017 (0.016)	-0.016 (0.014)
Capacity utilization	-0.349*** (0.063)	-0.244*** (0.064)	-0.382*** (0.061)	-0.263*** (0.067)	-0.460*** (0.104)	-0.382*** (0.137)	-1.369*** (0.050)	-1.303*** (0.042)
Compete in national markets	0.131*** (0.034)	0.146*** (0.035)	0.191*** (0.037)	0.241*** (0.037)	0.213*** (0.069)	0.356*** (0.076)	0.009 (0.022)	0.007 (0.020)
Elasticity with respect to access to finance	-1.016*** (0.224)	0.045 (0.027)	-1.650*** (0.221)	-0.021 (0.032)	-1.988*** (0.304)	0.023 (0.056)	-0.492*** (0.146)	0.013 (0.015)
Observations	10,660	10,660	10,591	10,591	5,263	5,263	4,668	4,668
Over-id p-val	0.663		0.425		0.192		0.295	
1st stage F-stat	58.09		57.17		19.26		28.53	

Notes: *Solow residual* measures log total factor productivity computed as in equation (10). *New technology* is the dummy variable equal to one if the firm reports successful development and/or adaption of new technology and zero otherwise. *New good* is the dummy variable equal to one if the firm reports successful introduction of a new good or service and zero otherwise. *Positive R&D spending* is the dummy variable equal to one if the firm reports positive research and development spending and zero otherwise. Robust standard errors are in parentheses. ***, **, * denote significance at 0.01, 0.05, and 0.10 levels. *Over-id p-val* is the p-value for the overidentifying restrictions test. *Elasticity* is the marginal effect divided by the mean value of the dependent variable and multiplied by the mean value of the difficulty in access to external finance. *1st stage F-stat* is the value of the F statistic for the hypothesis that instrumental variables have jointly zero coefficients in the first stage regression. Fixed effects for year, country, industry and location are included but not reported. Only private domestically owned firms are included in the estimation sample.

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Table 4. IV probits estimates: Sample splits.

	New good			New technology		
	Estimate (1)	Elasticity (2)	Obs. (3)	Estimate (4)	Elasticity (5)	Obs. (6)
Sector						
Manufacturing	-0.402***	-0.795***	3,628	-0.567***	-1.264***	3,605
	(0.139)	(0.275)		(0.108)	(0.245)	
Services	-0.462***	-1.245***	5,687	-0.736***	-2.816***	5,628
	(0.159)	(0.466)		(0.078)	(0.462)	
Firm age						
New	-0.454***	-1.100***	8,276	-0.653***	-1.895***	8,233
	(0.117)	(0.292)		(0.075)	(0.264)	
Old	-0.387***	-0.926***	2,356	-0.382**	-0.971***	2342
	(0.147)	(0.360)		(0.161)	(0.430)	
Firm Size						
2-10	-0.668***	-1.999***	4,889	-0.766***	-3.162***	4,906
	(0.084)	(0.300)		(0.058)	(0.399)	
11-49	-0.578***	-1.303***	3,349	-0.697***	-1.811***	3,318
	(0.153)	(0.354)		(0.101)	(0.294)	
50-99	-0.423*	-0.854*	986	-0.604*	-1.316*	980
	(0.263)	(0.532)		(0.369)	(0.824)	
100+	-0.381**	-0.728**	1,381	-0.457***	-0.907***	1,380
	(0.185)	(0.355)		(0.173)	(0.344)	
Ownership						
State	-0.209	-0.502	1,831	-0.323**	-0.795**	1,467
	(0.170)	(0.413)		(0.155)	(0.395)	
Foreign	-0.289	-0.504	1,840	-0.297	-0.634	1,824
	(0.290)	(0.505)		(0.271)	(0.591)	
Region						
New EU members	-0.027	-0.068	3,260	-0.335	-0.974	3,238
	(0.244)	(0.606)		(0.242)	(0.773)	
South-East Europe	-0.425**	-0.897**	2,214	-0.572***	-1.467***	2,202
	(0.167)	(0.353)		(0.128)	(0.350)	
Western CIS	-0.810***	-1.793***	2,112	-0.765***	-2.122***	2,094
	(0.104)	(0.238)		(0.122)	(0.404)	
Eastern CIS	-0.886***	-2.557***	2,324	-0.889***	-2.410***	2,310
	(0.049)	(0.178)		(0.046)	(0.167)	
Year						
2002	-0.469***	-1.200***	3,945	-0.622***	-1.930***	3,950
	(0.126)	(0.340)		(0.101)	(0.388)	
2005	-0.357**	-0.798***	2,214	-0.463***	-1.205***	6,672
	(0.136)	(0.353)		(0.124)	(0.349)	

