REALLOCATION, COMPETITION and PRODUCTIVITY: EVIDENCE FROM A FINANCIAL LIBERALIZATION EPISODE*

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Abstract

This paper studies the impact of distortions in the access to international capital markets on competition and productivity. I show that a reduction in these distortions leads to an increase in aggregate productivity through two different channels. First, previously credit-constrained firms respond to better financing terms by increasing their investment in technology, a reallocation effect. Second, non-constrained firms also expand their investment in technology due to increased competition, a pro-competitive effect. I provide evidence for these two channels using firm-level census data around the deregulation of international financial flows in Hungary.

Keywords: TFP, firm-level distortions, market competition, financial liberalization.

JEL: F36, F43, O47.

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1 Introduction

International financial integration has been traditionally viewed as an engine of growth leading to a more efficient allocation of capital across countries, and accelerating the convergence of developing economies. Yet financial crises in emerging markets during the nineties challenged this view, and led to a reassessment of the benefits of capital account liberalization. Scholars and policy makers started to consider the possibility of, and even advocate, capital controls to reduce the extent of financial liberalization. This paper assesses the impact of capital account openness on firms' access to external finance, and their implications for market competition and economic growth.

This paper shows that capital controls can create asymmetries in the access to capital markets across firms that distort competition and economy-wide incentives to innovate. I start by showing theoretically that, provided financial development is sufficiently high, financial liberalization leads to aggregate productivity growth through two different channels. First, it improves financing terms and encourages previously credit-constrained firms to invest in technology, a reallocation effect. Second, it tightens product market competition and induces unconstrained firms to do the same, a pro-competitive effect. Next, I test empirically these two channels using firm-level census data of the period covering the deregulation of international financial flows in Hungary. This reform revoked capital controls that had imposed an asymmetry in the access to international borrowing across firms. This pre-reform asymmetry between discriminated firms -those that, by law, were previously shut out of international credit markets- and non-discriminated firms allows me to identify the effects of financial liberalization across firms. The empirical results support the view that financial liberalization episodes can lead to a reduction in the asymmetries in the access to external finance across firms that deepen competition and promote a broad-based increase in firms' investment in technology. This provides, for the first time, firm-level evidence for the micro-mechanisms underpinning the substantial increases in aggregate productivity that follow financial liberalization episodes, a robust correlation previously documented by a large cross-country literature.

To guide my empirical work, I develop a small open economy model in which capital controls create asymmetries in the access to capital markets across firms that affect the tightness of competition and investment in technology. The model shows that the impact of financial liberalization on capital-scarce economies depends on the level of financial development of the country. If financial development is sufficiently high, a reduction in capital controls leads to capital inflows and to a decrease in the domestic interest rate that reduces asymmetries in the access to external finance across firms. Financial liberalization promotes aggregate productivity growth through two channels. Discriminated firms innovate more because the reduction in the domestic interest rate raises their post-innovation profits. Non-discriminated firms also innovate more because increased competition raises their incremental profits from innovating. In this case, financial liberalization is associated with capital inflows, deeper competition and aggregate productivity growth. Instead, if financial development is low, a reduction in capital controls leads to capital outflows, and to an increase in the asymmetries in the access to capital markets across firms, which undermines competition and economy-wide incentives to invest in technology.

I next use the deregulation of international financial flows in Hungary in 2001 to test the model's qualitative implications. A key feature of the period before the liberalization is that capital controls had distorted the access to international borrowing across firms, allowing me to identify the effect of the reform within Hungary. In particular, capital controls restricted domestic firms to borrow locally in a tight credit market, while allowed foreign firms to raise funds abroad and, thus, circumvent the low credit of the Hungarian financial system. In 2001, all capital controls were lifted and, with them, the ban on domestic firms' international borrowing. In my empirical analysis, I exploit this asymmetry in the access to international funds between domestic and foreign firms prior to the liberalization as a first source of cross-sectional variation. I complement this analysis by adding a second source of cross-sectional variation - differential needs for external finance at the sector level - and test whether the liberalization affected firms differentially as a function of their sectoral exposure to the reform.

The firm-level census data that I analyze (APEH) provides information on firms' balance sheets reported to tax authorities for the entire population of firms during the period 1992-2008. This extensive database allows me to build comprehensive measures of productivity, capital, and use of external finance for all firms in the economy over a long panel. It constitutes an advance over previous studies in the financial liberalization literature that focused only on small samples of large and public-listed firms. In addition, I complement my analysis with the Business Environment and Enterprise Performance Surveys (BEEPS) of the World Bank and the European Bank for Reconstruction and Development, which report direct information on firms' R&D, innovation activities and financing terms.

In my empirical analysis, I document first that capital controls in Hungary were associated with a low level of credit, and worse financing conditions and lower leverage for domestic firms, even after controlling for firm-observable characteristics. The liberalization of capital controls in 2001 led to large capital inflows and to an expansion of the local credit supply that substantially improved financing terms for these firms. By 2004, the difference in the interest rate paid by domestic and foreign firms fell five-fold, and the difference in the required collateral dropped by four-fold. This improvement in financing terms was associated with a 23% increase in domestic firms' leverage and a reallocation of credit towards these firms, whose share in total credit increased by seventeen percentage points.

I then assess whether this reduction in capital market distortions is consistent with reallocation towards domestic firms. In line with this first channel, I demonstrate that, while prior to the financial liberalization domestic and foreign firms' growth rates were not statistically different, following the reform, domestic firms started growing much faster. In particular, I find that domestic firms differentially increase their capital intensity (25%), labor productivity (5%), revenue TFP (RTFP) (3%), and their probability of conducting R&D and innovation activities (9 and 12 percentage points).[1] In line with the easing of financing terms, this expansion is greater in sectors

[1]It is important to differentiate revenue TFP from physical TFP. Unfortunately, I am only able to measure RTFP given the lack of information on firms' prices. See also Foster, Haltiwanger, and Syverson (2008).

where domestic firms had greater needs for external finance. Notably, domestic firms differentially increase their leverage as a function of sectoral financial needs.

Additionally, my results point to the second, pro-competitive, channel. First, foreign firms' markups decreased by 3% relative to domestic firms. Second, this decline is larger in sectors with greater needs for external finance, which are sectors where competition was initially more distorted as domestic firms were more affected by the asymmetric access to capital markets. I find that foreign firms operating in a one standard deviation more financially dependent sector see a 6% larger decline in their markups. Third, I also show that foreign firms increased their labor productivity, RTFP and skill intensity as a function of sector dependence on external finance. Importantly, they did not increase their capital intensity or leverage. This suggests that these firms were not initially credit constrained but were responding to tighter competition of domestic firms in those sectors. Finally, at the industry level, I find that the greater expansion of domestic firms led to reductions in industry concentration, and in productivity and markup dispersion within sectors.

The expansion in firms' productivity resulted in an increase in aggregate productivity growth. Notably, the source of this growth completely reversed following the liberalization. Prior to the reform within-firm productivity explained only 17% of aggregate productivity growth, but, after the reform, within-firm productivity explained 82% of aggregate productivity growth. This upsurge in the within-firm component is consistent with the mechanism proposed in this paper, arguing for the pro-competitive forces of financial liberalization that lead all firms to increase their productivity.

The empirical identification of the effect of the financial liberalization is based on the asymmetric access to international borrowing between domestic and foreign firms prior to the reform. To test that the observed effects correspond to the liberalization and not something else, I conduct a full set of robustness tests. First, I estimate the effects by year and show that the differential response of domestic and foreign firms coincides with the timing of the reform, as the estimated coefficients do not vary prior to the liberalization, while they monotonically change following it. Second, I demonstrate that the results are not driven by sector-specific trends as they are robust to including four-digit sector pre-reform growth trends, and sector-year fixed effects. Third, the general context around the liberalization and its timing minimizes reverse causality concerns, as it was part of a general program of fourteen transition economies to join the European Union (EU). Importantly, by 2001, the deregulation of capital controls in Hungary was the only missing requirement to join the EU. The Hungarian economy was already deeply integrated with the EU and trade and foreign direct investment (FDI) flows remained constant in the years prior to and following the liberalization. Notably, I do not find any differential pattern of growth between exporter and non-exporter firms. Additionally, I also show that other transition economies undergoing the same process of joining the EU but with already deregulated financial accounts did not witness the same pattern of capital inflows observed in Hungary.

This paper adds to a long literature on the relationship between international financial integration and economic growth in developing countries (Gertler and Rogoff 1990; Gourinchas and Jeanne 2006; Mendoza, Quadrini, and Rios-Rull 2009; and Levchenko, Ranciere, and Thoenig 2009,

among others). It illustrates that, in capital-scarce economies, the impact of financial liberalization depends on the local level of financial development. Unlike models in which capital account openness always leads to capital outflows and to lower income in these economies, this paper shows that financial liberalization can lead to capital inflows or outflows depending on the local level of financial development. Notably, if financial development is sufficiently high, capital openness induces inflows, higher investment, competition and economic growth. This paper also relates to cross-country studies associating financial liberalization with increases in aggregate productivity.[2] Bonfiglioli (2008), Bekaert, Harvey, and Lundblad (2011), and Chari, Henry, and Sasson (2012) find, over the five years following the reform, a positive effect of financial integration on aggregate productivity. This paper proposes a mechanism that can explain the large increase in aggregate productivity found in cross-country studies, and uses firm-level census data around a particular reform to test it. This paper also informs about the debate on the impact of capital controls in developing economies, and shows that these controls can create asymmetries in the access to capital market across firms that can undermine competition, investment in technology and economic growth.[3]

This paper is also related to the misallocation literature emphasizing how firm-level distortions can lower aggregate productivity (Restuccia and Rogerson 2008; Hsieh and Klenow 2009; Peters 2013; and Restuccia and Rogerson 2013). This paper is closest to Peters (2013) who shows that these distortions can affect both the static allocation of resources and firms' dynamic innovation incentives. My paper departs from Peters' (2013) in that I identify in the data a particular policy distortion and study how this distortion affects competition and all firms' innovation incentives. Focusing on access to capital markets, Gopinath, Kalemli-Ozcan, Karabarbounis, and Villegas-Sanchez (2015) report large productivity losses from misallocation due to financial frictions. Additionally, Midrigan and Xu (2014) show that financial frictions can preclude credit-constrained firms from adopting more efficient technologies. This paper shows that the effect of financial frictions on productivity can be amplified through pro-competitive forces, which undermine both constrained and unconstrained firms' incentives to invest in technology. This is complementary to the view developed by Edmond, Midrigan, and Xu (2015), who uncovered large pro-competitive effects from a removal of another distortion in a trade liberalization reform.

The remainder of the paper is structured as follows. In Section 2, I present the model that guides the empirical work. Section 3 describes the liberalization of international financial flows in Hungary. Section 4 presents the data. In Section 5, I discuss the identification strategy and test the model's predictions at the firm, industry and aggregate level. Section 6 concludes.

[2]In a similar vein, several studies show a positive relationship between financial deepening and productivity enhancements. In particular, they find that countries with more developed financial systems enjoy higher rates of productivity growth. See for example, King and Levine (1993a); King and Levine (1993b); Benhabib and Spiegel (2000); and Beck, Levine, and Loayza (2000).

[3]See for example, Forbes (2007a); Forbes (2007b); Desai, Foley, and Hines (2006); Devereux and Yetman (2014); and Schmitt-Grohé and Uribe (2016), who discuss the impact of capital controls on countries.

2 Model

This section develops a small open economy model to study the impact of distortions in the access to international capital markets on competition and aggregate productivity. The model has three main ingredients. First, there are domestic and foreign firms that engage in R&D and produce in oligopolistic markets. Second, there is a local banking sector that has a low level of financial development and affects the direction of capital flows upon the financial liberalization. Third, there are capital controls that prevent local firms to access international funds. I employ the model to study the impact of financial liberalization on competition and firms' investment in technology. Focusing on the case in which the liberalization leads to capital inflows, I derive qualitative implications to confront against the data in Section 5. These implications are derived analytically in partial equilibrium, and illustrated in general equilibrium using a numerical exercise in Appendix B.4.

2.1 Environment

Consider a small economy populated by an infinite sequence of overlapping generations, each of which lives for two periods. The economy is composed by firms, workers and banks. This overlapping generations setting simplifies households' saving decisions, and focuses on the impact of capital controls on firms' incentives to invest in technology and on market competition. A final good is an aggregate of a continuum of intermediate varieties. In each intermediate variety, domestic firms compete with foreign producers. Domestic and foreign firms differ in their initial productivity and access to capital markets. Labor is international immobile.

i) Firms' Production and Innovation

-Production. Intermediate firms operate with a Cobb-Douglas function: $f(q,k,l) = q\,k^{\alpha}l^{1-\alpha}$, where q, k, and l are productivity, capital and labor, and $\alpha \in (0,1)$. Capital fully depreciates after production. Within each intermediate variety, a foreign and a home firm compete *à la Bertrand*. In equilibrium, only the firm with the lowest marginal cost is active in the variety. To deter entry, this firm resorts to limiting pricing, and sets its price equal to the marginal cost of its closest rival.[4]

-Innovation and Technology. Intermediate firms are heterogeneous in productivity, and conduct innovation activities in the first period to try to obtain a frontier technology. The innovation process is stochastic and depends on the firm's innovation efforts: x_s, where $s = \{H, F\}$ denotes home and foreign firms. If the firm gets a frontier technology in the variety, it produces in $t+1$; otherwise it exits the market. For expositional simplicity, I assume that, in each variety, foreign firms enjoy a higher initial productivity level, but home firms can leapfrog the technology frontier.[5] Hence, in

[4]The pro-competitive effects of financial liberalization are also present in other oligopolistic frameworks, as in Devereux and Lee (2001), Atkeson and Burstein (2008) and Edmond, Midrigan, and Xu (2015) in which firms compete by quantities in a Cournot setting. See Appendix B.7.

[5]The assumption that foreign firms are more productive than home firms is consistent with the empirical pattern observed in Hungary prior to the reform, as shown in Section 5. Moreover, this is a common trait of developing

each intermediate variety, innovations can stem from two sources: either the foreign firm improves the existing technology, or the home firm innovates and obtains a new state-of-the-art technology.[6] Let the initial productivity of firm s in variety j be: $q_{sj} \equiv \lambda^{n_{sj}}$, where $\lambda > 1$ and n_{sj} is the firm's technology level, which evolves as in a quality ladder. Express the initial productivity difference between foreign and home firms in variety j as a function of the technological gap between them: $\Delta_j \equiv n_{Fj} - n_{Hj}$. Finally, consider a R&D technology such that if a firm aims for an innovation effort of x_{sj}, it needs to undertake Γ units of labor:

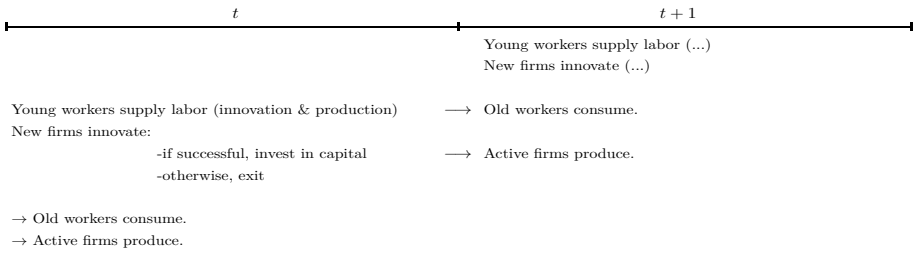
$$\Gamma(x_{Fjt}, \Delta_j) = \lambda^{-\Delta_j} \frac{1}{\phi} \frac{x_{Fjt}^2}{2} \quad \text{and} \quad \Gamma(x_{Hjt}) = \frac{1}{\phi} \frac{x_{Hjt}^2}{2},$$

where ϕ denotes the efficiency of the innovation technology, and $x_{sjt} \in (0, 1)$ and are firms' endogenous innovation probabilities. As in Klette and Kortum (2004), Atkeson and Burstein (2010) or Peters (2013), I let more efficient firms have lower innovation costs to account for the empirical finding that innovation efforts are constant for large firms. As in Peters (2013), I assume that the innovation of foreign firms are easier when their technological advantage is greater, i.e. $\lambda^{-\Delta}$. This assumption simplifies the exposition and does not affect the model's implications (as shown in Appendix B.8). Firms take the innovation efforts of other agents and factor prices as given.

The final good aggregates a continuum of measure one of j intermediate varieties, employing a Cobb-Douglas production function: $Y_{t+1} = \exp\left(\int_0^1 \log(y_{jt+1}) dj \right)$. Given this final good production, the optimal demand for each intermediate variety j is $y_{jt+1} = \frac{Y_{t+1}}{p_{jt+1}}$.

The timeline is as follows. Workers supply inelastically labor for a wage during their youth in t, and consume during their old-age in $t+1$. In the first period, intermediate firms make two decisions: first, they choose their optimal innovation efforts; next, once the innovation process is realized, they decide whether to produce in their second period. To produce, firms need to invest in physical capital in t. Banks collect savings from households to lend to firms.[7] Active firms produce.

TIMING



economies, as reported by Gorodnichenko and Schnitzer (2010). Notice, finally, that home firms would not invest to simply catch-up its rival's technology, as it would earn zero profits (see also Grossman and Helpman 1991).

[6] I assume that the probability of two firms innovating at the same time is zero to be consistent with standard models of innovation (Grossman and Helpman 1991; Aghion and Howitt 2009; among others).

[7] For simplicity, I let firms borrow from banks once they learn about the result of the innovation process and, hence, there is no uncertainty in the debt contract. As standard in innovation models, this assumption implies that workers are able to insurance against the innovation risk (see Acemoglu 2009; Aghion and Howitt 1992; Peters 2013).

ii) Banking Sector and Capital Controls

Consider a perfectly competitive banking sector, in which risk-neutral banks act as intermediaries that collect savings from young workers to lend to local firms. Banks face an intermediation cost μ per unit of amount lent that depends on the level of financial development in the country, $\mu > 0$. In equilibrium, the domestic lending (R^L_{t+1}) and deposit (R^D_{t+1}) interest rates satisfy

$$R^L_{t+1} = R^D_{t+1} + \mu. \tag{1}$$

Capital controls on domestic agents allow only local banks to intermediate foreign funds, but they incur a cost. In particular, banks need to pay a tax $\tilde{\tau}$ per unit of foreign borrowing or lending, which is then redistributed lump-sum to local households. Importantly, this tax level determines whether banks have incentives to intermediate foreign funds and, accordingly, whether the economy is open or closed to international financial flows.

To determine the direction of capital flows upon the liberalization is necessary to solve for the equilibrium interest rate in the closed economy. Accordingly, I start by presenting an economy in which the tax rate on foreign transactions is high enough such that banks do not intermediate foreign funds and international financial flows are shut down (Sections 2.2 and 2.3), and turn next to study the effects of a reduction in capital controls (Section 2.4). I normalize the intermediation cost of the world to zero, and denote the foreign interest rate as R^*_{t+1}. Focusing on a capital-scarce economy, I let the domestic lending rate -to be determined below- be higher than the foreign rate: $R^L_{t+1} > R^*_{t+1}$.

2.2 Firms' Optimal Behavior and Aggregate Productivity Growth

Firms' optimal strategies are solved by backward induction.

-Production and Price Setting. In this Bertrand setting, only the firm with the lowest marginal cost in each variety is active in equilibrium. The marginal cost of the active firm in variety j is: $MC_{sjt+1} = \frac{1}{q_{sjt+1}}(\frac{R^{s'}_{t+1}}{\alpha})^{\alpha}(\frac{w_{t+1}}{1-\alpha})^{1-\alpha}$, where $R^{s'}$ is either the local lending rate for home firms (R^L), or the world rate (R^*) for foreign firms. Higher financing terms imply higher marginal costs. After minimizing its production costs and setting its price, the active firm's profit from production activities is: $\Pi^p_{sjt+1} = (1 - \xi^{-1}_{sjt+1})Y_{t+1}$, where ξ_{sjt+1} denotes its markup. This expression shows that a firm's profit is proportional to its markup, which is the only firm-specific variable in the expression. In equilibrium, the active firm's markup is equal to the intermediate good's price over the marginal cost; where the price is set to the marginal cost of the firm's closest competitor, and its marginal cost depends on the result of the innovation process and the financing costs. I present separately the cases in which either the foreign or the home firm is active in equilibrium.

If the foreign firm in variety j is active, its markup will be either

$$\xi^{post}_{Fjt+1} \equiv \frac{p_{jt+1}}{MC^{post}_{Fjt+1}} = \tau_{t+1}\,\lambda^{\Delta_j+1} \quad \text{or} \quad \xi^{pre}_{Fjt+1} \equiv \frac{p_{jt+1}}{MC^{pre}_{Fjt+1}} = \tau_{t+1}\,\lambda^{\Delta_j}, \tag{2}$$

where *post* and *pre* denote whether it succeeds in improving its technology or maintains its initial productivity level. Equations (2) show that the foreign firm's markup has two components. First, as in quality ladder models, the leader's markup increases with the technology gap with its closest market rival (Δ_j) because the productivity advantage allows setting higher prices. Second, the new feature of the model is that the foreign firm's markup is distorted by: τ_{t+1}, where $\tau_{t+1} \equiv (R^L_{t+1}/R^*_{t+1})^\alpha > 1$ and represents the difference in borrowing costs between home and foreign firms. Therefore, besides any technological advantage that foreign firms might enjoy, they can obtain higher markups stemming from their preferential access to capital markets. That is, the higher local lending rate implies high marginal costs for home firms, which undermines their competitive pressure and allows foreign firms to set higher prices.

If instead the home firm in variety j is active, its markup will be:

$$\xi^{post}_{Hjt+1} \equiv \frac{p_{jt+1}}{MC^{post}_{Hjt+1}} = \frac{1}{\tau_{t+1}}\,\lambda. \tag{3}$$

Similar to foreign firms' markups, equation (3) shows that the home firm's markup depends on the technology advantage and the asymmetric access to international capital markets. However, unlike the foreign firm, the home firm's markup is reduced by the differential access to finance, τ_{t+1}. The reason is that, even if the home firm manages to obtain a frontier technology and the lowest marginal cost, it still faces higher borrowing costs than its foreign rival. If the home firm does not succeed in obtaining a frontier technology, it will continue to have a higher marginal cost than its foreign rival, and will remain out of the market. I turn now to study how this distortion in firms' profits affects their incentives to invest in technology.

-Innovation Activities. In the first period, firms choose their optimal innovation efforts so as to maximize their expected profits net of the innovation costs. After maximizing their total profits, their optimal innovation intensities, x_{Ft} and x_{Ht}, become:

$$x_{Ft} = \frac{\phi}{\tau_{t+1}}\frac{(1-\lambda^{-1})}{w_t}\frac{Y_{t+1}}{R^*_{t+1}} \qquad \text{and} \qquad x_{Ht} = \frac{\phi}{\tau^{1/\alpha}_{t+1}}\frac{(1-\tau_{t+1}\,\lambda^{-1})}{w_t}\frac{Y_{t+1}}{R^*_{t+1}}. \tag{4}$$

As in quality ladder models, firms' optimal innovation efforts depend on the market size (Y), the efficiency of the innovation technology (ϕ), the increment in technology (λ), and the innovation cost in labor units (w). The new feature of the model is that all firms' optimal innovation efforts also depend on the distortion in the access to international capital markets. Critically, home and foreign firms' efforts are reduced by τ_{t+1}. Two forces lead to this result. As regards home firms, their higher borrowing costs reduce their post-innovation profits and, hence, their innovation incentives.

Concerning foreign firms, their innovation efforts are reduced because -when they are the market leaders- they face weak competition and enjoy greater monopolistic power to set prices. Higher prices lower their production levels and, hence, their innovation incentives aiming to reduce the production costs. In this way, differences in borrowing costs affect *all* firms' markups and, hence, their profits and optimal innovation efforts.

-Aggregate Productivity Growth. In each intermediate variety, the expected productivity increase is given by $\log(\lambda)(x_{Ht} + x_{Ft})$, as each innovation raises productivity by a factor of $\log(\lambda)$ and domestic and foreign firms innovate with a probability x_{Ht} and x_{Ft}. Under the law of large numbers, a continuum of varieties ensures that aggregate productivity growth is given by,

$$g_{Qt+1} = \log(\lambda)\ (x_{Ft} + x_{Ht}). \tag{5}$$

Equation (5) shows that distortions in the access to international capital markets significantly reduce aggregate productivity growth, as they decrease home and foreign firms' innovation efforts.

2.3 Equilibrium

An equilibrium is represented by the sequence $\{x_{st}, p_{sjt+1}, y_{sjt+1}, w_{t+1}, R^L_{t+1}\}^{\infty}_{t=0}$ *such that: banks have zero profits and equation (1) is satisfied; active firms in each variety set the price equal to the marginal cost of the closest competitor, and the intermediate optimal demand for each variety* (y_{jt+1}) *is satisfied; firms' innovation intensities are given by equation (4), such that* x_{Ht} *and* x_{Ft} *maximize expected profits taking aggregate output, wages, interest rates and the innovation efforts of other firms as given; the economy growth rate is* $g_{Yt+1} = \frac{1}{1-\alpha} g_{Qt+1}$*, where* g_{Qt+1} *is given by (5); labor and capital markets clear; aggregate consumption is the sum of old workers' consumption, and aggregate output is given by* Y_{t+1}. For ease of references, I derive all formal conditions in Appendix B.1.

Labor market clearing implies that all workers are either employed in production (L^P) or innovation activities (L^I), i.e. $L_{t+1} \equiv 1 = L^I_{t+1} + L^p_{t+1}$. In this closed economy, capital market clearing implies that home firms' investment equals the local saving of young workers, and the domestic lending and deposit interest rates are given by:

$$R^D_{t+1} = R^L_{t+1} - \mu = \alpha \frac{Y_{t+1}}{K^H_{t+1}} \Lambda^H_{t+1} - \mu, \tag{6}$$

where K^H_{t+1} and Λ^H_{t+1} are the aggregate capital demand and markups of active home firms. Equation (6) shows that the domestic deposit rate depends on two components: the domestic capital stock and the local level of financial development. Importantly, they operate in opposite directions. First, as in a standard small economy model, the more capital scarce is the economy, the higher

is the lending rate and, hence, the deposit interest rate. Second, the lower the level of financial development (higher μ), the lower is the deposit rate. Hence, the equilibrium level of the deposit interest rate in the closed economy depends on which of the two components prevails. The economy's budget constraint is given by $C_{t+1} + I^H_{t+1} = w_{t+1}L^p_{t+1} + \Pi^H_{t+1} + R^D_{t+1}K^H_{t+1}$, where domestic consumption and home investment equal the wages in production activities, net profits of active domestic firms, and payments to home capital. Note that foreign firms invest capital until their return equalizes the world interest rate. The balance of payment implies that the current and capital account sum to zero, and that foreign firms' net profits and capital repayment equal their investment: $-[\Pi^F_{t+1} + R^*_{t+1}K^F_{t+1}] + I^F_{t+1} = 0$.

2.4 Financial Liberalization

I turn to study how a reduction in capital controls affects capital flows, competition and investment in technology. I first introduce how these controls affect banks' optimal behavior and, through them, the direction of capital flows upon the financial liberalization (Section 2.4.1). Next, I present the case in which financial liberalization leads to capital inflows and derive the qualitative implications of a reduction in capital controls to guide the empirical analysis (Section 2.4.2).[8]

2.4.1 Banks and the Direction of Capital Flows

Under capital controls, banks have two financing choices: they can either use local savings and pay the deposit rate R^D_{t+1}, or they can borrow foreign savings and pay the world rate plus the per unit tax, $R^*_{t+1} + \tilde{\tau}$. Similarly, banks have two lending options: they can either lend to home firms for a net return of $R^L_{t+1} - \mu$, or pay the tax and lend internationally for a return $R^*_{t+1} - \tilde{\tau}$. I have assumed earlier that $\tilde{\tau}$ was prohibitively hight such that banks did not intermediate foreign funds (i.e. $R^D_{t+1} < R^*_{t+1} + \tilde{\tau}$, and $R^L_{t+1} - \mu > R^*_{t+1} - \tilde{\tau}$). I present below how a reduction in capital controls affects their financing and lending activities and, hence, the direction of capital flows upon the liberalization.

Financial liberalization implies a reduction of the tax of foreign transactions to $\hat{\tau}$. In this capital-scarce economy, the direction of capital flows upon the liberalization depends on the level of financial development of the country. This economy faces two different cases. First, if the local level of financial development is sufficiently high (low μ), the closed-economy domestic deposit rate is greater than the foreign rate plus the new tax of foreign transactions ($R^D_{t+1} > R^*_{t+1} + \hat{\tau}$), and banks find it less costly to finance themselves using foreign funds. Furthermore, since the return from lending abroad is lower than the net local lending rate, banks only lend locally.[9] This is the case in which the economy receives capital inflows. Second, if instead the level of financial

[8] Section B.5 develops the case in which financial liberalization leads to capital outflows.

[9] To see this, consider that $R^D_{t+1} > R^*_{t+1} + \hat{\tau}$ implies that $R^L_{t+1} - \mu > R^*_{t+1} + \hat{\tau}$, which is greater than $R^*_{t+1} - \hat{\tau}$ -i.e. the net interest rate that banks would obtain from lending abroad.

development is low (high μ), the net interest rate that banks would perceive from lending locally is lower than the net return from lending abroad ($R^L_{t+1} - \mu < R^*_{t+1} - \hat{\tau}$) and banks prefer to lend to foreign agents. Additionally, banks only finance themselves employing local savings because the local deposit rate is lower than the cost of employing foreign saving.[10] This is the case in which the economy sees capital outflows. Banks' optimal choices are derived formally in Appendix B.2. The next section discusses the implications of a reduction in capital controls leading to capital inflows on market competition and investment in technology for an economy subject to capital controls with $\hat{\tau}$.

2.4.2 Qualitative Predictions

Capital inflows reduce the domestic deposit rate until it equalizes the foreign interest rate plus the new tax level ($\hat{\tau}$), and banks become indifferent between using local or foreign savings. In the new equilibrium, the domestic deposit and lending rates - $\hat{R}^D_{t+1}$ and $\hat{R}^L_{t+1}$ - are given by:

$$\hat{R}^D_{t+1} = R^*_{t+1} + \hat{\tau} \qquad \text{and} \qquad \hat{R}^L_{t+1} = R^*_{t+1} + \hat{\tau} + \mu.$$

The domestic deposit and lending rates become exogenously determined and lower than in the closed economy. Crucially, this decrease in the local lending rate reduces the asymmetry in the access to external finance between foreign and home firms.[11]

To analyze the effects of financial liberalization on competition and productivity, I conduct comparative statics exercises with respect to τ, and derive five qualitative implications of the effect of a reduction in capital controls. These propositions - discussed formally in Appendix B.3 - are derived analytically in a partial equilibrium setting where aggregate output and wages are held constant, and confirmed in general equilibrium using a numerical illustration in Appendix B.4.[12]

-Proposition 1: Innovation intensities. A reduction in the asymmetry in the access to international borrowing (τ) encourages home and foreign firms to increase their innovation intensities (x_{Ht} and x_{Ft}). Notably, the innovation efforts of home firms increase relatively more.

$$\frac{\partial x_{Ft}}{\partial \tau_{t+1}} < 0, \qquad \frac{\partial x_{Ht}}{\partial \tau_{t+1}} < 0 \qquad \text{and} \qquad |\frac{\partial x_{Ft}}{\partial \tau_{t+1}}| < |\frac{\partial x_{Ht}}{\partial \tau_{t+1}}|.$$

Proposition 1 states that financial liberalization leading to capital inflows encourage home and foreign firms to increase their innovation efforts. Home firms invest more in technology because the

[10] Note that as $R^D_{t+1} < R^*_{t+1} - \hat{\tau}$, $R^D_{t+1} < R^*_{t+1} + \hat{\tau}$ implying that the local deposit rate is lower than the cost of raising foreign funds.

[11] Note that, given a change in capital controls, the lower the level of financial development, the lower is the decrease in the domestic lending interest rate and the increase in capital inflows. This is in line with cross-country studies showing that the impact of financial liberalization is larger in countries with higher level of financial development, as shown by Bekaert, Harvey, and Lundblad (2011); and Kose, Prasad, Rogoff, and Wei (2008).

[12] In these propositions, I assume an additional technical restriction on $\lambda < 2$. This parameter relates to the frequency of the innovations, and is usually parametrized between 1.05-1.25 (see Stokey 1995, Bloom, Schankerman, and Reenen 2012 and Acemoglu and Akcigit 2011, among others).

liberalization reduces their financing costs, increasing their post-innovation profits. Foreign firms invest more in technology because the benefit from innovating increases. That is, the liberalization narrows the gap between firms' marginal costs, deepening competition and inducing foreign firms to increase innovation efforts to escape competition.[13] Importantly, the innovation efforts increase more for home firms. As foreign firms are more productive than home firms, then -in the average intermediate variety- the former are the incumbents and the latter are the entrants. Since the distortion affects more the innovation incentives of the entrant-home firms than what undermines the foreign market leader (Arrow's replacement effect), the liberalization increases the home firms' innovation efforts relatively more.

-Proposition 2: Leverage. A reduction in τ raises home firms' expected debt-to-sales ratio (d/y^e_{Hjt+1}).

$$\frac{\partial (d/y)^e_{Hjt+1}}{\partial \tau_{t+1}} < 0.$$

Financial liberalization reduces home firms' financing terms, encouraging their investment and leverage; where leverage is defined as the debt-to-sales ratio.

-Proposition 3: Markups. A decrease in τ reduces foreign firms' expected markups (ξ^e_{Fjt+1}).

$$\frac{\partial \xi^e_{Fjt+1}}{\partial \tau_{t+1}} > 0.$$

Foreign firms' markups stem from two sources: the difference in the borrowing costs and the technological gap with their local competitors. Both of these drop following the reduction of capital controls. First, the improvement in financing terms deepens the competitive pressure of home firms, undermining foreign firms' ability to set higher prices and obtain higher markups. Second, the greater innovation efforts of home firms reduce their technology gap with their foreign rivals.

-Proposition 4: Productivity gap. Reductions in the asymmetric access to capital markets (τ) decrease the expected productivity gap between home and foreign firms (Δ^e_{t+1}). In particular, this drop is greater in varieties where foreign firms were technologically far ahead of their local competitors.

$$\frac{\partial \Delta^e_{t+1}}{\partial \tau_{t+1}} > 0 \qquad \text{and} \qquad \frac{\partial \Delta^e_{t+1}}{\partial \tau_{t+1} \partial \Delta_{t+1}} > 0.$$

As home firms' innovation efforts increase relatively more, they are more likely to overtake their foreign rivals and to decrease the technology gap with them. In addition, as home firms are more likely to entry, the productivity gap drops more in varieties where the initial gap was the largest.

[13] Leader firms' innovation efforts depend on the difference between the post- and pre-innovation profits and both of them decrease with the fall in capital controls. Importantly, pre-innovation profits decrease more, which raises the benefit from innovating. The reason is that capital market distortions affect foreign firms' profits more, the narrower is their technology gap with their home competitors.

-Proposition 5: Aggregate productivity growth. A decrease in τ increases aggregate productivity growth (g_{Qt+1}).

$$\frac{\partial g_{Qt+1}}{\partial \tau_{t+1}} < 0.$$

As firms rise their innovation efforts, aggregate productivity growth increases. Notably, this expansion stems from the two channels proposed in the paper: better financing terms induce home firms to innovate more, and deeper competition encourages foreign firms to do the same.[14]

Propositions 1-5 provide qualitative implications about the impact of financial liberalization on competition and firms' investment in technology. In the next sections, I use the deregulation of international financial flows in Hungary in 2001 to confront these implications against the data.

3 The Deregulation of International Financial Flows in Hungary

In this section, I present the capital controls in place in Hungary prior to 2001, and describe the liberalization of international financial flows and its impact firms' access to external funds.[15]

Prior to 2001, regulations in the foreign exchange (FX) market were the main capital control tool in Hungary.[16] Foreign exchange operations were regulated by the Act XCV of 1995, which employed three main tools to limit international financial flows. It used two tools to restrict banks' ability to intermediate foreign funds, and one tool to restrict firms from borrowing internationally. The first tool restricting banks' international financial flows was the ban on currency forward instruments -chiefly among them, FX swaps and forward contracts. These instruments allow hedging against exchange rate fluctuations and, hence, are crucial for banks to raise foreign funds. The second tool was the regulations on the spot market, which required banks' transactions in foreign currency to be pre-approved by the Central Bank (National Bank of Hungary- NBH) and made the spot FX market very illiquid.[17] These restrictions substantially limited banks' ability to intermediate foreign

[14] As discussed above, if the local level of financial development is low, $R^L_{t+1} - \mu < R^*_{t+1} - \hat{\tau}$ and banks prefer to lend to foreign agents. In this case, the model's predictions are reversed and a reduction in capital controls leads to capital outflows, and lower competition and productivity growth (Appendix B.5).

[15] This reform was driven by the accession to the European Union. To join the EU, all candidate countries have to accomplish the Copenhagen Criteria of 1993. One of these criteria is that candidates have to ensure free movement of capital, the only missing requirement in Hungary. The reform completed the deregulation of international financial flows. In Section 5.1, I discuss the identification strategy with more detail.

[16] FX market controls are commonly used to regulate international capital flows, as they restrict agents from acquiring foreign currency, hedging the exchange rate risk and, hence, borrowing or lending internationally. These controls were widely implemented during the Bretton Woods, when countries had fixed exchange rates regimes (see Smith, Walter, and DeLong 2012). Lately, during the Great Recession, many emerging markets -as for example Korea and Brazil- imposed them to restrict capital inflows.

[17] In particular, the regulations in the spot market included: a ban on foreign financial investors to participate in

funds and made them reluctant to borrow internationally. As a result, banks based their credit supply on domestic savings, which led to a low level of credit. In 2000, Hungary's credit-to-GDP ratio (0.27) was three times smaller than the OECD average (0.86), and its credit-to-deposit ratio was a third lower (0.83 against 1.2 in OECD countries).

The third tool that the Act XCV used to limit international financial flows was the regulation on firms' borrowing in foreign currency. Under this law, only firms declaring to tax authorities to receive foreign currency income were allowed to borrow in foreign currency.[18] Crucially, this regulation divided firms into two groups. A first group of firms, domestic firms, were limited to borrow locally in national currency and, hence, were disproportionally affected by the low level of credit of the local financial system. A second group of firms were foreign companies that, unlike domestic firms, could avoid the local restrictions by directly obtaining international funds.[19] Although there is no precise record indicating the exact amount of foreign indebtedness at the firm level, there is substantial evidence that foreign firms used these funds intensively. As reported by the IMF (1998), these firms employed two main sources of international funds. First, they enjoyed the relationship between the parent company and its banks to access to foreign bank credit. Second, they intensively used internal capital markets with their parent companies. In 1998, more than one third of total credit in the economy (35%) was internal credit between parent companies and subsidiaries in Hungary. This use of internal capital markets offers foreign firms financial advantages relative to their local competitors, as shown by Desai, Foley, and Hines (2003); and Desai, Foley, and Forbes (2008), among others.

In this way, FX controls created asymmetries in the access to international borrowing between domestic and foreign firms. This asymmetry was reflected in differences in firms' financing terms, as implied in the model. The BEEPS survey indicates that domestic firms paid interest rates 3.2 percentage points higher than foreign firms, and the required value of the collateral on total debt was 58% greater (Table 1). As a result, domestic firms' leverage was a third lower than foreign's (NBH). In my empirical analysis, I exploit this pre-reform asymmetry to identify the effect of the financial liberalization within Hungary.

In 2001, the Act XCIII removed the regulations in the FX market, namely the ban on forward currency instruments, and the restrictions in the spot market and in firms' foreign currency

the market, restrictions in the amount of interbank lending in foreign currency, and the requirement for banks to apply for individual licenses to acquire foreign currency.

[18] In particular, the Act regulated which firms could have bank accounts in foreign currency. Under this law, only firms reporting to tax authorities to receive foreign currency income were allowed to apply for *convertible accounts*, i.e. bank accounts denominated in foreign currency. Without declaring foreign currency income, firms were not allowed to open convertible accounts and, thus, could not borrow in foreign currency.

[19] While the law allowed domestic exporters to borrow internationally, the empirical evidence suggests that they did not obtain international funds. As discussed in Section 5.2, prior to the reform, domestic exporters had the same level of leverage and financing terms than domestic non-exporters, and shared the same post-reform pattern of growth (see Tables A.4 and A.5). Notably, even after the financial liberalization, domestic exporters had limited access to international capital markets. In 2004, only fourteen of domestic exporters reported to have debt in foreign markets. In this way, the empirical evidence suggests that Hungarian exporters and non-exporters were similarly constrained from borrowing from abroad. For this reason, I treat these firms together and focus on a much sharper contrast revealed in the data: the asymmetry in the access to international borrowing between foreign and domestic firms.

borrowing. The liberalization had a large impact on banks' use of foreign funds. As shown in Figure 1, within the three years before and after the reform (1998-2004), net capital inflows of financial institutions rose from 0.6 to 3.3 billion U.S. dollars per year, and their external debt more than tripled, reaching 20 billions of U.S. dollars. In parallel, banks started employing intensively financial derivatives, particularly FX swaps. Both cross-border and local derivatives soared and, by 2004, they had increased by more than three-fold. The increase in banks' liquidity associated with an expansion of the local credit supply. Table 1 shows that, by 2004, the credit-to-GDP ratio had almost doubled and the credit-to-deposit ratio had grown by more than a third.