Notes: The table reports estimates of the coefficient on the *difficulty in access to external credit* in equation (11). *New technology* is the dummy variable equal to one if the firm reports successful development and/or adaption of new technology and zero otherwise. *New good* is the dummy variable equal to one if the firm reports successful introduction of a new good or service and zero otherwise. *Elasticity* is the marginal effect divided by the mean value of the dependent variable (unconditional probability of success) and multiplied by the mean value of difficulty in access to external finance. Fixed effects for year, country, industry and location are included but not reported. The sample includes only private domestically owned firms unless stated otherwise. Robust standard errors are in parentheses. ***, **, * denote significance at 0.01, 0.05, and 0.10 levels.

Table 5. IV probits estimates: Robustness checks.

	New good			New technology		
	Coefficient (1)	Elasticity (2)	Obs. (3)	Coefficient (4)	Elasticity (5)	Obs. (6)
Cost of external finance	-0.399*** (0.091)	-0.962*** (0.225)	10,665	-0.565*** (0.071)	-1.580*** (0.228)	10,739
Additional instrument	-0.421*** (0.090)	-1.016*** (0.224)	10,660	-0.589*** (0.068)	-1.650*** (0.221)	10,591
Control for initial productivity, $ln(\frac{Y_{t-3}}{L_{t-3}})$	-0.374*** (0.109)	-0.910*** (0.273)	7,626	-0.600*** (0.074)	-1.705*** (0.249)	7,582
Control for initial debt, $(\frac{D_{t-3}}{Y_{t-3}})$	-0.553*** (0.126)	-1.429*** (0.348)	3,778	-0.722*** (0.081)	-2.334*** (0.350)	3,782
De novo firms founded after 1991	-0.397*** (0.133)	-0.961*** (0.332)	6,830	-0.638*** (0.088)	-1.887*** (0.318)	6,774
New technology Machine-based				-0.517*** (0.114)	-1.602*** (0.428)	6,732
Non Machine-based				-0.784*** (0.052)	-6.679*** (1.206)	6,732

Notes: The table reports estimates of the coefficient on the *difficulty in access to external credit* in equation (11) except the first row where estimates are reported for the *cost of external finance* which is the self-reported measure of the cost of external credit on scale from 1 ("No obstacle") to 4 ("Major obstacle"). *Additional instrument* is the dummy variable equal to one if the firm reported being plaintiff in resolving overdue payments in court and zero otherwise. This additional instrument is combined with other instruments. *New technology* is the dummy variable equal to one if the firm reports successful development and/or adaption of new technology and zero otherwise. *New good* is the dummy variable equal to one if the firm reports successful introduction of a new good or service and zero otherwise. *Elasticity* is the marginal effect divided by the mean value of the dependent variable (unconditional probability of success) and multiplied by the mean value of difficulty in access to external finance or, where appropriate, cost of external finance. Productivity $ln(\frac{Y_{t-3}}{L_{t-3}})$ and initial debt $(\frac{D_{t-3}}{Y_{t-3}})$ are from retrospective questions. Information about debt was collected only in the 2002 wave of BEEPS. *De novo firms* are firms founded after 1991. Only private domestically owned firms are included in the estimation sample. Fixed effects for year, country, industry and location are included but not reported. Robust standard errors are in parentheses. ***, **, * denote significance at 0.01, 0.05, and 0.10 levels.

Table 6. Effect of financial constraints on export and innovation.