Capital inflows led to a decrease in the lending interest rate, which substantially improved financing terms for domestic firms and - as in the model - reduced the asymmetry in the access to finance across firms. By 2004, the interest rate differential between domestic and foreign firms had fallen five-fold from 3.2 to 0.65 percentage points, and the difference in the value of the required collateral had dropped four-fold from 58 to 11 percentage points (BEEPS survey). In addition, data from the NBH reveals that small and medium enterprises (SME) increased their share of total credits by 17 percentage points. Importantly, this expansion was driven by credits in FX: one third of their credit was denominated in foreign currency. On the aggregate, the expansion of banks' international borrowing was also reflected on the financial account, whose deficit almost doubled by 2004 (from 3.8 to 6.9 billions of U.S. dollars).

The figures above indicate that the financial liberalization in Hungary was associated with capital inflows and with a reduction in the asymmetry in the access to finance between domestic and foreign firms, as the model illustrates. In the next sections, I employ the model's qualitative implications to assess whether this reduction affects competition and productivity growth.

4 Data

I test the model's predictions using two firm-level databases: APEH, which contains panel data on firms' balance sheets reported to the tax authorities and is provided by the Statistical Department of the National Bank of Hungary, and the Business Environment and Enterprise Performance Surveys (BEEPS) of the World Bank and the European Bank for Reconstruction and Development.

The APEH database is census data and spans the period 1992-2008. This database contains information on firms' value added, sales, output, stock of capital, employment, wages, materials, exports, and ownership structure that I employ to construct measures of capital intensity (capital per worker), labor productivity (value added per worker), RTFP, markup, and ownership status. To obtain real values, I use price indexes at four-digit NACE industries for materials, investment, value added, and production. The RTFP measure is computed using the Olley and Pakes (1996) method to estimate the parameters of the production function. I estimate markups as a wedge between the firm's labor share and the labor elasticity of production. Following the standard literature, I define a firm as foreign if more than 10% of their shares belong to foreign owners. From 1999, firms were

asked to report short-term debt undertaken with financial institutions. I use this information to construct a proxy for leverage: the short-term debt-to-sales ratio. Since providing this information is optional, only few firms filled it in and the sample shrinks by approximately 50%.

The firm-level analysis in Sections 5.2-5.4 focuses on a balanced panel of 5,548 firms present over the period 1998-2004 and for which there is enough information to compute the RTFP measure. Since smaller firms are more subject to measurement error problems, I retain firms with five or more employees. This balanced panel accounts for 77% of value added and 70% of employment in the manufacturing sector. Additionally, I employ the unbalanced panel to conduct several robustness tests, and conduct the industry- and aggregate-level analysis in Sections 5.5 and 5.6.

I assess changes in firms' innovation activities using the BEEPS surveys (2002 and 2005). These surveys provide information on all economic activities, and employ stratified random sampling to ensure that they are representative of the population of firms. BEEPS surveys report information on innovation activities and expenditures in R&D. The surveys ask whether the firm has conducted any of the following activities in the previous three years: developed a major product line, upgraded an existing product line, acquired a new production technology, obtained a new licensing agreement, or obtained a new quality accreditation.[20] I construct a dummy variable - Innovation - if the firm has undertaken any of these activities, and a dummy - R&D - if the firm reports R&D spending. The surveys also report information on firms' financing terms -cost of loans and the value of the collateral required on total loans- that I employ in Section 5.3.

To test the financial channel, I use information on sector dependence on external finance from Raddatz (2006), who re-estimated the financial dependence index of Rajan and Zingales (1998) for U.S. listed firms at the four-digit industry level. This index measures the amount of investment that cannot be financed through internal cash flows, and is used as a proxy for sectors' *technological* needs for external finance. As capital markets are largely advanced in the U.S. and listed firms are less likely to be credit constrained, this index tends to capture the technical needs for external finance in the sector. Using an index estimated for U.S. firms avoids endogeneity concerns.[21]

5 Empirics

This section assesses the impact of the financial liberalization in Hungary on market competition and firms' investment in technology. To guide the empirical analysis, I employ the model's qualitative implications (derived in Section 2.4.2). In Section 5.1, I start by describing the identification

[20] These measures of innovation follow the recommendations of the Oslo Manual developed by the OECD and Eurostat for innovation surveys. This definition of innovation focuses on new and improved product and processes that are "new to the firm". This emphasis on "what is new to the firm" is of special interest to this study, as Hungary is a developing economy, the easing of credit conditions might have encouraged more domestic firms to adopt frontier technologies rather than develop new ones. Importantly, the majority of firms (75%) have reported that these activities were a critical contributor to their growth. See also Gorodnichenko and Schnitzer (2010).

[21] More precisely, Rajan and Zingales (1998) define needs for external finance as firms' capital expenditures minus cash flows from operations divided by capital expenditures for U.S. listed firms. They next use the sector median value to construct the dependence of external finance for each industry at the three-digit level.

strategy. In Sections 5.2 and 5.3, I test whether domestic firms expanded more in terms of investment in technology (Proposition 1), and whether this expansion correlates with increase in leverage (Proposition 2). In Sections 5.4 and 5.5 , I evaluate whether deeper competition leads to reductions in foreign firms' markups (Proposition 3), and changes in the productivity gap within sectors (Proposition 4). In Section 5.6, I check whether aggregate productivity growth accelerates (Proposition 5), and explore the source of this growth.

5.1 Identification Strategy

This section presents the identification strategy, and discusses possible concerns regarding the empirical analysis, as for example: differences in firms' initial characteristics and previous growth trends, differences in industrial patterns of growth, sample selection and reverse causality.

The identification strategy of the effect of financial liberalization is based on the asymmetric access to international capital markets for domestic and foreign firms prior to the reform. I exploit this source of cross-sectional variation to test the two forces proposed in this paper. I test the first force - financial liberalization encouraging home firms' investment in technology - in two steps. I first estimate the differential impact of the reform on domestic firms' investment. I next add another source of cross-sectional variation: sector financial needs, to test the financial channel. More precisely, I exploit three sources of variation: time, sector reliance on external finance, and firms' access to international borrowing prior the reform, and test whether home firms with greater needs for external finance expand more after the liberalization. I complement this analysis by using direct information on firms' leverage and financing terms to test whether home firms increase the use of bank credit. To test the second force - financial liberalization deepening competition - I exploit the variations in terms of sector financial needs. Since the asymmetric access to international borrowing distorted competition more in sectors in which domestic firms employ external finance more intensively, market competition deepens relatively more in those sectors. Hence, I exploit differences in sector financial needs to identify the pro-competitive forces on foreign firms across sectors.

To identify the effect of the reform, it is important to determine whether domestic and foreign firms differed in characteristics that could involve heterogeneous patterns of investment and productivity growth. If these differences were not accounted for, the estimated coefficients could be biased. Table 2 breaks down the data into domestic and foreign firms and presents sample means in the initial year (1998) by type of firm. Prior to the reform, foreign firms were older, and larger in terms of value added, employment, labor productivity and RTFP, and enjoyed higher markups. These firms also had higher probability of conducting innovation and R&D activities, as shown in Table 3. Since the difference in means in these variables is statistically significant, in my reduced-form regressions I control for them.

A main assumption of the empirical strategy is that before the reform, firms shared similar growth trends. Indeed, a first glance at the data confirms that domestic and foreign firms saw

similar pattern of growth within the five years preceding the reform (1996-2000). Figure 2 plots the evolution of the main outcomes analyzed: labor productivity, RTFP, capital intensity, markups and leverage. Values are normalized to their initial levels. Remarkably, these parallel patterns of growth were reversed after the reform. In line with the theory proposed in this paper, following the liberalization, the average domestic firm has grown faster in terms of labor productivity, RTFP, capital intensity and leverage. Also, consistent with the model's predictions, foreign firms' markups shrank faster. The analysis of the sample means confirms that the growth rates of foreign and home firms were not statistically different over the five years before the deregulation (Table 4).

The previous paragraph discussed the concern over firms' pre-existing growth trends. If domestic firms were correlated with some industry characteristics, however, it would be necessary to control for them so as to rule out possible sources of bias. I estimate the equations in first differences, so that time-invariant industry characteristics are differenced out. However, if sectors with different initial characteristics were on different trends, the estimated coefficient could capture some omitted industry-level time-dependent variable. I tackle this issue in three different ways. First, to account for sectoral pre-existing growth trends, I include the capital intensity and productivity growth at the four-digit NACE industry level in Hungary before the reform (1996-1997). Second, since sectors' investment and productivity could be growing at a different pace in the global economy, I also control for capital intensity and productivity growth in the United States. Third, as a robustness test, I also consider sector and sector-year fixed effects at four-digit NACE industry level.

A critical hypothesis underlying the study is that the sample is not subject to selection issues; that is, pro-competitive forces may not only affect firms' outcomes, but also the probability of a firm being observed. If this probability differed between domestic and foreign firms over time, the conditional expectations on the OLS residuals would be different from zero and the estimated coefficients would be biased (see Heckman 1974 and Heckman 1979). To assess whether this missing data problem challenges my estimations, I check whether there are differences in the probability of domestic and foreign firms being observed. In particular, I define a surviving firm if it existed the year before the reform (2000) and did not exit within the three years following it. Next, I compute the survival ratio of domestic and foreign firms and test whether there are differences in their means. The results show no statistically significant difference between the survival probability of domestic and foreign firms, and suggest that this missing data problem does not affect the estimated coefficients (Table A.1).

The general context around the reform and its timing make it likely to be exogenous with respect to the main outcome analyzed, i.e. changes in home firms' investment in technology. The reform was driven by the accession of transition economies to the EU. The requirements to join the EU were predetermined by the Copenhagen Criteria in 1993, and have been equal for all accessing countries since then. In this sense, the content of the reform was exogenous to the country's political choice. As the agenda was jointly determined by the European Council and the candidate countries, it is unlikely to have been driven by political pressure from Hungarian firms.[22]

[22]It is worth mentioning that, given the speed of the reform, it is unlikely that firms have anticipated it, and have

Even though the preceding points address the reverse causality problem, any event occurring in the years around the reform and altering firms' investment choices differentially could affect the estimated coefficients. To identify the effect of the reform, I restrict the analysis to the three years preceding and following it. Importantly, during this period no other significant event that could affect firms' investment in technology differentially occurred in Hungary. First, the economy was growing at a steady pace, with no significant shock in these years. Notably, real external flows -as trade and foreign direct investment- remain constant.[23] Second, major reforms had already taken place during the early 1990s, such as privatization of public companies, bank deregulation or competition laws.[24] Third, the EU did not require any further reform that could affect the development of the manufacturing sector. Finally, the Hungarian economy was already deeply integrated with the EU. This integration was remarkable in the manufacturing sector, which exports to the EU already accounted for 80% of total exports in 2001 (Figure A.2). It is worth mentioning that the patterns of capital inflows observed in Hungary cannot be attributed to the joining of the EU, as the timing does not coincide with the accession and other similar candidates with already deregulated financial accounts do not show the pattern of capital inflows observed in Hungary (Figure A.3). Notice that Hungary did not join the Euro zone and, hence, did not have to fulfill any monetary or fiscal criteria.

5.2 Impact on Home Firms' Investment

In Hungary, the deregulation of international financial flows reduced financing terms for domestic firms. Proposition 1 in the model states that this reduction encourages home firms to differentially increase their investment in technology. In this section, I assess this prediction in two steps. I first study whether domestic firms increase their capital intensity and productivity. I turn next to test whether they expand their R&D and innovation activities.

Investment in Capital and Productivity

I analyze the differential impact of the liberalization of international financial flows on domestic firms' capital and productivity using the following model:

undertaken investment in advanced. In December 2000, the European Council defined the timing for the accession vote and the last requirements to be met by each candidate. The reform had to take place before the accession vote in December 2002. Soon after the European Council meeting, in March 2001, Hungary deregulated the remaining controls on financial flows.

[23] During the years preceding and following the reform, FDI remained constant, and even showed a small slowdown following the deregulation (see Figure A.4). Moreover, Hungarian external trade did not seem to have particularly suffered from the world recession in 2001. The volume of exports and imports continued to grow during that period (Figure A.5).

[24] Major privatization programs occurred in the early 1990s, and - by 1997 - the share of public companies in manufacturing value added was only 2%. The Competition Act entered into force in 1997, and - according to the Hungarian Competition Authority - the accession to the EU did not cause a major change in this field. The banking sector had already achieved a major transformation by 1997, and neither banking concentration nor its efficiency changed around the liberalization. In particular, according with data from Beck, Demirguc-Kunt, and Levine (2009), there were no changes in banks' concentration index, interest rate margin, overhead costs-to-assets ratio nor cost-income ratio (Figure A.1). Furthermore, the number of credit institutions did not change (Table A.2).

$$y_{it} = \delta_0 H_i + \delta_1 T_t + \delta_2 (H_i \, \mathrm{x} \, T_t) + \varepsilon_{it}, \tag{7}$$

where i indexes firms, t denotes times, H is a dummy variable for domestic firms, T is dummy variable for the post-reform period, and y is a vector of {capital intensity, labor productivity and RTFP}. The coefficient of interest is δ_2 and captures the impact of the reform on domestic firms' outcomes.

A potential pitfall of regression (7), estimated with yearly firm-level data, is that residuals could be serially correlated - across time within firms, and across firms within sectors for a given year. Serial correlation in the error term might understate the OLS standard errors and induce a type II error, i.e. rejecting the null hypothesis when this is true. To account for this source of bias of the OLS standard errors, I use one of the solutions proposed by Bertrand, Duflo, and Mullainathan (2004) and remove the time series dimension of the data. More precisely, I aggregate the data into pre- and post-reform periods, defined as the three years before and after the deregulation.[25] The dependent variable is computed as the average value between 1998 and 2000, and between 2002 and 2004,

$$\Delta \, y_i = \log(\frac{1}{3} \sum_{2002}^{2004} y_{it}) - \log(\frac{1}{3} \sum_{1998}^{2000} y_{it}).$$

Equation (7) in first differences becomes:

$$\Delta y_i = \delta_1 + \delta_2 H_i + \Delta \varepsilon_i. \tag{8}$$

I cluster the OLS standard errors at four-digit NACE industries to take into account the correlation across firms within sectors. Regression (8), in first differences, removes firm- and sector-fixed effects, and therefore controls for time unvarying unobserved characteristics at the firm and industry levels. However, the fixed effects do not absorb individual characteristics that could lead firms to benefit differently from the introduction of the reform. When estimating equation (8), therefore, I add a set of initial conditions at firm level, Z_i, as: size (employment), productivity (RTFP), and age at the initial year (1998). As sectors could be on different trends, I control for pre-existing growth trends of RTFP and capital intensity at four-digit NACE industries between 1996 and 1997 in Hungary, X_j. To account for differences in industry growth trends in the world economy, I add as controls: capital intensity and TFP growth at four-digit level in the US between 1998 and 2004, ψ_j. The final statistical model I estimate is:

$$\Delta y_{ij} = \delta_1 + \delta_2 H_i + \delta_3 Z_i + \delta_4 X_j + \delta_5 \Delta \psi_j + \Delta \varepsilon_{ij}. \tag{9}$$

[25]Notice that, as the reform took place in the middle of 2001, this year is only a partially treated year and, hence, does not belong to either of the two groups. As the purpose of the analysis is to estimate the average effect of the policy, it would be misleading to include it in either of the groups. For this reason, I drop the year 2001 in the main specifications. Importantly, I show below that all results are robust to its inclusion when estimating the effect of the reform by year (Tables A.11, A.17, A.18 and Figure 3).

The estimation of equation (9) by OLS is reported in Table 5. The coefficient for capital intensity estimated in the baseline specification of column 1, where only the dummy for the domestic firm is included as a regressor, implies a differential expansion of these firms' capital intensity by 0.239 log points (t = 10.24). The estimated coefficient is not affected by the inclusion of firm-level controls in column 2 or by the inclusion of local and global trends in column 3, and remains stable across estimations. Results for labor productivity are presented in columns 4-6. The baseline specification in column 4 indicates a differential impact for domestic firms of 0.074 log points (t = 4.35). The inclusion of firm and industry controls does not significantly affect the estimated coefficient, which stands at 0.053 log points (t = 3.36). The estimates for RTFP confirm the greater expansion in productivity for home firms. After controlling for firm and sector characteristics, the estimated coefficient in column 9 shows a differential increase of 0.032 logs points (t = 2.03) for domestic firms.

In the online Appendix, I present a full set of robustness tests. Table A.3 shows that these results are robust to control for: four-digit industry fixed effects (column 1), wholly foreign companies (column 2), foreign firms used as export platforms (column 3), 1% of top firms (column 4), and firms that change their ownership status (column 5). The empirical evidence does not suggest any significant difference between domestic exporters and non-exporters, as i) they faced similar leverage and financing terms - interest rate and collateral - prior to the liberalization (Table A.4), and ii) they showed non-statistically different pattern of growth in the post-reform period (Table A.5). For robustness, I also compute the RTFP using the Petrin and Levinsohn (2011) and De Loecker and Warzynski (2012) methodologies, and show that results are robust to these estimates of RTFP (Table A.6). Importantly, results are robust to controlling for firms' subsidies and tax exemptions, to considering firms with less than five employees and the unbalanced panel, and to controlling for four-digit industry-year fixed effects (Tables A.7, A.8 and A.9). Home firms' expansion is wide spread across manufacturing sectors, as shown in Table A.10.

Equation (9) pooled the estimated effect across all years before and after. To check whether the estimates are capturing the effect of the financial liberalization and not something else, I test whether the timing coincides with the deregulation. To this end, I interact the dummy for home firms with year dummies and re-estimate equation (9) using four-digit NACE industries fixed effects. In this way, I compare domestic and foreign firms within each four-digit industry and test whether domestic firms evolve differentially over time. Results are presented in Table A.11 and plotted in Figure 3. The estimated coefficients for the interaction terms are statistically significant, confirming that domestic firms were smaller in size (capital intensity, labor productivity and RTFP) than their foreign-industry competitors. Importantly, while the estimated coefficients do not change significantly before the reform, they monotonically decrease after it. These results suggest that home firms grew much faster and gradually closed the gap with their foreign rivals (Figure 3). The F-test on equality of coefficients confirms these results. While the estimated coefficients for the interaction terms are not statistically different from 1998 to 2000, they differ significantly when comparing the pre-reform and post-reform years (Table A.11). As a further falsification test,

I estimate a placebo test on the year 1998, and estimate equation (9) for the period 1996-2000, with a two-years window. Results - presented in Table A.12- show that during this period domestic firms did not evolve differently than their foreign competitors.

R&D and Innovation Activities

To assess whether domestic firms increase their R&D and innovation activities after the liberalization - as stated in Proposition 1-, I employ the BEEPS survey and estimate the following model

$$y_{ijt} = \delta_0 H_{it} + \delta_1 T_t + \delta_2 (H_{it} \,\mathrm{x}\, T_t) + \delta_3 Z_{it} + \mu_j + \varepsilon_{ijt}, \tag{10}$$

where t denotes year; T is a dummy indicating the reform period and j represents sectors, which break down into eight categories. y_{ijt} is a dummy of whether the firm conducts R&D or innovation activities. Z_{it} is a vector of firm characteristics: age and size (employment).[26] To control for sector-specific characteristics, I add sector fixed effects: μ_j. I cluster the standard errors at sector level. Equation (10) with fixed effects cannot be consistently estimated by probit (incidental parameters problem), so I estimate a linear probability model. The coefficient of interest is δ_2, which identifies the change in the probability of domestic firms undertaking R&D and innovation activities after the reform.

Columns 1-3 in Table 6 report the results on R&D activities. The baseline specification suggests that the reform increased the probability of domestic firms undertaking R&D activities by 10.7 percentage points (t = 2.24). The estimated coefficient remains stable and statistically significant after the inclusion of firm- and industry-level controls (columns 2 and 3). Along the same lines, results on innovation activities in columns 4-6 also suggest that the reform increased the probability of domestic firms conducting these activities. The coefficient in the regression including all controls (column 6) implies a 12 percentage points increase (t = 2.19).

5.3 Investigating the Financial Channel

The previous section showed that domestic firms grew faster after the reform. This section tests -first- whether this increase is higher for home firms with greater sectoral needs for external funds and, hence, more exposed to the liberalization. Next, it takes Proposition 2 to the data, and tests if financial terms decrease for domestic firms and whether they increase their leverage accordingly.

[26] As few firms report data on sales, controlling for firm's productivity highly reduces the sample. Importantly, results are robust to this control.

Investment in Capital and Productivity

I test the financial channel by exploiting an additional source of cross-sectional variation: sector needs for external finance. In this way, I employ three sources of variation: time, sector reliance on external finance, and firms' access to international borrowing prior to the reform.

This third source of variation allows assessing the two forces proposed in this paper: better financing terms encouraging domestic firms' investment in technology, and reductions in capital market distortions triggering pro-competitive forces on foreign firms. As regards the first force, sector's financial needs allow testing whether domestic firms operating in sectors relying intensively on external finance expand relatively more; or saying it differently, whether those home firms more exposed to the reform benefited more from it. As concerns the second force, differences in sector financial needs allow testing whether competition tightened more in those sectors. Intuitively, since the asymmetric access to international capital markets distorts competition more in sectors where firms rely more intensively on external funds, foreign firms should increase their productivity in accordance with sector's financial needs. Hence, this third source of cross-sectional variation allows recovering the differential impact of the reform on foreign firms. Importantly, as the distortion affects domestic firms' innovation incentives more (proposition 1), conditional on the sector, home firms should expand relatively more.

To evaluate these two channels, I include sector financial needs in equation (7) and consider the following model:

$$y_{it} = \delta_0 H_i + \delta_1 T_t + \delta_2 (H_i \,\mathrm{x}\, T_t) + \delta_3 (FD_j \,\mathrm{x}\, T_t) + \delta_4 (H_i \,\mathrm{x} FD_j \,\mathrm{x}\, T_t) + \delta_5 FD_j + \delta_6 (H_i \,\mathrm{x}\, FD_j) + \varepsilon_{it}, \quad (11)$$

where j denotes four-digit NACE industries and FD_j is the index of external finance of Rajan and Zingales (1998) at four-digit NACE industries. Coefficient δ_3 in equation (11) -where the dummy for the home firm equals zero- captures the differential impact of the reform on foreign firms across sectors. A positive and significant coefficient would imply that foreign firms expanded more in sectors where the need for external finance was greater. Coefficient δ_4 absorbs the differential impact of the reform on domestic firms in accordance with sector financial needs. Importantly, it indicates whether home firms expand more than their foreign competitors with the same level of reliance on external funding.

As discussed earlier, a potential pitfall of estimating equation (11) using yearly firm-level data is that residuals could be serially correlated. To avoid serial correlation in the error term, I estimate equation (11) in first differences. After the inclusion of firm-level and sector controls, the final model I estimate is,

$$\Delta y_{ij} = \delta_1 + \delta_2 H_i + \delta_3 \, FD_j + \delta_4 \, (H_i \,\mathrm{x}\, FD_j) + \delta_5 Z_i + \delta_6 X_j + \delta_7 \, \Delta \psi_j + \Delta \varepsilon_{ij}. \quad (12)$$

Similarly to equation (11), δ_3 captures the effect of the reform on foreign firms across sectors. δ_4 absorbs the differential effect of home firms over their foreign rivals in accordance with sector financial needs. I control for firm-initial characteristics, sector pre-growth trends in Hungary and

global trends, and cluster the standard errors at four-digit NACE industries, as in equation (9).

Columns 1-3 in Table 7 report the main results on capital intensity. The coefficient on the interaction term for home firms δ_4 is statistically significant and robust to the inclusion of firms' initial characteristics and local and global trends (column 3). After including all controls, the estimated coefficient implies that one standard deviation increase in the index of external finance raises domestic firms' capital intensity by 0.045 log points (t = 2.02). It is important to remark on the estimated coefficient for foreign firms, δ_3. This coefficient is not statistically significant in any specification, showing that foreign firms did not expand their capital intensity in accordance with sector financial needs. Notably, this lack of correlation between needs of external finance and capital investment suggests that foreign firms were not credit constrained nor in needs of external funds before the liberalization.

Columns 4-6 present the results for labor productivity. The estimated coefficients are consistent with the two forces proposed in this paper, implying that foreign and domestic firms should increase their productivity in accordance with sector financial needs, but home firms should expand relatively more. In particular, the coefficient δ_3 implies that foreign firms operating in one standard deviation more financially dependent sector experience a 0.09 log points (t = 2.50) larger increase in labor productivity after the inclusion of firm- and industry-level controls in column 6. As predicted by the model, the effect is even greater for domestic firms. The coefficient δ_4 implies an expansion of 0.04 log points (t = 3.17) more than their foreign competitors in the same sector. Results on RTFP confirm the pattern of growth of labor productivity (columns 7-9). After considering all controls, the estimated coefficients indicate that foreign firms in one standard deviation more financially dependent sector see a 0.08 log points (t = 3.02) larger increase in their RTFP (column 9). Just like the trends in labor productivity, the estimated coefficient implies that domestic firms expanded relatively more: their RTFP grew 0.05 log points (t = 2.48) above the increase of their foreign rivals.

The online Appendix presents four additional robustness tests. First, I re-estimate equation (11) non-parametrically by splitting the sample into quartiles of dependence on external finance. Results presented in Table A.13 confirm that home firms expanded monotonically with the level of financial dependence, and that the increase is significantly larger for the third and fourth quartiles. Second, to test whether the response of foreign firms corresponds to tighter competition and not to financial constraints on these firms, I estimate whether their responses vary when considering different ownership structures. In particular, the presence of pro-competitive forces should remain true even when considering foreign firms that have tight links with their parent companies and, thus, are less likely credit constrained. To test this, I estimate regression (12) on foreign firms with more than 50% foreign shares. Results presented in Table A.14 show that the estimated coefficients on labor productivity and RTFP remain positive and statistically significant even for this group of foreign firms. Third, to show that the pro-competitive effects remain after controlling for foreign firms operating as export platforms, I re-estimate equation (12) excluding foreign firms that sell more than 75% and 90% of their total sales abroad (Table A.15). Finally, to check

whether the increase in firms' productivity is in line with a more intensive use of technology, I construct a measure of skill intensity and test whether firms employ more skilled- labor after the liberalization.[27] Results -presented in Table A.16- confirm that foreign firms increase their skill intensity in accordance with sector financial needs and, as the previous trends, home firms expanded their skill intensity relatively more in those sectors.

These results provide support to the two forces proposed in this paper. First, consistent with the greater exposure to the reform, domestic firms with higher sectoral needs for external funds expanded their capital intensity and productivity relatively more. Second, in line with the presence of pro-competitive forces, foreign firms increased their productivity and skill intensity in sectors where competition was initially more distorted.[28] I turn to test whether financing terms improve for home firms and whether they increase their leverage.

Financing Terms and Leverage

The model indicates that capital inflows upon the liberalization lead to a decrease in financing terms for domestic firms, which allows them to increase their leverage. This was stated in Proposition 2. In this section, I test this proposition in two steps. First, I employ the BEEPS survey to evaluate whether financing terms improved for home firms. Second, I use information on firms' debt with banks from the APEH database to investigate whether domestic firms increased their leverage.

The BEEPS surveys ask firms to report the interest rate paid on loans and the value of the collateral required. I use this information as outcome variables and examine whether these values decreased for domestic firms after the reform. Table 8 reports the estimated coefficients of regression (10) on these outcomes. The coefficient on home firms is positive and significant before the reform, suggesting that domestic firms faced tighter financing terms than foreign companies. After the inclusion of firm-level controls and sector-fixed effects, the estimated coefficients indicate that domestic companies paid interest rates 3.7 percentage points (t = 3.55) higher. Likewise, the value of the required collateral as a percentage of the total loan was 52 percentage points (t = 4.63) greater than that for foreign companies (columns 3 and 6). As expected, the liberalization of international financial flows improved financing terms for home firms: the coefficients of both the interest rate and value of the collateral are negative and statistically significant in all specifica-

[27]This data comes form the NBH, which collects a representative labor survey at firm-level for the years 1999-2004 offering information on employees' education level. Following Bustos (2011), I construct this measure as the share of skilled labor in total employment in primary school equivalents. I define skilled workers (S) as college graduates plus tertiary education graduates converted to college equivalent, and unskilled workers (U) as high and primary school graduates converted to primary school equivalents. The conversion of workers to college and primary school equivalents was done using the 1998 industrial sector wage premium. More formally, skill intensity is measured as:

$$SK_{(i,t)} = \frac{S_{(i,t)}(w_s/w_u)_{1998}}{S_{(i,t)}(w_s/w_u)_{1998} + U_{(i,t)}}$$

[28]This evidence is also consistent with previous industry-level studies reporting that increases in competition induce incumbent firms to raise their productivity (see for example, Holmes and Schmitz 2010).

tions. Regressions including all controls of columns 3 and 6 show that their interest rate fell by 3.9 percentage points (t = 3.67) and the value of the collateral by 31.2 percentage points (t = 2.86).

I examine changes in firms' leverage by using the APEH database to estimate regression (9) on the debt-to-sales ratio. Results presented in Table 11 confirm that domestic firms increased their leverage after the reform. The baseline regression, where only a dummy for domestic firm is included, indicates a differential increase of 0.16 log points (t = 2.17) for domestic firms (column 1). The inclusion of firm- and industry-level controls suggests a slightly larger increase of 0.23 log points (t = 2.61). Column 4 shows that, as expected, the increase in leverage is larger for firms operating in sectors with greater needs for external finance: one standard deviation increase in the index of financial dependence raises domestic firms' leverage by 0.15 log points (t = 1.98). Importantly, consistent with the interpretation of the previous section that foreign firms were not credit constrained before the liberalization, foreign firms did not increase their leverage in accordance with sector financial needs. Instead, the estimated coefficient is negative and statistically significant, which could indicate a reallocation of financial funds towards domestic firms as suggested above.

To test whether the expansion of domestic firms' debt really coincides with the timing of the financial liberalization, I estimate the effect by year. Results plotted in Figure 3 show that the increase in domestic firms' leverage only starts in 2001 and monotonically increase after it. The F-test of equality of coefficients presented in Table A.17 confirms these results. While during the years prior to the reform the estimated coefficients on domestic firms' leverage were not statistically different, following the liberalization they monotonically and significantly differ.

This section has assessed the financial channel implied by the liberalization. In line with Proposition 2, I have shown that financial terms improved for domestic firms, and that they expanded their leverage accordingly -particularly in more financially dependent sectors. In addition, the empirical evidence argues for the presence of pro-competitive forces, as foreign firms responded to the deeper competition in more financially dependent sectors by also increasing their productivity and skill intensity. Next section advances the analysis of pro-competitive forces by studying changes in foreign firms' markups.

5.4 Foreign Firms' Markups

Proposition 3 states that the improvement in financing terms for domestic firms deepens market competition and leads to a reduction in foreign firms' markups. In this section, I test this implication against the data.

To compute firms' markups, I follow De Loecker and Warzynski (2012) and derive them from the firm's optimal labor demand equation,

$$w_t\, l_{ijt} = \beta_j\, y_{ijt} \frac{\left(\frac{w_t}{\beta}\right)^{\beta} \left(\frac{R_t}{\alpha}\right)^{\alpha}}{q_{ijt}}.$$

$$\xi_{ijt} = \frac{1}{\theta_{ijt}} \beta_j, \tag{13}$$

where l is the firm's optimal labor demand and y is its production; β_j is the estimated labor elasticity of the production function in sector j; w denotes the wage and R the interest rate; q expresses firm's productivity; and θ represents the firm's labor share. As shown in equation (13), markups ξ are defined as a wedge between the firm's labor share and the labor elasticity of production. I test for the differential decline in foreign firms' markups using the following model,

$$\Delta\xi_{ij} = \delta_1 + \delta_2 F_i + \delta_3 Z_i + \delta_4 X_j + \delta_5 \Delta\psi_j + \Delta\varepsilon_{ij}, \tag{14}$$

where F_i is a dummy for foreign firms. In this model, δ_2 captures the differential impact of the reform on foreign firms' markups. I control for firms' initial characteristics, local and global trends, and cluster the standard errors at the four-digit industry level as in equation (9).

Column 1 in Table 10 shows changes in markups regressed on a dummy for a foreign firm. As predicted by the model, the estimated coefficient suggests a greater decrease of foreign firms' markups of 0.017 log points (t = 1.9) relative to domestic firms. The inclusion of firm- and industry-level controls does not significantly affect the results: on average, foreign firms' markups drop by 0.026 log points (t = 2.26). This relative decrease of foreign firms' markups is consistent with the evidence presented in the previous sections and the model's implications. As domestic firms increase their productivity relative to foreign firms, foreign firms' cost advantage decreases and, therefore, their markups fall relatively more. Note as well that the magnitude of the relative drop in foreign firms' markups (0.026 log points) is in line with the relative increase in domestic firms' RTFP (0.032 log points).

For robustness, I also compute markups using the elasticities of the production function estimated with the Petrin and Levinsohn (2011) and De Loecker and Warzynski (2012) methodologies. Table A.6 confirms the decline in foreign firms' markup following the financial liberalization and shows that this reduction is robust to either estimates of the production function (Cobb-Douglas in the first, and translog in the second case). Results are also robust to using the price-cost margin, which proxies markups as firm's sales minus total costs over sales following Aghion, Bloom, Blundell, Griffith, and Howitt (2005) (see column 3 of Table A.6). Additionally, I estimate equation (14) by year and test whether this decline coincides with the timing of the reform. Results plotted in Figure 3 and presented in Table A.18 confirm the decrease of foreign firms' markups since 2001. As demonstrated by the F-test, the estimated coefficients on foreign firms' markups were not statistically different between 1998 and 2000, but they monotonically and significantly differ in the years following the reform. I also estimate a falsification test for 1998 and show that foreign firms' markups did not change differently regarding their local competitors prior to 2001 (Table A.19). Finally, results on foreign firms' markups are robust to controlling for subsidies and tax exemptions (Table A.20) and firms with less than five employees (Table A.21).

As discussed above, asymmetries in the access to international capital markets should have distorted competition more in sectors with greater needs for external finance. As firms in those sectors use external funds more intensively, the difference in the borrowing costs should have undermined the competitive pressure of domestic firms relatively more, allowing foreign companies to obtain higher markups. Therefore, financial liberalization should be associated with a greater decline of foreign firms' markups in more financially dependent sectors. To assess this implication, I test whether foreign firms' markups in these sectors decreased relatively more by interacting the dummy for foreign firms with the financial dependence index of Rajan and Zingales (1998). The estimated equation is,

$$\Delta y_{ij} = \delta_1 + \delta_2 F_i + \delta_3 FD_j + \delta_4 (F_i \,\mathrm{x}\, FD_j) + \delta_5 Z_i + \delta_6 X_j + \delta_7 \Delta\psi_j + \Delta\varepsilon_{ij}, \tag{15}$$

where δ_4 absorbs the differential effect on foreign firms in more financially dependent sectors. The estimated coefficients are reported in column 4 of Table 10, and indicate that the reform is associated a relatively greater decline in foreign firms' markups in those sectors. Foreign firms operating in one standard deviation more financially dependent sector experience a 0.05 log points (t = 4.74) larger decline in their markups. Importantly, this differential decrease in foreign firms' markups across sectors remains true when estimating markups using different methodologies as the PCM, and Petrin and Levinsohn (2011) and De Loecker and Warzynski (2012) procedures (Table A.22), or controlling for foreign firms that operate as export platforms (Table A.23). Note, finally, that this greater decline of foreign firms' markups in more financially dependent sectors is consistent with the greater expansion of domestic firms in those sectors. It is interesting that the coefficient on financial dependence for domestic firms δ_3 is positive and significant, suggesting that their markups rose in sectors with higher financial needs. This result is in line with their greater expansion in productivity observed in those sectors. As domestic firms' productivity grew more, so did their markups.

Firm-Level Evidence: Taking Stock

This section has confronted the firm-level implications of the model against the data. First, I have shown that the liberalization in Hungary associates with increases in domestic firms' capital intensity, labor productivity and RTFP, and in their probability of conducting R&D and innovation activities, in line with Proposition 1. Second, I have provided direct evidence that domestic firms' expansion correlates with an improvement in financing terms and an increase in leverage, as stated in Proposition 2. Third, the empirical results also point to the presence of pro-competitive forces as foreign firms' markups decreased (Proposition 3), particularly in sectors where competition was initially more distorted. Furthermore, in those sectors, foreign firms expanded their labor productivity, RTFP and skill intensity relatively more.

5.5 Industry-Level Evidence: Technological Gap and Concentration

Proposition 4 states that the greater increase in domestic firms' innovation efforts yields a decline in the productivity gap with their foreign-industry rivals, and that this decline is greater in sectors where the initial productivity gap was largest. The previous sections have shown that domestic firms have expanded their productivity relatively more than their foreign competitors, arguing for a reduction in the productivity gap among them. In this section, I test whether this decline is higher in sectors where the initial gap was larger, and whether it is parallel to changes in the industry concentration.

Proposition 4 refers to the gap in physical productivity between foreign and domestic firms. Unfortunately, the lack of information on firms' prices does not allow recovering their physical productivity and, thus, assessing this proposition directly against the data. However, through the lens of the model, markups and RTFP are proportional to the productivity gap and, hence, can be employed as proxies for it (see equations (2) and Appendix B.1). Therefore, one could regress:

$$\Delta\kappa_j = \alpha + \beta\kappa_j + \varepsilon_j,$$

where κ_j denotes the markup or RTFP difference between the 50th percentile foreign and home firms in each three-digit industry j before the reform (1998-00), and Δ denotes the change between before and after (1998-00 and 2002-04). A negative β would imply that the productivity gap fell more in sectors where the initial gap was largest. A potential drawback of this regression is that it does not consider pre-existing trends within sectors. To account for this, I include a third period of analysis 1996-97, and estimate the following model:

$$\Delta\kappa_{jt} = \alpha + \beta_1\kappa_{jt} + \beta_2 T_t + \beta_3(\kappa_{jt} * T_t) + \varepsilon_{jt}, \tag{16}$$

where t denotes the period, and T_t is a dummy indicating the reform. The change after the reform, taking into account pre-existing trends, is captured by the coefficient β_3 of the interaction term.

Table 11 reports the results for the RTFP and markups gaps. In line with Proposition 4, it shows a greater decrease in the RTFP gap in sectors where its initial level was larger. After the inclusion of historial trends in column 3, the estimated coefficient implies that an increase in one standard deviation in the initial RTFP dispersion lowers 15% the RTFP gap between foreign and domestic firms following the reform. Similarly, the estimated coefficient for markups is negative and statistically significant, indicating that one standard deviation increase in the initial markup dispersion, decreases the markup gap between foreign and home firms by 13% (column 6). The reduction in the RTFP and markup gaps within sectors should be parallel to a decrease in the level of industry concentration and, particularly, in initially more concentrated sectors.[29] To test

[29]Prior to the reform the Hungarian manufacturing sector presented high levels of market concentration. Foreign firms' share in total value added was 74%, and the Lerner and Herfindahl indexes of industry concentration were high at 0.22 and 0.40. Importantly, by 2004, market competition had increased: foreign firms' market share had dropped six percentage points, and the Lerner and Herfindahl indexed had shrunk by 10% and 7.5%.

this, I follow the standard literature and use the Lerner index as a measure of concentration (see Nickell 1996, Aghion, Bloom, Blundell, Griffith, and Howitt 2005, among others). Column 9 in Table 11 confirms that the liberalization associates with a larger decrease in the Lerner index in initially more concentrated sectors. After the inclusion of pre-existing trends, the estimated coefficient implies that one standard deviation increase in the initial Lerner index drops the industry concentration by 3% following the reform.

5.6 Aggregate Productivity Growth

This section assesses whether the expansion in firms' productivity correlates with an increase in aggregate productivity growth, as stated in Proposition 5. Additionally, it conducts a decomposition exercise to understand the contribution of within-firm and reallocation effects in aggregate productivity growth.

In the late nineties, aggregate productivity was growing at a fast pace in Hungary. Three years prior to the liberalization -between 1998 and 2000-, aggregate productivity grew at 5.8% per year. The financial liberalization correlates with an acceleration in this growth. Within the three years after the reform (2002-04), aggregate productivity grew at 9.7% per year, and 8.5% within the five years after it. Importantly, a structural test in the aggregate productivity trend confirms this result (see Perron and Zhu 2005), even after controlling for other reforms such as the trade liberalization in 1996, the accession to the EU in 2004, and a falsification test for 1998 (Table A.24).

To understand the source of the increase in aggregate productivity growth and how it relates to the expansion in firms' productivity reported above, I follow a decomposition exercise in the spirit of Petrin and Levinsohn (2011). In particular, I break down aggregate productivity growth into a component related to changes in technical efficiency (TE) and a component aggregating reallocation effects (RE). The technical efficiency component reflects the contribution to growth of increases in firms' efficiency, holding inputs constant. More precisely, this term is the sum of changes in firm's RTFP weighted by the firm's share in total value added. The reallocation term arises from wedges between the input elasticities and input shares in production. As is well established in the misallocation literature, in the presence of these wedges, reallocation of inputs across firms can affect aggregate RTFP (Restuccia and Rogerson 2008; Hsieh and Klenow 2009, among others). Formally, this term is the sum of the net gain in the allocation of inputs across firms weighted by the firm's share in value added. Hence, as in Petrin and Levinsohn (2011), aggregate RTFP growth can be expressed as,

$$\Delta\, RTFP_t = TE_t + RE_t = \sum_{i,t}^{N_t} D_{it}\, \Delta RTFP_{it} + \sum_{i,t}^{N_t} \sum_{i,z,t}^{Z_t} D_{it}(\varepsilon_{izt} - \theta_{izt})\Delta Z_{izt}, \tag{17}$$

where i and t denote firm and year; N_t denotes the total number of firms in the economy; D_{it} is the firm's share in total value added, where the weight is computed as the average between t and $t-1$; $\Delta RTFP_{it}$ is firm's RTFP growth; Z denotes inputs: capital and labor; ε is the input elasticity;

and θ is the input share in value added.