	Export				New Export			
	Separate IV Probits		Multinomial IV Probit		Separate IV Probits		Multinomial IV Probit	
	Coefficient	Elasticity	Coefficient	Elasticity	Coefficient	Elasticity	Coefficient	Elasticity
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Export								
Export	-0.282**	-0.682**	-	-	-0.429***	-1.081*	-	-
	(0.126)	(0.351)			(0.137)	(0.617)		
Panel B: New good								
E&I	-0.589***	-2.303**	-0.592***	-1.428***	-0.665***	-3.765**	-0.512***	-1.134***
	(0.095)	(0.901)	(0.062)	(0.179)	(0.082)	(1.744)	(0.082)	(0.161)
EorI	-0.334***	-0.795***	-0.401***	-0.736***	-0.457***	-1.139***	-0.288***	-0.443
	(0.096)	(0.232)	(0.111)	(0.070)	(0.083)	(0.216)	(0.103)	0.063
Panel C: New technology								
E&I	-0.764***	-5.110***	-0.596***	-1.293***	-0.746***	-5.880***	-0.705***	-1.143***
	(0.045)	(1.144)	(0.062)	(0.171)	(0.059)	(2.191)	(0.055)	(0.159)
EorI	-0.384***	-0.981***	-0.344***	-0.578***	-0.449***	-1.218**	-0.330***	-0.497***
	(0.092)	(0.245)	(0.116)	(0.065)	(0.089)	(0.262)	(0.122)	(0.061)

Notes: The table reports estimates of the coefficient on the *difficulty in access to external credit* in equation (11). *Export* is the dummy variable equal to one if the firm reports positive export sales and zero otherwise. *New Export* is the dummy variable equal to one if the firm started exporting goods over last three years and zero otherwise. *New technology* is the dummy variable equal to one if the firm reports successful development and/or adaption of new technology and zero otherwise. *New good* is the dummy variable equal to one if the firm reports successful introduction of a new good or service and zero otherwise. *Elasticity* is the marginal effect divided by the mean value of the dependent variable (unconditional probability of success) and multiplied by the mean value of difficulty in access to external finance. Only private domestically owned firms are included in the estimation sample. Fixed effects for year, country, industry and location are included but not reported. Robust standard errors are in parentheses. ***, **, * denote significance at 0.01, 0.05, and 0.10 levels.

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Appendix Tables

Appendix table A1. Descriptive statistics.

	Mean	St.Dev.
Innovation Variables		
New Product	0.374	0.484
New Technology	0.302	0.459
Positive R&D spending	0.370	0.482
Total factor productivity	1.668	0.710
Measures of financial constraints		
Difficulty of access to external finance	2.333	1.145
Cost of external finance	2.574	1.129
Export activity		
Export	0.204	0.403
New Export	0.095	0.294
Vertical Transfer of Capability		
Share of sales to multinationals (MNEs)	0.066	0.196
Share of imported inputs	0.258	0.359
Controls		
ln(Labor)	3.000	1.604
ln(Labor)^2	11.577	11.530
Share of skilled workers	0.487	0.309
Share of workers with university education	0.272	0.290
Log(age)	2.367	0.777
Compete in national markets	0.667	0.471
Markup	0.209	0.118
Capacity utilization	0.794	0.177
Location		
Capital	0.313	0.464
Other, over 1 million	0.060	0.237
Other, 250,000-1,000,000	0.157	0.364
Other, 50,000-250,000	0.224	0.417
Under 50,000	0.241	0.428

Appendix table A2. Unconditional probabilities of innovation.

	New technology	New good	R&D expenditure
	(1)	(2)	(3)
Sector			
Manufacturing	0.492	0.431	0.431
Services	0.314	0.227	0.302
Firm age			
New	0.300	0.375	0.336
Old	0.329	0.372	0.459
Firm Size			
2-10	0.207	0.298	0.188
11-50	0.333	0.395	0.351
51-100	0.376	0.440	0.450
100+	0.430	0.459	0.695
Ownership			
Private domestic	0.299	0.366	0.307
State	0.309	0.320	0.561
Foreign	0.352	0.463	0.582
Region			
New EU members	0.262	0.357	0.355
South-East Europe	0.361	0.456	0.353
Western CIS	0.322	0.417	0.500
Eastern CIS	0.326	0.314	0.309

Appendix table A3. Unconditional probabilities of innovation and export status by types of financial constraints.