Table 12 Panel A presents the average growth rate of aggregate RTFP and its components within the three years before and after the reform (1998-00 and 2002-04). Panel B reports the source of this growth. As shown in Panel A, prior to the liberalization, aggregate productivity growth was growing at 5.8% per year, from which 4.8% was explained by reallocation effects and only 1% by increases in within-firm productivity. Remarkably, this pattern of growth reversed after the financial liberalization. Following the reform, aggregate productivity accelerated to 9.7% per year, from which 7.9% was accounted by within-firm productivity grow, and only 1.7% by reallocation effects. As a result, within-firm productivity turned to explain the bulk of the expansion in aggregate RTFP: 82% after the liberalization (Panel B). The rise in within-firm productivity is mostly explained by the balanced panel of firms used above (column 4).[30]

What can create these two opposite patterns of growth before and after the financial liberalization? Or, put differently, why did within-firm productivity grow at such a low pace before the reform and at a high pace after it? The conjecture that emerges from this paper is that it is the change in all firms' incentives to invest in technology that raises it. In particular, according to the mechanism studied in this paper, distortions in the access to capital markets undermine competition and economy-wide innovation incentives. It is then natural that before the reform, within-firm productivity grew at a low pace. By reducing distortions in the access to international capital markets across firms, financial liberalization relaxes financing terms of previously discriminated firms, and unchains pro-competitive forces that lead both discriminated and non-discriminated firms to invest more in technology. As all firms increase their productivity, within-firm productivity becomes a key driver of aggregate productivity growth.

6 Conclusion

The debate about the desirability of international financial flows is nowadays at the center of the discussion of researchers and policymakers. This paper focuses on one key aspect of capital controls: their impact on firms' access to capital markets, and their consequences for competition and aggregate productivity growth.

Throughout the paper, I have shown that capital controls can create asymmetries in the access to external finance across firms, and undermine market competition and economy-wide investment in technology. In developing economies with sufficiently developed financial systems, capital account openness can lead economic growth. Capital inflows reduce asymmetries in the access to capital markets across firms, promoting market competition and a broad-based expansion in productivity growth. Previously policy-discriminated firms invest more in technology because they face better

[30]This large increase in within-firm productivity is consistent with Bollard, Klenow, and Sharma (2013), who also find that the bulk of the increase in aggregate productivity in India following structural reforms is explained by the expansion of within-firm productivity.

financing terms, non-discriminated firms also innovate more as they see deeper competition.

This paper also sheds light about the current debate on capital controls. It is often argued that countries might see beneficial to encourage foreign direct investment and discourage financial flows. The evidence presented in this paper warns about possible distortions created by this policy. By restricting financial flows, capital controls can reduce local credit and tight financing terms for domestic firms. This creates an asymmetry in the access to external funds between domestic and foreign firms that undermine competition and economic growth. Through the lens of the paper, non-FDI flows might benefit the economy by improving access to credit for domestic firms.

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Figures and Tables

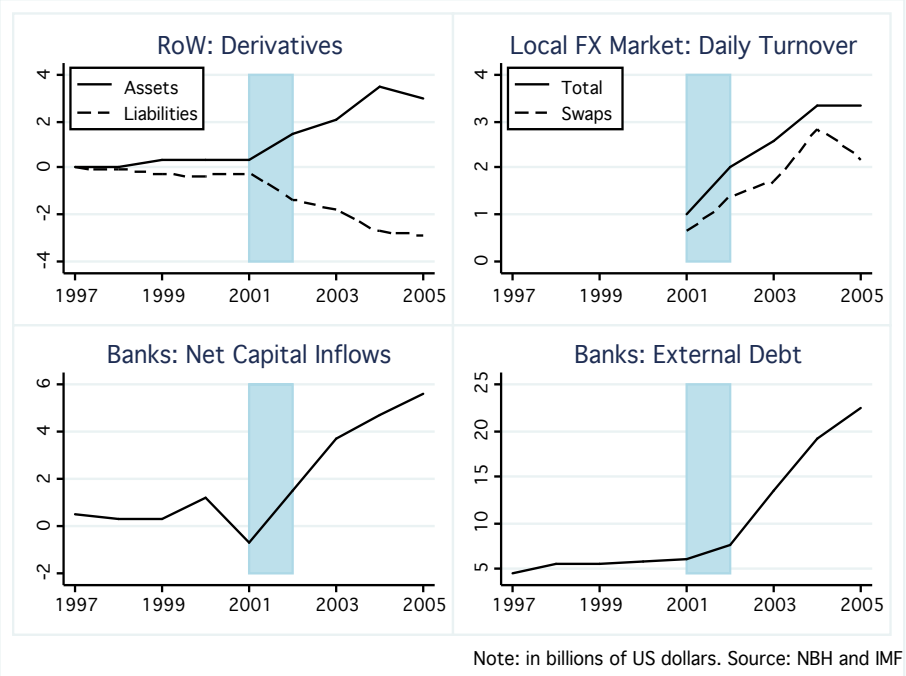


Figure 1: International Borrowing of Financial Institutions

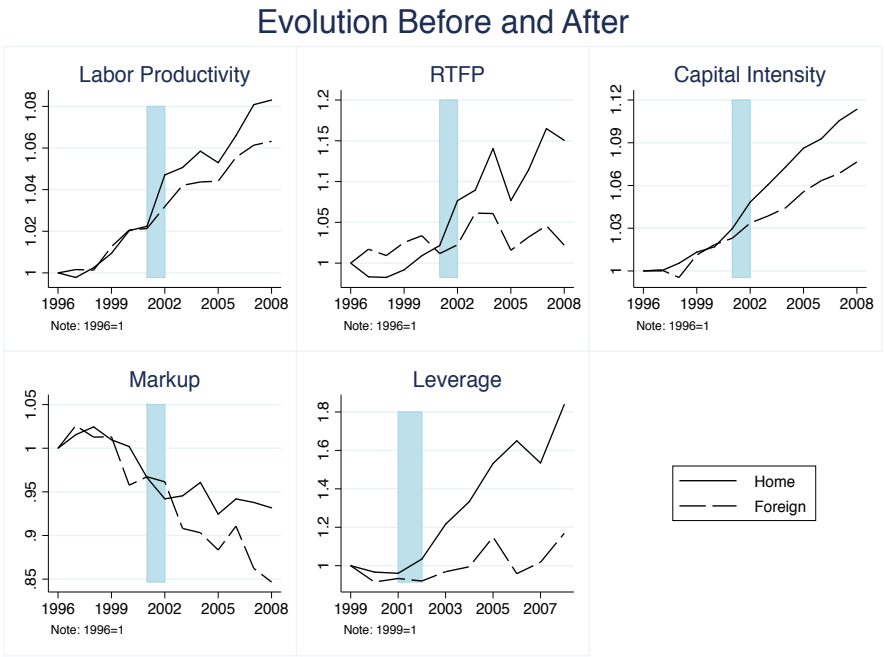


Figure 2: Evolution of Main Variables Before and After the Reform

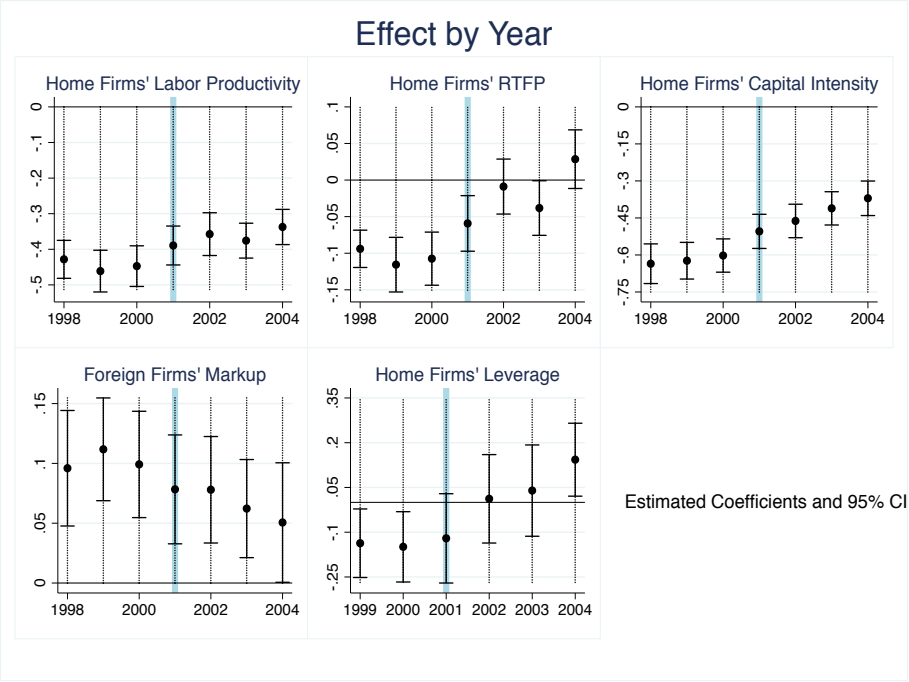


Figure 3: Effect by Year

Table 1: Credit Market Before and After the Liberalization

Aggregate Economy (in%)	Before	After
Credit-to-GDP ratio	27	44
Credit-to-deposit ratio	83	113
Lending interest rate	12.8	7.5
Firms		
Credits to SME	34	51
SME debt in FX	0	33
Interest rate differential b. Home and Foreign	3.2	0.65
Differential in collateral b. Home and Foreign	58	11

Notes: For rows 1-5 the source is National Bank of Hungary, and data corresponds to December 2000 and December 2004. Rows 6-7 come from Business Environment and Enterprise Performance Survey of the World Bank and EBRD, for the years 2001 and 2004.

Table 2: Mean Characteristics of Home and Foreign Firms (1998)-APEH Database

	Foreign	Home	Difference in Means
	(In logs)		
Value Added	10.6549	9.0769	1.5779***
	(0.0525)	(0.0226)	(0.0500)
Employment	3.8952	2.8602	1.0349***
	(0.0429)	(0.0191)	(0.0418)
Labor productivity	6.7596	6.2167	0.5429***
	(0.0263)	(0.0131)	(0.0278)
RTFP	1.4093	1.1959	0.2133***
	(0.0267)	(0.0139)	(0.0291)
Markup	0.2391	0.1774	0.0617***
	(0.0159)	(0.0098)	(0.0197)
Age	1.6167	1.4777	0.1390***
	(0.0136)	(0.0090)	(0.0179)
Number of Firms	1,283	4,165	5,448

Notes: *, **, *** significant at 10, 5, and 1 percent. Std. errors in parenthesis. Source: APEH.

Table 3: Mean Characteristics of Home and Foreign Firms (2001)-BEEPS Database

	Foreign	Home	Difference in Means
Probability of Innovation	0.5946	0.3521	0.2425***
	(0.0818)	(0.0328)	(0.0858)
Probability of R&D	0.3206	0.1675	0.1532***
	(0.0647)	(0.0267)	(0.0614)
Interest Rate Paid	9.0667	13.3198	-4.2531***
	(0.9200)	(0.5845)	(1.2687)
Required Value of Collateral	124.2105	185.2874	-61.0768***
	(13.7504)	(11.5619)	(25.6236)
Number of Firms	53	197	250

Notes: *, **, *** significant at 10, 5, and 1 percent. Std. errors in parenthesis. Source: BEEPS.

Table 4: Growth Rates Preceding the Reform

Balanced Panel	Home	Foreign	Difference in Means
Capital Intensity	0.0235	0.0289	-0.0054
	(0.0032)	(0.0040)	(0.0061)
Labor Productivity	0.0554	0.0697	-0.0143
	(0.0043)	(0.0074)	(0.0087)
RTFP	0.0264	0.0395	-0.0132
	(0.0041)	(0.0071)	(0.0082)
Markup	-0.0076	0.0058	-0.0133*
	(0.0040)	(0.0068)	(0.0080)
Leverage	-0.0077	0.0364	-0.0441
	(0.0345)	(0.0644)	(0.0692)
N	17,765	5,654	23,419

Notes: *, **, *** significant at 10, 5, and 1 percent. Std. errors in parenthesis. The table reports the mean of the variable growth rate within the five years prior to the reform (1996-2000). Source: APEH.

Table 5: Investment in Capital and Productivity

	Δ Capital Intensity			Δ Labor Productivity			Δ RTFP		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Home	0.239***	0.253***	0.252***	0.074***	0.051***	0.053***	0.098***	0.032**	0.032**
	(0.023)	(0.025)	(0.025)	(0.017)	(0.017)	(0.016)	(0.015)	(0.014)	(0.016)
Firm-level controls		yes	yes		yes	yes		yes	yes
Local trends			yes			yes			yes
Global trends			yes			yes			yes
R^2	0.019	0.030	0.030	0.004	0.027	0.040	0.008	0.075	0.088
N	5,448	5,448	5,448	5,448	5,448	5,448	5,448	5,448	5,448

Notes: *, **, *** significant at 10, 5, and 1 percent. Std. errors are clustered at 4-digit NACE industries. All regressions include a constant term. Global industry controls include capital intensity and TFP growth rates of the 4-digit NACE industries in the United States between 1998 and 2004. Local industry controls are capital intensity and RTFP average growth rates at 4-digit level in Hungary in the late 90s. Firm-level controls are age, employment and RTFP in the initial year (1998). Source: APEH.

Table 6: R&D and Innovation Activities

	R&D Activities			Innovation Activities		
	(1)	(2)	(3)	(4)	(5)	(6)
Home	-0.153***	-0.058	-0.032	-0.242***	-0.158**	-0.090
	(0.028)	(0.032)	(0.030)	(0.057)	(0.054)	(0.056)
Home*Reform	0.107*	0.083**	0.090*	0.176**	0.167**	0.122*
	(0.048)	(0.033)	(0.044)	(0.066)	(0.055)	(0.056)
Reform	0.023	0.046	0.023	-0.084	-0.071	-0.099
	(0.055)	(0.052)	(0.043)	(0.063)	(0.075)	(0.081)
Firm-level controls		yes	yes		yes	yes
Sector-fixed effects			yes			yes
R^2	0.019	0.064	0.081	0.014	0.037	0.069
N	774	774	774	774	774	774

Notes: *, **, *** significant at 10, 5, and 1 percent. Std. errors are clustered industry level. All regressions include a constant term. R&D is a dummy if the firm reports positive R&D expenditures. Innovation is a dummy if a firms reports any of the following activities: developed successfully a major product line, upgraded an existing product line, acquired a new production technology, obtained a new licensing agreement, and obtained a new quality accreditation. Firm-level controls are age and size. Source: BEEPS.

Table 7: Financial Dependence: Investment in Capital and Productivity

	Δ Capital Intensity			Δ Labor Productivity			Δ RTFP		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Home	0.210***	0.221***	0.219***	0.058***	0.017	0.015	0.083***	-0.010	-0.016
	(0.021)	(0.024)	(0.024)	(0.017)	(0.015)	(0.017)	(0.018)	(0.023)	(0.023)
Home * Fin.Dep.	0.142*	0.156*	0.155*	0.093*	0.155***	0.147***	0.087	0.181**	0.167**
	(0.080)	(0.076)	(0.077)	(0.053)	(0.045)	(0.046)	(0.072)	(0.080)	(0.067)
Fin. Dep.	-0.084	-0.061	-0.053	0.276**	0.320**	0.334**	0.162	0.222**	0.277***
	(0.064)	(0.070)	(0.077)	(0.124)	(0.124)	(0.134)	(0.107)	(0.10)	(0.092)
Firm-level controls		yes	yes		yes	yes		yes	yes
Local trends			yes			yes			yes
Global trends			yes			yes			yes
R^2	0.020	0.031	0.031	0.034	0.074	0.081	0.022	0.111	0.120
N	5,143	5,143	5,143	5,143	5,143	5,143	5,143	5,143	5,143

Notes: *, **, *** significant at 10, 5, and 1 percent. Std. errors are clustered at 4-digit NACE industries. All regressions include a constant term. Financial Dependence is the Rajan and Zingales' (1998) index. Global industry controls include capital intensity and TFP growth rates of the 4-digit NACE industries in the United States between 1998 and 2004. Local industry controls are capital intensity and RTFP average growth rates at 4-digit level in Hungary in the late 90s. Firm-level controls are age, employment and RTFP in the initial year (1998). Source: APEH.

Table 8: Financing Terms

	Interest Rate			Value of Collateral		
	(1)	(2)	(3)	(4)	(5)	(6)
Home	4.253***	3.707***	3.729***	60.789***	49.174**	52.106***
	(1.132)	(1.027)	(1.051)	(15.391)	(15.727)	(11.263)
Home*Reform	-3.879**	-3.858***	-3.947***	-37.653*	-35.438*	-31.170**
	(1.134)	(1.018)	(1.076)	(17.130)	(17.104)	(10.911)
Reform	-0.026	-0.159	-0.221	20.968	19.574	13.368
	(0.951)	(0.830)	(0.890)	(12.571)	(13.192)	(11.635)
Firm-level controls		yes	yes		yes	yes
Sector- fixed effects			yes			yes
R^2	0.175	0.202	0.217	0.035	0.045	0.103
N	415	415	415	399	399	399

Notes: *, **, *** significant at 10, 5, and 1 percent. Std. errors are clustered industry level. All regressions include a constant term. Firm-level controls are age and size. Source: BEEPS.

Table 9: Leverage

	Δ Leverage			
	(1)	(2)	(3)	(4)
Home	0.160**	0.239***	0.230***	0.238**
	(0.073)	(0.085)	(0.088)	(0.100)
Home* Fin. Dep.				0.526**
				(0.266)
Financial Dependence				-0.595**
				(0.234)
Firm-level controls		yes	yes	yes
Local trends			yes	yes
Global trends			yes	yes
R^2	0.002	0.006	0.007	0.015
N	2,742	2,742	2,742	2,742

Notes: *, **, *** significant at 10, 5, and 1 percent. Std. errors are clustered at 4-digit NACE industries. All regressions include a constant term. Financial Dependence is the Rajan and Zingales (1998) index. Global industry controls include capital intensity and TFP growth rates of the 4-digit NACE industries in the United States between 1998 and 2004. Local industry controls are capital intensity and RTFP average growth rates at 4-digit level in Hungary in the late 90s. Firm-level controls are age, employment and RTFP in the initial year (1998). Source: APEH.

Table 10: Foreign Firms' Markups

	Δ Markups			
	(1)	(2)	(3)	(4)
Foreign	-0.017*	-0.025**	-0.026**	0.030*
	(0.009)	(0.011)	(0.012)	(0.016)
Foreign*Fin.Dep.				-0.205***
				(0.043)
Financial Dependence				0.212***
				(0.069)
Firm-level control		yes	yes	yes
Local trend			yes	yes
Global trends			yes	yes
R^2	0.000	0.023	0.024	0.057
N	5,376	5,376	5,376	5,086

Notes: *, **, *** significant at 10, 5, and 1 percent. Std. errors are clustered at 4-digit NACE industries. All regressions include a constant term. Financial Dependence is the Rajan and Zingales (1998) index. Global industry controls include capital intensity and TFP growth rates of the 4-digit NACE industries in the United States between 1998 and 2004. Local industry controls are capital intensity and RTFP average growth rates at 4-digit level in Hungary in the late 90s. Firm-level controls are age, employment and RTFP in the initial year (1998). Source: APEH.

Table 11: Markup and RTFP Dispersions and Industry Concentration

	Change in RTFP Dispersion			Change in Markup Dispersion			Change in Concentration		
	Late 90s	Reform	Accounting for Pre-trends	Late 90s	Reform	Accounting for Pre-trends	Late 90s	Reform	Accounting for Pre-trends
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Initial Value	-0.076	-0.202**	-0.076	-0.419***	-0.730***	-0.419***	-0.177***	-0.317***	-0.177***
	(0.064)	(0.079)	(0.077)	(0.063)	(0.135)	(0.079)	(0.075)	(0.085)	(0.060)
Initial Value *T			-0.222**			-0.310**			-0.245***
			(0.107)			(0.140)			(0.091)
T			0.186			0.134**			0.211***
			(0.128)			(0.054)			(0.072)
R^2	0.018	0.074	0.100	0.354	0.280	0.325	0.101	0.145	0.223
N	82	82	164	78	78	156	82	82	164

Notes: all regressions include a constant term. *, **, *** significant at 10, 5, and 1 percent. Std errors in parenthesis. 3-digit NACE industries correlations. Source: APEH.

Table 12: Contribution to Aggregate RTFP Growth

	Total Sample			Balanced Panel
	ΔRTFP	Reallocation	Within-Firm	Within-Firm
	(1)	(2)	(3)	(4)
	A- Mean Growth Rate			
Before	5.8	4.8	1.0	0.9
After	9.7	1.7	7.9	7.3
	B- Contribution to Aggregate RTFP Growth (column 1)			
Before	100.0	83.4	16.5	16.5
After	100.0	18.0	82.0	75.4

Additional Figures, Robustness Tests, and Model's Additional Derivations and Extensions

(Not for publication)

Appendix A Additional Figures

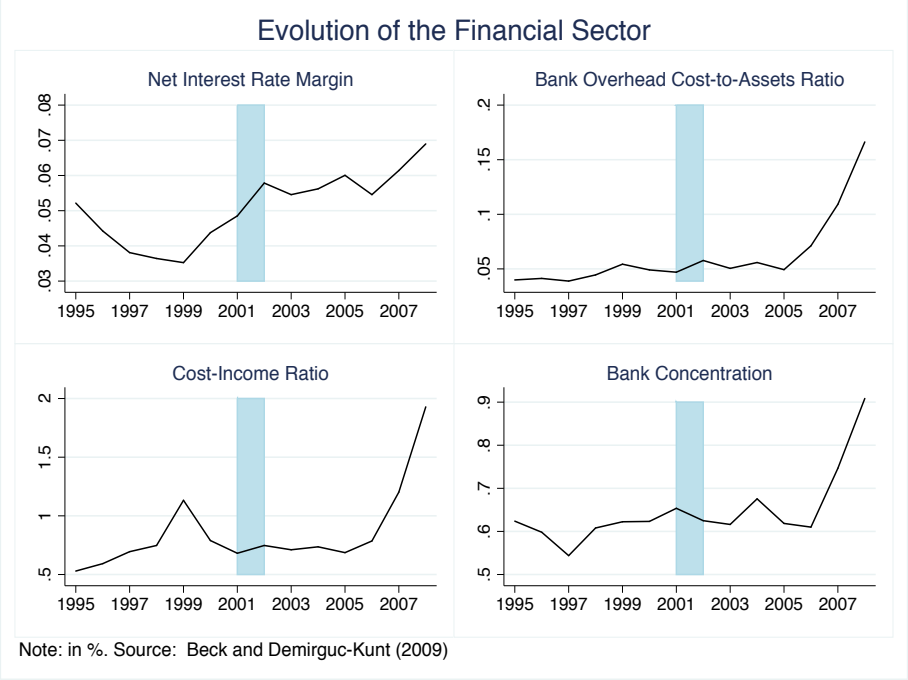


Figure A.1: Evolution of the Financial Sector in Hungary

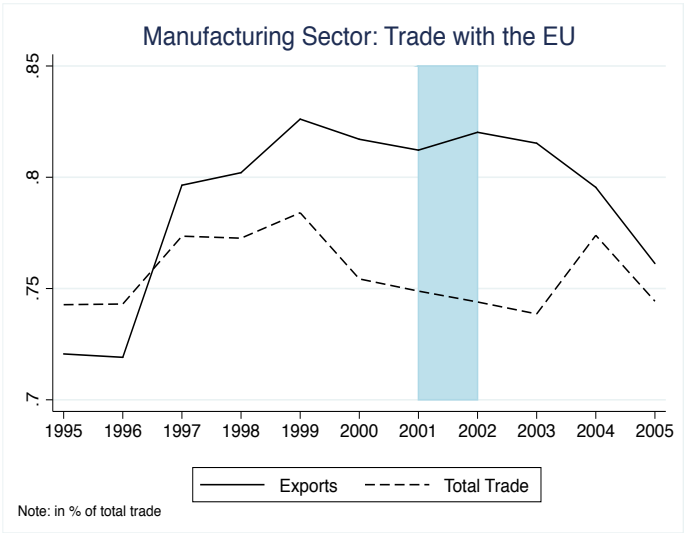


Figure A.2: Total trade and exports with the European Union

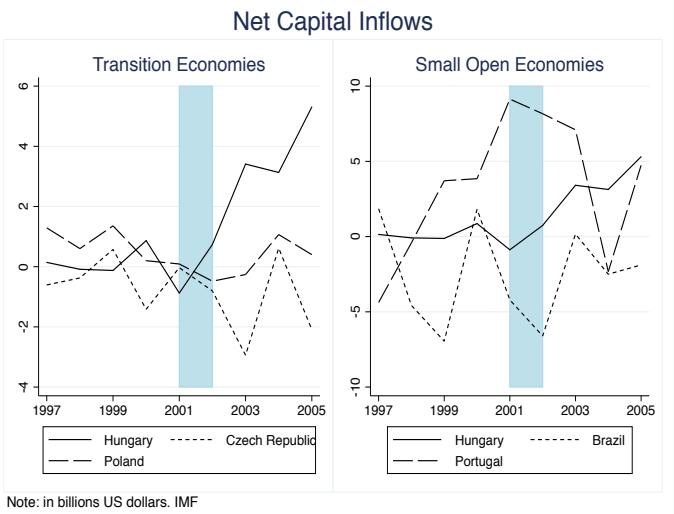


Figure A.3: Net Capital Inflows to Transition and Small Open Economies. Comparison

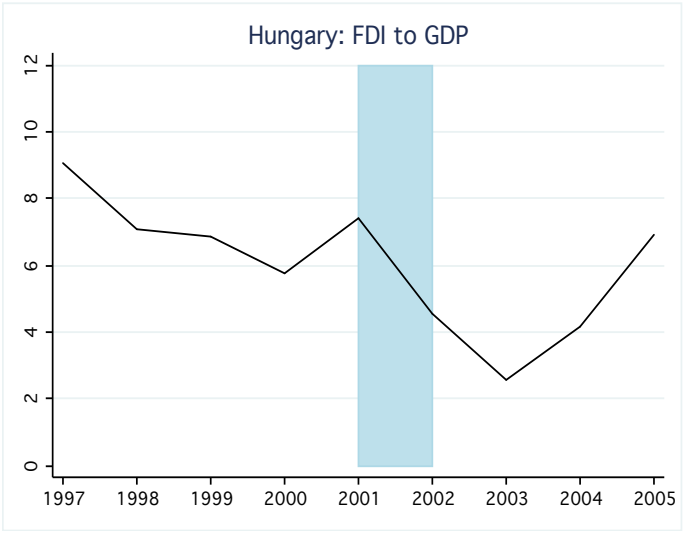


Figure A.4: Evolution of Foreign Direct Investment

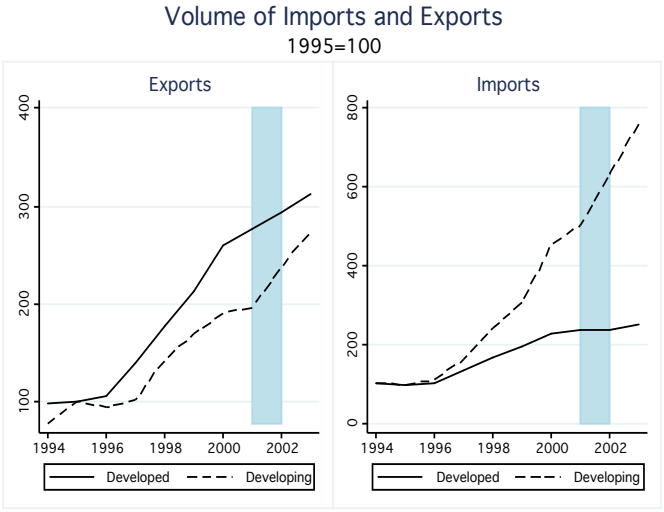


Figure A.5: Evolution of Trade

Additional Tables: Robustness Tests

Table A.1: Firm Survival

	Firm Survival		
	Home	Foreign	Difference in Means
Survival Ratio	0.8672	0.8579	0.0092
	(0.0026)	(0.0060)	(0.0064)
N	16,826	3,323	20,149

Notes: *, **, *** significant at 10, 5, and 1 percent. Std errors in parenthesis. The table reports the mean of a dummy variable on surviving after the reform. In particular, for all existing firms prior to the reform (in 2000), surviving = 1 if the firm did not exit within the three years following the reform (2002-2004), and 0 otherwise. Source: APEH.

Table A.2: Number of Banks in Hungary

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Number of Banks	43	43	43	45	45	45	45	44	44	44	44

Source: National Bank of Hungary.

Table A.3: Robustness Test: Investment in Capital and Productivity

	Δ Capital Intensity				
	(1)	(2)	(3)	(4)	(5)
Home	0.249***	0.171***	0.254***	0.241***	0.282***
	(0.026)	(0.031)	(0.027)	(0.026)	(0.026)
Firm-level controls	yes	yes	yes	yes	yes
Sector-fixed effects	yes				
Local trends		yes	yes	yes	yes
Global trends		yes	yes	yes	yes
R^2	0.060	0.019	0.029	0.029	0.031
N	5,448	4,747	4,950	4,881	5,158
	Δ Labor Productivity				
	(1)	(2)	(3)	(4)	(5)
Home	0.046***	0.070***	0.052***	0.061***	0.060***
	(0.015)	(0.020)	(0.018)	(0.016)	(0.017)
Firm-level controls	yes	yes	yes	yes	yes
Sector-fixed effects	yes				
Local trends		yes	yes	yes	yes
Global trends		yes	yes	yes	yes
R^2	0.235	0.040	0.039	0.029	0.040
N	5,448	4,747	4,950	4,881	5,158
	Δ RTFP				
	(1)	(2)	(3)	(4)	(5)
Home	0.032*	0.057***	0.031*	0.039**	0.039**
	(0.016)	(0.020)	(0.018)	(0.017)	(0.018)
Firm-level controls	yes	yes	yes	yes	yes
Sector-fixed effects	yes				
Local trends		yes	yes	yes	yes
Global trends		yes	yes	yes	yes
R^2	0.155	0.088	0.086	0.077	0.087
N	5,448	4,747	4,950	4,881	5,158

Notes: *, **, *** significant at 10, 5, and 1 percent. Std errors are clustered at 4-digit NACE industries. All regressions include a constant term. Global industry controls include capital intensity and TFP growth rates of the 4-digit NACE industries in the United States between 1998 and 2004. Local industry controls are capital intensity and TFP average growth rates at 4-digit level in Hungary in the late 90s. Firm-level controls are age, employment and RTFP in the initial year (1998). Column 1 controls for four-digit industry fixed effects. Column 2 removes those foreign firms whose foreign shares exceed more than 75% of total shares on average between 1998 and 2000. Column 3 restrict the analysis to foreign firms that are not used as export platforms (more than 75% of exports). Column 4 removes the top 1 percentile of firms (in value added). Column 5 controls for firms that change the ownership status between the pre- and post-reform periods. Source: APEH.

Table A.4: Credit Market Before the Liberalization: Home Firms

	Exporters	Non-Exporters	Difference in Means
Paid Interest Rate	13.3250	13.2015	0.1234
	(1.5917)	(0.6585)	(1.5478)
Required Collateral	4.8618	5.0060	-0.1441
	(0.1301)	(0.0479)	(0.1134)
Leverage	0.0952	0.0977	0.0025
	(0.0058)	(0.0054)	(0.0086)

Notes: *, **, *** significant at 10, 5, and 1 percent. Std. errors in parenthesis. Rows 1 and 2 come from Business Environment and Enterprise Performance Survey of the World Bank and EBRD, for the years 2001 and 2004. Row 3 uses APEH data. The ratio debt-to-sales is computed using the short-term debt over sales. Row 2 is in logs.

Table A.5: Investment in Capital and Productivity: Home Exporters vs Non-Exporters

	Δ Capital Intensity	Δ Labor Productivity	Δ RTFP
	(1)	(2)	(3)
Home	0.255***	0.060***	0.034*
	(0.027)	(0.019)	(0.018)
Home*Exporter	-0.012	-0.023	-0.004
	(0.025)	(0.025)	(0.020)
Firm controls	yes	yes	yes
Local trends	yes	yes	yes
Global trends	yes	yes	yes
R^2	0.030	0.041	0.088
N	5,448	5,448	5,448

Notes: *, **, *** significant at 10, 5, and 1 percent. Std. errors are clustered at 4-digit NACE industries. All regressions include a constant term. Exporter is defined as having an average export share larger than 0.05 between 1998 and 2000. Global industry controls include capital intensity and TFP growth rates of the 4-digit NACE industries in the United States between 1998 and 2004. Local industry controls are capital intensity and RTFP average growth rates at 4-digit level in Hungary in the late 90s. Firm-level controls are age, employment and RTFP in the initial year (1998). Source: APEH.

Table A.6: Robustness Test: RTFP and Markups

	Δ RTFP		Δ Markups		
	WLP	DLTL	PCM	WLP	DLTL
	(1)	(2)	(3)	(4)	(5)
Home	0.028***	0.081***			
	(0.009)	(0.026)			
Foreign			-0.127**	-0.034***	-0.024*
			(0.051)	(0.011)	(0.013)
Firm-level controls	yes	yes	yes	yes	yes
Local trends	yes	yes	yes	yes	yes
Global trends	yes	yes	yes	yes	yes
R^2	0.034	0.065	0.006	0.028	0.019
N	4,864	4,839	5,029	4,864	4,839

Notes: *, **, *** significant at 10, 5, and 1 percent. Std errors are clustered at 4-digit NACE industries. All regressions include a constant term. Global industry controls include capital intensity and TFP growth rates of the 4-digit NACE industries in the United States between 1998 and 2004. Local industry controls are capital intensity and TFP growth rates at 4-digit level in Hungary in the late 90s. Firm-level controls are age, employment and RTFP in the initial year (1998). Column 1 reports the RTFP measure with the coefficients of the production function estimated following Wooldridge (2009) and Petrin and Levinsohn (2011) methodology. Column 2 reports the RTFP of the translog production function using the De Loecker and Warzynski (2012) methodology to estimate the elasticities of the factor of production. Column 3 reports the price-cost margin estimated as in Aghion, Bloom, Blundell, Griffith, and Howitt (2005). Column 4 and 5 present the markup estimated using the elasticities computed for columns 1 and 2, and following equation (13). Source: APEH.

Table A.7: Robustness Tests: Subsidies and Exceptions II

	Δ Capital Intensity		Δ Labor Productivity		Δ RTFP		Δ Leverage	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Home	0.254***	0.224***	0.054***	0.018	0.034**	-0.014	0.233***	0.239**
	(0.025)	(0.023)	(0.016)	(0.016)	(0.016)	(0.023)	(0.088)	(0.100)
Home* Fin. Dep.		0.146*		0.142***		0.164**		0.526**
		(0.077)		(0.047)		(0.068)		(0.266)
Fin. Dep.		-0.045		0.339**		0.279***		-0.594**
		(0.078)		(0.133)		(0.092)		(0.234)
Subsidy and Tax Ex.	-0.313**	-0.294**	-0.032	-0.037	-0.240*	-0.267**	-0.560	-0.146
	(0.152)	(0.126)	(0.164)	(0.109)	(0.123)	(0.123)	(0.671)	(0.568)
(Other) Firm controls	yes	yes	yes	yes	yes	yes	yes	yes
Local trends	yes	yes	yes	yes	yes	yes	yes	yes
Global trends	yes	yes	yes	yes	yes	yes	yes	yes
R^2	0.030	0.031	0.041	0.081	0.089	0.122	0.008	0.015
N	5,448	5,143	5,448	5,143	5,448	5,143	2,742	2,742

Notes: *, **, *** significant at 10, 5, and 1 percent. Std. errors are clustered at 4-digit NACE industries. All regressions include a constant term. Global industry controls include capital intensity and TFP growth rates of the 4-digit NACE industries in the United States between 1998 and 2004. Local industry controls are capital intensity and RTFP average growth rates at 4-digit level in Hungary in the late 90s. Firm-level controls are subsidies and tax exceptions over sales, age, employment and RTFP in the initial year (1998). Source: APEH.

Table A.8: Robustness Tests: All Firms

	Δ Capital Intensity		Δ Labor Productivity		Δ RTFP		Δ Leverage	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Home	0.218***	0.177***	0.090***	-0.014	0.067***	0.004	0.204***	0.082
	(0.028)	(0.036)	(0.021)	(0.025)	(0.023)	(0.019)	(0.079)	(0.104)
Home* Fin. Dep.		0.189*		0.138**		0.115**		0.551**
		(0.092)		(0.069)		(0.055)		(0.275)
Fin. Dep.		-0.153*		0.427***		0.269**		-0.355
		(0.081)		(0.062)		(0.116)		(0.237)
Firm-level controls	yes	yes	yes	yes	yes	yes	yes	yes
Local trends	yes	yes	yes	yes	yes	yes	yes	yes
Global trends	yes	yes	yes	yes	yes	yes	yes	yes
R^2	0.019	0.023	0.021	0.103	0.065	0.082	0.007	0.008
N	7,247	6,930	7,247	6,930	7,247	6,930	3,138	3,104

Notes: *, **, *** significant at 10, 5, and 1 percent. Std. errors are clustered at 4-digit NACE industries. All regressions include a constant term. Global industry controls include capital intensity and TFP growth rates of the 4-digit NACE industries in the United States between 1998 and 2004. Local industry controls are capital intensity and RTFP average growth rates at 4-digit level in Hungary in the late 90s. Firm-level controls are age, employment and RTFP in the initial year (1998). Source: APEH.

Table A.9: Panel Regressions: Investment in Capital and Productivity

	Log Capital Intensity			Log Labor Productivity			Log RTFP		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Home*Reform	0.208***	0.251***	0.231***	0.062***	0.070***	0.043***	0.076***	0.056***	0.051***
	(0.015)	(0.015)	(0.016)	(0.012)	(0.016)	(0.014)	(0.012)	(0.017)	(0.014)
Reform	0.017			0.099***			0.020		
	(0.016)			(0.017)			(0.015)		
Firm FE	yes	yes	yes	yes	yes	yes	yes	yes	yes
Sector*Year FE		yes	yes		yes	yes		yes	yes
Balanced Panel	no	no	yes	no	no	yes	no	no	yes
R^2	0.880	0.882	0.871	0.784	0.791	0.805	0.809	0.814	0.826
N	59,976	59,976	38,136	60,864	60,864	38,136	59,771	59,771	38,136

Notes: *, **, *** significant at 10, 5, and 1 percent. Std. errors are clustered at year and 4-digit NACE industries. All regressions include firm-fixed effects. Regressions (2), (3), (5), (6), (8), (9) include 4-digit NACE industries-year fixed effects. Regressions (1), (2), (4), (5), (7) and (8) includes all firms with 5 or more employees. Regressions (3), (6) and (9) are estimated for the balance panel employed in Table 5. Source: APEH.

Table A.10: Results by Industry

	Differential Impact on Home Firms				Foreign Firms
	Δ Capital Intensity	Δ Labor Productivity	Δ RTFP	Δ Leverage	Δ Markups
	(1)	(2)	(3)	(4)	(5)
H*Food & Beverage	0.266***	0.131***	0.106***	0.270***	-0.031**
(Foreign in col (5))	(0.066)	(0.009)	(0.011)	(0.025)	(0.011)
H*Textiles	0.132*	0.021***	0.001	0.256***	0.049***
(Foreign in col (5))	(0.068)	(0.005)	(0.004)	(0.020)	(0.004)
H*Wood and of Wood	0.300***	0.158***	0.128***	0.185***	-0.076***
(Foreign in col (5))	(0.109)	(0.003)	(0.002)	(0.010)	(0.002)
H*Pulp, Paper & Printing	0.285***	-0.007	-0.069***	0.406***	0.015**
(Foreign in col (5))	(0.047)	(0.007)	(0.005)	(0.019)	(0.005)
H*Chemical, Rubber & Plastic	0.191***	0.022***	-0.008	0.425***	-0.013*
(Foreign in col (5))	(0.055)	(0.006)	(0.006)	(0.023)	(0.006)
H*Basic Metals	0.322***	0.076***	0.048***	0.300***	-0.032***
(Foreign in col (5))	(0.067)	(0.006)	(0.016)	(0.016)	(0.005)
H*Machinery	0.245***	0.047***	-0.016***	-0.472***	-0.057***
(Foreign in col (5))	(0.039)	(0.006)	(0.017)	(0.017)	(0.005)
H*Electrical Equipment	0.292***	0.008	0.033*	0.440***	-0.028***
(Foreign in col (5))	(0.058)	(0.020)	(0.048)	(0.047)	(0.007)
H*Transport	0.334***	0.138***	0.166***	0.192***	-0.054***
(Foreign in col (5))	(0.127)	(0.012)	(0.027)	(0.029)	(0.010)
H*Manufacturing NEC	0.174**	0.105***	0.080***	0.169***	-0.052***
(Foreign in col (5))	(0.079)	(0.006)	(0.004)	(0.021)	(0.004)
Firm-level controls	Yes	Yes	Yes	Yes	Yes
Global trends	Yes	Yes	Yes	Yes	Yes
Local trends	Yes	Yes	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes	Yes	Yes
R^2	0.037	0.144	0.199	0.017	0.059
N	5,448	5,448	5,448	2,742	5,376

Notes: *, **, *** significant at 10, 5, and 1 percent. Std. errors are clustered at industry level. Columns (1)-(4) report the differential impact of the reform on home firms' capital intensity, labor productivity, RTFP and leverage. Column (5) presents the differential impact of the reform on foreign firms' markups. All regressions include sector fixed-effects at 2-digit NACE industries. Global industry controls include capital intensity and TFP growth rates of the 4-digit NACE industries in the United States between 1998 and 2004. Local industry controls are capital intensity and RTFP average growth rates at 4-digit level in Hungary in the late 90s. Firm-level controls are age, employment and RTFP in the initial year (1998). Source: APEH.