Difficulty in access to external finance	No obstacle		Minor obstacle		Moderate obstacle		Major obstacle		Total	
	prob.	N obs	prob.	N obs	prob.	N obs	prob.	N obs	prob.	N obs
Export										
Export	0.202	3,889	0.212	2,395	0.202	2,900	0.211	2,442	0.206	11,626
Export AND new good	0.097	3,878	0.094	2,391	0.104	2,898	0.105	2,439	0.100	11,606
Export AND new technology	0.081	3,848	0.090	2,375	0.084	2,883	0.078	2,418	0.083	11,524
Export OR new good but not both	0.351	3,878	0.392	2,391	0.372	2,898	0.401	2,439	0.375	11,606
Export OR new technology but not both	0.331	3,848	0.338	2,375	0.346	2,883	0.357	2,418	0.342	11,524
New Export										
Export	0.093	3,774	0.099	2,328	0.096	2,791	0.103	2,283	0.097	11,176
Export AND new good	0.056	3,765	0.048	2,325	0.060	2,788	0.056	2,281	0.055	11,159
Export AND new technology	0.046	3,736	0.047	2,306	0.050	2,773	0.042	2,258	0.046	11,073
Export OR new good but not both	0.322	3,765	0.365	2,325	0.352	2,788	0.391	2,281	0.352	11,159
Export OR new technology but not both	0.290	3,736	0.312	2,306	0.308	2,773	0.324	2,258	0.306	11,073

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Appendix table A4. First stage regression.

	New good (1)	New technology (2)	Positive R&D spending (3)	Solow residual (4)
Overdue dummy	0.290***	0.288***	0.295***	0.302***
	(0.031)	(0.031)	(0.042)	(0.046)
NTPcustomer dummy	0.055	0.088	-0.018	-0.172
	(0.122)	(0.121)	(0.169)	(0.184)
NTPsupplier dummy	0.232**	0.206*	0.248	0.395**
	(0.108)	(0.107)	(0.154)	(0.165)
Share of sales to MNE	-0.052	-0.056	-0.042	0.006
	(0.057)	(0.057)	(0.083)	(0.086)
Share of imported	0.146***	0.148***	0.152***	0.159***
inputs	(0.033)	(0.033)	(0.047)	(0.049)
ln(Labor)	-0.041	-0.036	-0.055	-0.064
	(0.027)	(0.027)	(0.040)	(0.044)
ln(Labor)^2	-0.003	-0.004	-0.001	-0.000
	(0.004)	(0.004)	(0.005)	(0.006)
Share of skilled labor	0.011	0.003	0.000	-0.128**
	(0.039)	(0.039)	(0.057)	(0.061)
Share of labor	-0.029	-0.029	-0.007	-0.075
with university degree	(0.045)	(0.045)	(0.067)	(0.073)
Markup	0.038	0.045	0.138	0.114
	(0.088)	(0.088)	(0.115)	(0.125)
Log(age)	-0.024	-0.022	-0.027	-0.009
	(0.017)	(0.017)	(0.024)	(0.026)
Compete in national markets	0.003	0.000	-0.036	0.011
	(0.029)	(0.029)	(0.040)	(0.043)
Capacity utilization	-0.279***	-0.281***	-0.306***	-0.273***
	(0.054)	(0.055)	(0.078)	(0.084)
Observations	10,690	10,591	5,263	4,668
R-squared	0.085	0.085	0.095	0.105

Notes: The table reports the first stage estimation results for estimates reported in Table 3. *Overdue dummy* is the dummy variable equal to one if a firm has overdue payments to suppliers. *NTPcustomer dummy* is the share of payments from customers settled by debt swaps or offsets and exchange of goods for goods (barter). *NTPsupplier dummy* is the share of payments to suppliers settled by debt swaps or offsets and exchange of goods for goods (barter). *Solow residual* measures log total factor productivity computed as log sales minus log capital, log employment, and log material input weighted by cost shares of each input and adjusted for capacity utilization (see equation (10)). Cost shares are allowed to vary by industry and country. *New technology* is the dummy variable equal to one if the firm reports successful development and/or adaption of new technology and zero otherwise. *New good* is the dummy variable equal to one if the firm reports successful introduction of a new good or service and zero otherwise. *Positive R&D spending* is the dummy variable equal to one if the firm reports positive research and development spending and zero otherwise. Only private domestically owned firms are included in the estimation sample. Robust standard errors are in parentheses. ***, **, * denote significance at 0.01, 0.05, and 0.10 levels.