Table A.11: Falsification Test: Effect by Year

	Log Capital Intensity	Log Labor Productivity	Log RTFP
	(1)	(2)	(3)
1998*Home	-0.636***	-0.428***	-0.094***
	(0.041)	(0.027)	(0.013)
1999*Home	-0.623***	-0.461***	-0.116***
	(0.038)	(0.030)	(0.019)
2000*Home	-0.602***	-0.447***	-0.107***
	(0.034)	(0.029)	(0.018)
2001*Home	-0.504***	-0.389***	-0.059***
	(0.035)	(0.028)	(0.019)
2002*Home	-0.462***	-0.357***	-0.009
	(0.035)	(0.031)	(0.019)
2003*Home	-0.411***	-0.376***	-0.038**
	(0.034)	(0.025)	(0.019)
2004*Home	-0.370***	-0.337***	0.029
	(0.036)	(0.025)	(0.020)
Year FE	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes
Firm-Level controls	Yes	Yes	Yes
Global trends	Yes	Yes	Yes
R^2	0.971	0.989	0.894
N	38,136	38,136	38,136
F Tests on Equality of Coefficients			
F-stat: 1998*Home=2000*Home	0.41	0.24	0.37
pvalue	0.5216	0.6257	0.5413
F-stat: 2000*Home=2002*Home	8.83	4.76	14.45
pvalue	0.0030	0.0293	0.0002
F-stat: 2000*Home=2003*Home	16.58	3.66	7.20
pvalue	0.0000	0.0558	0.0074
F-stat: 2000*Home=2004*Home	23.67	8.57	25.47
pvalue	0.0000	0.0035	0.0000

Notes: *, **, *** significant at 10, 5, and 1 percent. Std. errors are clustered at year and 4-digit NACE industries. Global industry controls include capital intensity and TFP of the 4-digit NACE industries in the United States between 1998 and 2004. Firm-level controls are employment, labor productivity and age in the initial year (1998). All regressions include 4-digit industries fixed-effects. Source: APEH.

Table A.12: Falsification Test-Year 1998: Investment in Capital and Productivity

	Δ Capital Intensity			Δ Labor Productivity			Δ RTFP		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Home	0.012	0.027	0.023	-0.018	-0.025	-0.022	0.020	-0.017	-0.016
	(0.022)	(0.021)	(0.020)	(0.020)	(0.021)	(0.021)	(0.017)	(0.018)	(0.018)
Firm controls		yes	yes		yes	yes		yes	yes
Local trends			yes			yes			yes
Global trends			yes			yes			yes
R^2	0.000	0.011	0.018	0.000	0.048	0.062	0.000	0.118	0.121
N	4,366	4,366	4,366	4,366	4,366	4,366	4,366	4,366	4,366

Notes: *, **, *** significant at 10, 5, and 1 percent. Period 1996-2000. Std. errors are clustered at 4-digit NACE industries. All regressions include a constant term. Global industry controls include capital intensity and TFP growth rates of the 4-digit NACE industries in the US between 1996-00. Local industry controls are capital intensity and RTFP average growth rates at 4-digit level in Hungary in the early 90s. Firm-level controls are age, employment and RTFP in the initial year (1996). Source: APEH.

Table A.13: Quartiles of Financial Dependence: Investment in Capital and Productivity

	Δ Capital Intensity			Δ Labor Productivity			Δ RTFP		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Home*1(Fin.Dep.=1)	0.225***	0.234***	0.234***	0.058***	0.017	0.034	0.087***	-0.009	-0.014
	(0.033)	(0.035)	(0.035)	(0.013)	(0.034)	(0.031)	(0.015)	(0.027)	(0.028)
Home*1(Fin.Dep.=2)	0.226***	0.226***	0.228***	0.089*	0.057**	0.052*	0.089*	0.024	0.022
	(0.050)	(0.047)	(0.046)	(0.043)	(0.028)	(0.029)	(0.044)	(0.042)	(0.042)
Home*1(Fin.Dep.=3)	0.271***	0.285***	0.279***	0.067***	0.051*	0.051*	0.083***	0.042*	0.036*
	(0.056)	(0.055)	(0.054)	(0.020)	(0.026)	(0.026)	(0.021)	(0.022)	(0.022)
Home*1(Fin.Dep.=4)	0.253***	0.292***	0.298***	0.077**	0.080**	0.091**	0.156***	0.083**	0.075**
	(0.041)	(0.040)	(0.042)	(0.030)	(0.031)	(0.035)	(0.047)	(0.038)	(0.036)
1(Fin.Dep.=2)	0.014	0.033	0.028	0.132	0.160***	0.172***	0.118	0.138**	0.134**
	(0.057)	(0.054)	(0.054)	(0.086)	(0.051)	(0.051)	(0.071)	(0.064)	(0.061)
1(Fin.Dep.=3)	-0.007	0.004	-0.010	0.139*	0.160***	0.180***	0.106	0.125**	0.119**
	(0.043)	(0.044)	(0.046)	(0.078)	(0.054)	(0.052)	(0.068)	(0.051)	(0.051)
1(Fin.Dep.=4)	-0.018	-0.015	-0.034	0.163*	0.190***	0.187***	0.055	0.124**	0.143**
	(0.056)	(0.059)	(0.072)	(0.088)	(0.057)	(0.061)	(0.080)	(0.058)	(0.057)
Firm-level controls		yes	yes		yes	yes		yes	yes
Local trends			yes			yes			yes
Global trends			yes			yes			yes
R^2	0.020	0.031	0.032	0.030	0.069	0.082	0.022	0.109	0.114
N	5,143	5,143	5,143	5,143	5,143	5,143	5,143	5,143	5,143

Notes: *, **, *** significant at 10, 5, and 1 percent. Std. errors are clustered at 4-digit NACE industries. All regressions include a constant term. Financial Dependence is the Rajan and Zingales' (1998) index. Global industry controls include capital intensity and TFP growth rates of the 4-digit NACE industries in the United States between 1998 and 2004. Local industry controls are capital intensity and RTFP average growth rates at 4-digit level in Hungary in the late 90s. Firm-level controls are age, employment and RTFP in the initial year (1998). Source: APEH.

Table A.14: Financial Dependence: Investment in Capital and Productivity-Robustness Test

	Δ Capital Intensity			Δ Labor Productivity			Δ RTFP		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Home	0.246***	0.253***	0.252***	0.061***	0.019	0.016	0.080***	-0.015	-0.023
	(0.028)	(0.031)	(0.031)	(0.021)	(0.016)	(0.015)	(0.018)	(0.025)	(0.025)
Home* Fin. Dep.	0.117	0.163*	0.162*	0.080	0.158***	0.154***	0.120	0.218***	0.208***
	(0.093)	(0.083)	(0.084)	(0.069)	(0.054)	(0.049)	(0.086)	(0.084)	(0.072)
Fin. Dep.	-0.066	-0.071	-0.059	0.285***	0.322***	0.329**	0.129	0.193*	0.245***
	(0.059)	(0.067)	(0.073)	(0.083)	(0.108)	(0.122)	(0.098)	(0.098)	(0.089)
Firm-level controls		yes	yes		yes	yes		yes	yes
Local trends			yes			yes			yes
Global trends			yes			yes			yes
R^2	0.022	0.034	0.034	0.035	0.075	0.082	0.022	0.115	0.124
N	4,915	4,915	4,915	4,915	4,915	4,915	4,915	4,915	4,915

Notes: *, **, *** significant at 10, 5, and 1 percent. Std errors are clustered at 4-digit NACE industries. All regressions include a constant term. Regressions only include foreign firms whose foreign owned shares exceed the 50%. Financial Dependence is the Rajan and Zingales (1998) index. Global industry controls include capital intensity and TFP growth rates of the 4-digit NACE industries in the United States between 1998 and 2004. Local industry controls are capital intensity and RTFP average growth rates at 4-digit level in Hungary in the late 90s. Firm-level controls are age, employment and RTFP in the initial year (1998). Source: APEH.

Table A.15: Export Platforms

	Δ Capital Intensity		Δ Labor Productivity		Δ RTFP		Δ Leverage	
	90%	75%	90%	75%	90%	75%	90%	75%
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Home	0.214***	0.212***	0.036*	0.022	0.024*	0.018	0.140	0.102
	(0.027)	(0.029)	(0.020)	(0.021)	(0.006)	(0.011)	(0.108)	(0.113)
Home* Fin. Dep.	0.174*	0.212**	0.081**	0.076*	0.025*	0.031*	0.481*	0.643**
	(0.089)	(0.101)	(0.038)	(0.044)	(0.007)	(0.009)	(0.288)	(0.300)
Fin. Dep.	-0.055	-0.090	0.380***	0.380***	0.266**	0.385*	-0.583**	-0.748***
	(0.093)	(0.105)	(0.101)	(0.095)	(0.030)	(0.107)	(0.261)	(0.274)
Firm-level controls	yes	yes	yes	yes	yes	yes	yes	yes
Local trends	yes	yes	yes	yes	yes	yes	yes	yes
Global trends	yes	yes	yes	yes	yes	yes	yes	yes
R^2	0.030	0.030	0.085	0.083	0.105	0.134	0.008	0.008
N	4,789	4,667	4,789	4,667	4,789	4,667	2,311	2,249

Notes: *, **, *** significant at 10, 5, and 1 percent. Std. errors are clustered at 4-digit NACE industries. All regressions include a constant term. Columns 1, 3, 5 and 7 restrict the analysis to foreign firms which export shares lower than 90% of their total sales. Columns 2, 4, 6 and 8 restrict the analysis to foreign firms which export shares lower than 75%. Global industry controls include capital intensity and TFP growth rates of the 4-digit NACE industries in the United States between 1998 and 2004. Local industry controls are capital intensity and RTFP average growth rates at 4-digit level in Hungary in the late 90s. Firm-level controls are age, employment and RTFP in the initial year (1998). Source: APEH.

Table A.16: Skill-Intensity

	Δ Skill-Intensity			
	(1)	(2)	(3)	(4)
Domestic	0.003*	0.014**	0.013**	-0.014**
	(0.002)	(0.006)	(0.006)	(0.006)
Domes.* Fin. Dep.				0.041**
				(0.016)
Financial Dependence				0.021**
				(0.009)
Firm-level control		yes	yes	yes
Local trend			yes	yes
Global trends			yes	yes
R^2	0.004	0.028	0.038	0.053
N	1,221	1,221	1,221	1,179

Notes: *, **, *** significant at 10, 5, and 1 percent. Std. errors are clustered at 4-digit NACE industries. All regressions include a constant term. Financial Dependence is the Rajan and Zingales (1998) index. Global industry controls include capital intensity and TFP growth rates of the 4-digit NACE industries in the United States between 1998 and 2004. Local industry controls are capital intensity and RTFP average growth rates at 4-digit level in Hungary in the late 90s. Firm-level controls are age, employment and RTFP in the initial year (1998). Source: APEH.

Table A.17: Falsification Test: Effect by Year

	Log Leverage
	(1)
1999*Home	-0.137**
	(0.055)
2000*Home	-0.149**
	(0.056)
2001*Home	-0.121
	(0.072)
2002*Home	0.012
	(0.071)
2003*Home	0.039
	(0.073)
2004*Home	0.143**
	(0.059)
Year FE	Yes
Sector FE	Yes
Firm-Level controls	Yes
Global trends	Yes
R^2	0.830
N	16,452
F Tests on Equality of Coefficients	
F-stat 1999-00	0.05
pvalue	0.8220
F-stat 2000-02	6.05
pvalue	0.0231
F-stat 2000-03	5.60
pvalue	0.0281
F-stat 2000-04	12.71
pvalue	0.0019

Notes: *, **, *** significant at 10, 5, and 1 percent. Std. errors are clustered at year and 4-digit NACE industries. Global industry controls include capital intensity and TFP of the 4-digit NACE industries in the United States between 1998 and 2004. Firm-level controls are employment, labor productivity and age in the initial year (1998). All regressions include 4-digit industries fixed-effects. Source: APEH.

Table A.18: Falsification Test: Effect by Year

	Log Markup
	(1)
1998*Foreign	0.096***
	(0.023)
1999*Foreign	0.112***
	(0.021)
2000*Foreign	0.099***
	(0.021)
2001*Foreign	0.078***
	(0.022)
2002*Foreign	0.078***
	(0.021)
2003*Foreign	0.062***
	(0.020)
2004*Foreign	0.051**
	(0.024)
Year FE	Yes
Sector FE	Yes
Firm-Level controls	Yes
Global trends	Yes
R^2	0.190
N	37,632
F Tests on Equality of Coefficients	
F-stat 1998-00	0.08
pvalue	0.7870
F-stat 2000-02	3.49
pvalue	0.0766
F-stat 2000-03	12.62
pvalue	0.0020
F-stat 2000-04	9.10
pvalue	0.0068

Notes: *, **, *** significant at 10, 5, and 1 percent. Std. errors are clustered at year and 4-digit NACE industries. Global industry controls include capital intensity and TFP of the 4-digit NACE industries in the United States between 1998 and 2004. Firm-level controls are employment, labor productivity and age in the initial year (1998). All regressions include 4-digit industries fixed-effects. Source: APEH.

Table A.19: Markups: Falsification Test, Year 1998

	Δ Markups		
	(1)	(2)	(3)
Foreign	-0.003	-0.007	-0.006
	(0.012)	(0.014)	(0.014)
Firm controls		yes	yes
Local trends			yes
Global trends			yes
R^2	0.000	0.024	0.028
N	3,953	3,953	3,953

Notes: *, **, *** significant at 10, 5, and 1 percent. Std errors are clustered at 4-digit NACE industries. All regressions include a constant term. Global industry controls include capital intensity and TFP growth rates of the 4-digit NACE industries in the US between 1996-00. Local industry controls are capital intensity and RTFP average growth rates at 4-digit level in Hungary in the early 90s. Firm-level controls are age, employment and RTFP in the initial year (1996). Source: APEH.

Table A.20: Markups: Controlling for Subsidies and Exceptions

	Δ Markups	
	(1)	(2)
Foreign	-0.027**	0.028*
	(0.011)	(0.015)
Foreign * Fin. Dep.		-0.202***
		(0.044)
Fin. Dep.		0.212***
		(0.070)
Subsidy and Tax Ex.	-0.202	-0.246
	(0.150)	(0.154)
(Previous) Firm controls	yes	yes
Local trends	yes	yes
Global trends	yes	yes
R^2	0.024	0.058
N	5,376	5,086

Notes: *, **, *** significant at 10, 5, and 1 percent. Std. errors are clustered at 4-digit NACE industries. All regressions include a constant term. Global industry controls include capital intensity and TFP growth rates of the 4-digit NACE industries in the United States between 1998 and 2004. Local industry controls are capital intensity and RTFP average growth rates at 4-digit level in Hungary in the late 90s. Firm-level controls are subsidies and tax exceptions, age, employment and RTFP in the initial year (1998). Source: APEH.

Table A.21: Markups: Including all Firms

	Δ Markups	
	(1)	(2)
Foreign	-0.026*	-0.001
	(0.012)	(0.016)
Foreign *Fin.Dep.		-0.106**
		(0.047)
Fin.Dep.		0.165**
		(0.062)
Firm-level controls	yes	yes
Local trends	yes	yes
Global trends	yes	yes
R^2	0.028	0.034
N	7,039	6,921

Notes: *, **, *** significant at 10, 5, and 1 percent. Std. errors are clustered at 4-digit NACE industries. All regressions include a constant term. Global industry controls include capital intensity and TFP growth rates of the 4-digit NACE industries in the United States between 1998 and 2004. Local industry controls are capital intensity and RTFP average growth rates at 4-digit level in Hungary in the late 90s. Firm-level controls are age, employment and RTFP in the initial year (1998). Source: APEH.

Table A.22: Markups: PCM, WLP and DLTL Methodologies

	Δ Markups		
	PCM	WLP	DLTL
	(1)	(2)	(3)
Foreign	-0.044	-0.032**	-0.013
	(0.041)	(0.013)	(0.028)
Foreign*Fin. Dep.	-0.333***	-0.086**	-0.186**
	(0.112)	(0.036)	(0.073)
Financial Dependence	0.236**	0.087*	0.003
	(0.100)	(0.043)	(0.073)
Firm-level controls	yes	yes	yes
Local trends	yes	yes	yes
Global trends	yes	yes	yes
R^2	0.008	0.036	0.023
N	4,811	4,646	4,621

Notes: *, **, *** significant at 10, 5, and 1 percent. Std. errors are clustered at 4-digit NACE industries. All regressions include a constant term. Global industry controls include capital intensity and TFP growth rates of the 4-digit NACE industries in the United States between 1998 and 2004. Local industry controls are capital intensity and RTFP average growth rates at 4-digit level in Hungary in the late 90s. Firm-level controls are age, employment and RTFP in the initial year (1998). Source: APEH.

Table A.23: Markups: Controlling for Export Platforms

	Δ Markups			
	90%	75%	90%	75%
	(1)	(2)	(3)	(4)
Foreign	-0.026**	0.015	-0.022*	0.017
	(0.010)	(0.014)	(0.011)	(0.011)
Foreign * Fin. Dep.		-0.152***		-0.136***
		(0.038)		(0.040)
Fin. Dep.		0.218***		0.218***
		(0.071)		(0.071)
Firm-level controls	yes	yes	yes	yes
Local trends	yes	yes	yes	yes
Global trends	yes	yes	yes	yes
R^2	0.021	0.061	0.041	0.063
N	4,841	4,737	4,720	4,616

Notes: *, **, *** significant at 10, 5, and 1 percent. Std. errors are clustered at 4-digit NACE industries. All regressions include a constant term. Columns 1 and 3 restrict the analysis to foreign firms which export shares lower than 90% of their total sales. Columns 2 and 4 restrict the analysis to foreign firms which export shares lower than 75%. Global industry controls include capital intensity and TFP growth rates of the 4-digit NACE industries in the United States between 1998 and 2004. Local industry controls are capital intensity and RTFP average growth rates at 4-digit level in Hungary in the late 90s. Firm-level controls are age, employment and RTFP in the initial year (1998). Source: APEH.

Table A.24: Acceleration of RTFP Growth

	Cumulative RTFP Growth					
	(1)	(2)	(3)	(4)	(5)	(6)
Time trend	17.586***	13.884***	13.523***	14.468***	13.845***	13.625***
	(0.630)	(0.537)	(0.601)	(3.319)	(1.019)	(0.574)
Structural break in slope		8.992***	8.407***	9.115***	8.897***	11.083***
(Financial Liberalization, 2001)		(1.120)	(1.194)	(1.351)	(2.368)	(2.100)
Structural break in level			7.015			
(Financial Liberalization, 2001)			(5.620)			
Structural break in slope				-0.673		
(Trade Liberalization, 1996)				(3.769)		
Structural break in slope					0.116	
(Falsification test,1998)					(2.527)	
Structural break in slope						-3.513
(Falsification test, 2004)						(2.999)
R^2	0.981	0.997	0.997	0.997	0.997	0.997
N	17	17	17	17	17	17

Notes: all regressions include a constant term. *,**, *** significant at 10, 5, 1%, respectively. Source: APEH.

Appendix B Model: Additional Derivations and Extensions

B.1. Additional Derivations

(i) *Firms' Markups and Profits.* In the first period, firms make two types of decisions. First, they decide their optimal innovation efforts. Next, after learning the result of the innovation process, they decide whether to produce in the second period. I solve firms' optimal innovation efforts by backward induction. That is, I first compute firms' production profits and, then, their optimal innovation efforts.

In this Bertrand competition setting, only the firm with the lowest marginal cost in each intermediate variety will be active in equilibrium. Given the production function and the market structure, the active firm minimizes its total production cost:

$$\text{Min}_{l_{sjt+1},k_{sjt+1}} \quad TC_{sjt+1} = w_{t+1} l_{sjt+1} + R^{s'}_{t+1} k_{sjt+1}$$

$$\text{st} \quad y_{sjt+1} \geq q_{sjt+1}\, k^{\alpha}_{sjt+1} l^{1-\alpha}_{sjt+1}$$

where $R^{s'}$ is either the domestic lending rate for home firms (R^L), or the international rate (R^*) otherwise. In variety j, the active firm's marginal cost becomes:

$$MC_{sjt+1} = \frac{1}{q_{sjt+1}} \left(\frac{R^{s'}_{t+1}}{\alpha} \right)^{\alpha} \left(\frac{w_{t+1}}{1-\alpha} \right)^{1-\alpha} \tag{18}$$

Equation (18) indicates that the active firm's marginal cost depends on its productivity level and, notably, on its financing costs. In particular, the higher is the interest rate, the higher is its marginal cost. Given the optimal demand for variety j: $y_{jt+1} = \frac{Y_{t+1}}{p_{jt+1}}$, the active firm's profit from production activities is $\Pi^{p}_{jt+1} = (p_{jt+1} - MC_{jt+1})\, y_{jt+1} = (1 - \xi^{-1}_{jt+1}) Y_{t+1}$, where ξ_{jt+1} is the firm's markup. I turn next to show how foreign and domestic firms' markups and profits are determined in equilibrium.

$\rightarrow$ *Foreign firms.* If the foreign firm in variety j succeeds in improving the existing technology and is the market leader in equilibrium, its markup will be:

$$\xi^{post}_{Fjt+1} \equiv \frac{p_{jt+1}}{MC^{post}_{Fjt+1}} = \frac{MC^{pre}_{Hjt+1}}{MC^{post}_{Fjt+1}} = \left(\frac{R^{L}_{t+1}}{R^{*}_{t+1}} \right)^{\alpha} \frac{q^{post}_{Fjt+1}}{q^{pre}_{Hjt+1}} = \tau_{t+1}\, \lambda^{\Delta_j + 1}. \tag{19}$$

where MC^{post}_{Fjt+1} is foreign firm's marginal cost if the innovation succeeds, and MC^{pre}_{Hjt+1} is the home firm's marginal costs in absence of innovation. Recall that under Bertrand competition, the leader sets its price equal to the marginal cost of the closest competitor. In this case, the foreign firm sets its price equal to the marginal cost of the home firm in that variety. Notice that, after minimizing production costs, firms' marginal costs are given by: $MC^{post}_{Fjt+1} = \frac{(\frac{R^{*}_{t+1}}{\alpha})^{\alpha} (\frac{w_{t+1}}{1-\alpha})^{1-\alpha}}{q^{post}_{Fjt+1}}$ and

$MC^{pre}_{Hjt+1} = \frac{(\frac{R^L_{t+1}}{\alpha})^{\alpha}(\frac{w_{t+1}}{1-\alpha})^{1-\alpha}}{q^{pre}_{Hjt+1}}$.

If the foreign firm does not succeed in improving the existing technology and keeps its initial productivity level, its markup will be:

$$\xi^{pre}_{Fjt+1} \equiv \frac{p_{jt+1}}{MC^{pre}_{Fjt+1}} = \frac{MC^{pre}_{Hjt+1}}{MC^{pre}_{Fjt+1}} = \left(\frac{R^L_{t+1}}{R^*_{t+1}}\right)^{\alpha} \frac{q^{pre}_{Fjt+1}}{q^{pre}_{Hjt+1}} = \tau_{t+1}\,\lambda^{\Delta_j}. \tag{20}$$

Given equations (19) and (20), the foreign firm's post- and pre-innovation profits are:

$$\Pi^{post}_{Fjt+1} = (1 - \frac{1}{\tau_{t+1}\,\lambda^{\Delta_j+1}})Y_{t+1} \quad \text{and} \quad \Pi^{pre}_{Fjt+1} = (1 - \frac{1}{\tau_{t+1}\,\lambda^{\Delta_j}})Y_{t+1}. \tag{21}$$

Equations (19)-(21) show that if foreign firms are active in equilibrium their markups and profits are distorted by $\tau_{t+1} = R^L_{t+1}/R^*_{t+1}$, namely the differential access to capital markets.

$\rightarrow$ *Home firms.* If the home firm in variety j succeeds in improving the existing technology and becomes the market leader, its markup will be:

$$\xi^{post}_{Hjt+1} \equiv \frac{p_{jt+1}}{MC^{post}_{Hjt+1}} = \frac{MC^{pre}_{Fjt+1}}{MC^{post}_{Hjt+1}} = \left(\frac{R^*_{t+1}}{R^L_{t+1}}\right)^{\alpha} \frac{q^{post}_{Hjt+1}}{q^{pre}_{Fjt+1}} = \frac{\lambda}{\tau_{t+1}}. \tag{22}$$

Otherwise, it will still have higher marginal cost than a foreign firm and remain out of the market. Home firm post-innovation profits will be:

$$\Pi^{post}_{Hjt+1} = (1 - \frac{\tau_{t+1}}{\lambda})Y_{t+1}. \tag{23}$$

As for foreign firms, equations (22) and (23) show that the home firms' markup and profit are distorted by asymmetric access to international capital markets. Notice that, in equations (19)-(23), the technology gap between foreign and home firms is the only variety-specific payoff-relevant variable, to simplify notation I drop the dependence on variety j and denote each variety as a function of the productivity gap. Note that the revenue TFP of the active producer becomes $RTFP_{s\Delta t+1} = [(\frac{w_{t+1}}{1-\alpha})^{1-\alpha}(\frac{R^{s'}_{t+1}}{\alpha})^{\alpha}]\xi_{s\Delta t+1}$.

(ii) *Firms' Innovation Efforts.* Firms choose their optimal innovation efforts, $x_{F\Delta t}$ and $x_{H\Delta t}$, so as to maximize their expected profits net of the innovation costs. Given the research technology,

foreign and home firms optimization programs are:[31]

$$\text{Max}_{x_{F\Delta t}}\, x_{F\Delta t}\, \Pi^{post}_{F\Delta t+1} + (1 - x_{F\Delta t} - x_{H\Delta t})\, \Pi^{pre}_{F\Delta t+1} - R^{*}_{t+1}[w_t\, \Gamma(x_{F\Delta t}, \Delta)] \tag{24}$$

$$\text{and} \qquad \text{Max}_{x_{H\Delta t}}\, x_{H\Delta t}\, \Pi^{post}_{H\Delta t+1} - R^{L}_{t+1}[w_t\, \Gamma(x_{H\Delta t})].$$

Firms' optimal innovation efforts become:

$$x_{Ft} = \frac{\phi}{\tau_{t+1}} \frac{(1 - \lambda^{-1})}{w_t} \frac{Y_{t+1}}{R^{*}_{t+1}} \qquad \text{and} \qquad x_{Ht} = \frac{\phi}{\tau^{1/\alpha}_{t+1}} \frac{(1 - \tau_{t+1}\, \lambda^{-1})}{w_t} \frac{Y_{t+1}}{R^{*}_{t+1}}.$$

As discussed above, both firms' optimal innovation intensities are distorted by the asymmetric access to international capital markets. Furthermore, firms' innovation intensities are constant across varieties and only differ in their borrowing costs (τ); hence, if firms enjoyed similar access to capital markets, their innovation efforts would be equal.

(iii) *Aggregate Productivity Growth.* Aggregate productivity growth is given by:

$$g_{Qt+1} = \log(\lambda)\ (x_{Ft} + x_{Ht}).$$

To see this, note that the aggregate productivity level is: $\log(Q_{t+1}) = \int_0^1 \log(q_{jt+1}) dj$. In each intermediate variety, productivity increases stem from two sources: either the domestic firm innovates with a probability x_{Ht}, or the foreign firm innovates with a probability x_{Ft}. In both cases, productivity increases by a factor $\log(\lambda)$. Therefore, the increase in productivity in each variety is: $x_{Ht} \log(\lambda) + x_{Ft} \log(\lambda)$. Under the law of large numbers, a continuum of varieties of measure one ensures that the change in aggregate productivity is given by $(x_{Ht} + x_{Ft}) \log(\lambda)$, and its level in $t+1$ is: $\log(Q_{t+1}) = (x_{Ht} + x_{Ft}) \log(\lambda) + \log(Q_t)$. As a result, aggregate productivity growth is given by:

$$g_{Qt+1} = \log(Q_{t+1}) - \log(Q_t) = \log(\lambda)(x_{Ht} + x_{Ft}).$$

(iv) *Labor Market Clearing.* After minimizing its total costs, the optimal labor demand of the active firm producing in variety Δ is: $l_{\Delta t+1} = (1 - \alpha) \frac{Y_{t+1}}{w_{t+1}} \frac{1}{\xi^{end}_{\Delta t+1}}$, where *end* denotes the obtained markups, which can be either *post* if the firm succeeded in innovating or *pre* otherwise. Aggregating across varieties, the total labor demand for production activities is: $L^{p}_{t+1} = (1 - \alpha) \frac{Y_{t+1}}{w_{t+1}} \Lambda_{t+1}$, where $\Lambda_{t+1} = \int \xi^{-1\, end}_{\Delta t+1} d\Delta < 1$ as in Peters (2013). Note that the labor demand is reduced by the

[31] For simplicity, I assume that firms borrow from banks once they learn about the result of the innovation process; and hence there is no uncertainty in the debt contact. This assumption allows focusing on firms' pure incentives to innovate, and separate these decisions from optimal debt contracts. As standard in innovation models, it implies that workers are able to insurance against the innovation risk. For example, this could be implemented through a mutual fund consisting of a continuous of risk-neutral workers. After being paid, workers deposit their wage payments in the fund and divide them equally among themselves (as in Acemoglu 2009; Aghion and Howitt 1992; Peters 2013).

presence of markups, as active firms set higher prices, produce less and, hence, demand fewer labor. Labor market clearing implies: $L_{t+1} \equiv 1 = L^p_{t+1} + L^I_{t+1}$, where L^I represents the labor employed in innovation activities by the new firms in $t+1$, and $L^I_{t+1} = \int \Gamma(x_{st}) d\Delta$. This determines the equilibrium wage in the economy.

(v) *Capital Market Clearing.* After minimizing its costs, the optimal capital demand of the active firm producing in variety Δ is: $k_{s\Delta t+1} = \frac{\alpha}{R^{s'}_{t+1}} \frac{Y_{t+1}}{\xi^{end}_{\Delta t+1}}$, where $R^{s'}_{t+1}$ is either the domestic lending rate if a home firm is active in equilibrium, or the international rate otherwise. Aggregating across varieties, total capital demands of home and foreign firms are:

$$K^H_{t+1} = \frac{\alpha}{R^L_{t+1}} Y_{t+1} \Lambda^H_{t+1} \qquad \text{and} \qquad K^F_{t+1} = \frac{\alpha}{R^*_{t+1}} Y_{t+1} \Lambda^F_{t+1}, \tag{25}$$

where $\Lambda^H_{t+1} = \int \xi^{-1}_{Ht+1} dH < 1$ and $\Lambda^F_{t+1} = \int \xi^{-1}_{F\Delta t+1} dF < 1$ and denote the distribution of markups of active domestic and foreign firms. Similarly to labor demands, firms' optimal capital demands are reduced by markups, as they reduce the optimal scale of production. Foreign firms invest capital until the return of their investment equalizes the international interest rate. As there are no financial flows in or out of the economy, home firms' total investment equals the local saving of young workers.

(vi) *Budget Constraint in the Closed-Economy.* The economy's budget constraint is given by,

$$C_{t+1} + I^H_{t+1} + I^F_{t+1} = w_{t+1} L^p_{t+1} + \Pi^H_{t+1} + \Pi^F_{t+1} + R^D_{t+1} K^H_{t+1} + R^*_{t+1} K^F_{t+1},$$

where investment (I^s_{t+1}) includes investment in capital and in technology of active firms. Aggregate consumption and investment equals the wages of workers employed by domestic and foreign firms, net profits of active domestic and foreign firms, and payments to home and foreign capital.[32] The balance of payment implies that the current account (CA) and capital account (KA) sum to zero and, in particular, that foreign firms' net profits and capital repayment (capital outflows) equal their investment (capital inflows):

$$CA_{t+1} - KA_{t+1} = 0 \qquad \Leftrightarrow \qquad -[\Pi^F_{t+1} + R^*_{t+1} K^F_{t+1}] + I^F_{t+1} = 0.$$

(vii) *Budget Constraint and Equilibrium in the Open Economy.* Since in the open economy local investment is no longer constrained by the availability of domestic savings, the expansion of home firms leads to capital inflows. The economy's budget constraint becomes,

$$C_{(t+1)} + \hat{I}^H_{(t+1)} + \hat{I}^F_{(t+1)} + T_{(t+1)} = w_{(t+1)} L^p_{(t+1)} + \Pi^H_{(t+1)} + \Pi^F_{(t+1)} + (R^*_{(t+1)} + \hat{\tau}) \hat{K}^H_{(t+1)} + R^*_{(t+1)} \hat{K}^F_{(t+1)},$$

[32] Remark that as the economy is shut down to international financial flows, lump-sum transfers to domestic households are equal to zero.

where consumption, investment and lump-sum transfers equalize payments of workers employed in production activities, home and foreign firms' net profits and payments to home and foreign capital. The balance of payments is now defined as,

$$CA_{(t+1)} - KA_{(t+1)} = 0 \qquad \Leftrightarrow \qquad -[\Pi^{F}_{(t+1)} + R^{*}_{(t+1)}(\hat{K}^{F}_{(t+1)} + \hat{K}^{H*}_{(t+1)})] + (\hat{I}^{F}_{(t+1)} + \hat{I}^{H*}_{(t+1)}) = 0,$$

where $\hat{K}^{H*}_{(t+1)}$ and $\hat{I}^{H*}_{(t+1)}$ denote home investment financed with international funds. The current account deficit expands as the increase aggregate investment exceeds the expansion of local savings.

In the open economy equilibrium, banks earn zero profits at $\hat{R}^{L}_{t+1}$ and $\hat{R}^{D}_{t+1}$; firms' innovation intensities are given by (4); active firms in each variety set the price equal to the marginal cost of the closest competitor; labor and capital market clear; aggregate output is given by Y_{t+1}; aggregate consumption is the sum of old workers consumption; the economy growth rate is g_{Yt+1}, and the balance of payments is determined by: $-[\Pi^{F}_{t+1} + R^{*}_{t+1}(\hat{K}^{F}_{t+1} + \hat{K}^{H*}_{t+1})] + (\hat{I}^{F}_{t+1} + \hat{I}^{H*}_{t+1}) = 0$, where $\hat{K}^{H*}_{t+1}$ and $\hat{I}^{H*}_{t+1}$ denote home investment financed with international funds. The increase in capital inflows induces a deterioration of the current account.

B.2. Banks and the Direction of Capital Flows

This section discusses banks' optimal lending and financing choices in an economy subject to capital controls. Consider that capital controls are such that only local banks are allowed to intermediate foreign funds, but they incur a cost. As in Farhi and Werning (2012), capital controls take the form of a per unit tax. In particular, banks have to pay a tax $\tilde{\tau}$ per unit of \$ of foreign borrowing or lending, which is then redistributed lump-sum to local households. In this economy, banks have two financing and lending choices: they can either use local or foreign savings to finance their activities; and they can either lend to local or foreign agents. Importantly, the level of capital controls determines banks' intermediation choices and, with them, whether the economy is open or closed to financial flows and its the level of international financial integration.

More precisely, to finance their activities banks' can either borrow from domestic agents and pay the deposit rate R^D_{t+1}, or borrow foreign savings and pay the international interest rate plus the per unit tax, i.e. $R^*_{t+1} + \tilde{\tau}$. Similarly, banks enjoy two lending choices: they can either lend to home firms at the rate R^L_{t+1} or pay the tax on foreign transactions and lend abroad for a net return of $R^*_{t+1} - \tilde{\tau}$. In this way, banks' international financial transactions depend on how the domestic deposit and lending interest rates compare with the foreign rate and the tax.

In this economy, there are two thresholds determining whether banks find profitable to intermediate foreign funds. One threshold defines banks' financing choices, and a second threshold determines banks' lending choices. The first threshold is given by the comparison between R^D_{t+1} and $R^*_{t+1} + \tilde{\tau}$, which establishes whether the domestic deposit interest rate is higher or lower than the foreign rate plus the tax. If the domestic deposit rate is higher than the international rate plus the tax on foreign transactions, banks' financing costs are cheaper abroad than in the local economy and, hence, they prefer to finance their activities using foreign savings. Importantly, as the return from lending abroad is lower than the local lending rate: $R^L_{t+1} - \mu > R^*_{t+1} + \tilde{\tau}$, banks do not lend abroad and focus their lending activities in the local market. Therefore, banks use foreign savings to finance their local activities. In this case, financial liberalization leads banks to import foreign funds until the local deposit rate equalizes the foreign interest rate plus the tax and they become indifferent between using local or foreign savings. This is the equilibrium in which the economy receives capital inflows.

The second threshold is given by $R^L_{t+1} - \mu < R^*_{t+1} - \tilde{\tau}$, which defines that the local net lending rate is lower than the return that banks would obtain from lending abroad. In this case, banks would prefer to lend to foreign agents, as the return from lending locally is lower than what they would obtain if they lend abroad. It is worth remarking that banks only finance themselves using local savings because the local deposit rate is lower than the cost of using foreign saving, i.e. $R^D_{t+1} < R^*_{t+1} + \tilde{\tau}$. As such, financial liberalization leads banks to finance themselves locally and use home savings to lend to foreign agents. Since banks use local savings to lend internationally, there are capital outflows from the economy. Lesser savings available for domestic firms increases the domestic lending rate until it equalizes the international rate minus the tax, and banks become indifferent between lending locally or abroad. This is the equilibrium in which the economy sees

capital outflows.

Importantly, if the tax rate is high enough, banks' optimal choice is to collect local savings to lend to home firms. In particular, for a sufficiently large $\tilde{\tau}$: $R^L_{t+1} > R^*_{t+1} - \tilde{\tau}$ and banks only lend to local agents; and $R^D_{t+1} - \mu < R^*_{t+1} + \tilde{\tau}$ such that banks only finance their lending activities using local deposits. As such, banks' lending and financing activities remain local whenever the equilibrium domestic deposit rate falls between $R^*_{t+1} - \tilde{\tau} - \mu < R^D_{t+1} < R^*_{t+1} + \tilde{\tau}$.

These two thresholds determine three regimes under which the economy could be: 1) if $R^D_{t+1} > R^*_{t+1} + \tilde{\tau}$, the economy receives capital inflows; 2) if $R^L_{t+1} - \mu < R^*_{t+1} - \tilde{\tau}$, the economy experiences capital outflows; and 3) if $R^*_{t+1} - \tilde{\tau} < R^D_{t+1} < R^*_{t+1} + \tilde{\tau}$, the economy is closed to international financial flows. These three regimes are presented in the table below. I derive formally banks' optimal choices below and show that only these three equilibrium are possible in this framework.

Capital Controls and International Capital Flows

Condition on R^D	Banks' Optimal Behavior	International Capital Flows
$R^D_{t+1} > R^*_{t+1} + \tilde{\tau}$	Use foreign savings to lend locally	Capital Inflows
$R^D_{t+1} < R^*_{t+1} - \tilde{\tau}$	Use local savings to lend abroad	Capital Outflows
$R^*_{t+1} - \tilde{\tau} < R^D_{t+1} < R^*_{t+1} + \tilde{\tau}$	Use local savings to lend locally	Closed Economy

Banks' Optimal Financing and Lending Choices

To study banks' optimal lending and financing decisions formally, recall that banks operate in a perfectly competitive sector, and, hence, choose their optimal lending and deposit from local and international markets. Banks' optimization program is as follows:

$$\text{Max}_{\{L^H_{t+1}, D^H_{t+1}, L^*_{t+1}, D^*_{t+1}\}} \quad R^L_{t+1} L^H_{t+1} + (R^*_{t+1} - \tilde{\tau}) L^*_{t+1} - R^D_{t+1} D^H_{t+1} - (R^*_{t+1} + \tilde{\tau}) D^*_{t+1} - \mu L^H_{t+1} - \mu L^*_{t+1}$$

$$\text{st} \qquad L^H_{t+1} + L^*_{t+1} = D^H_{t+1} + D^*_{t+1}, \tag{26}$$

$$L^*_{t+1} \geq 0, \tag{27}$$

$$D^*_{t+1} \geq 0, \tag{28}$$

$$L^H_{t+1} > 0,\ D^H_{t+1} > 0, \tag{29}$$

where $L^H_{t+1}, D^H_{t+1}, L^*_{t+1}, D^*_{t+1}$ represent the lending and deposits in the local and foreign markets, respectively. Using equation (27), banks' optimal maximization program becomes:

$$L = R^L_{t+1} L^H_{t+1} + (R^*_{t+1} - \tilde{\tau})(D^H_{t+1} + D^*_{t+1} - L^H_{t+1}) - R^D_{t+1} D^H_{t+1} - (R^*_{t+1} + \tilde{\tau}) D^*_{t+1} -$$

$$\mu L^H_{t+1} - \mu L^*_{t+1} - \lambda_1(L^H_{t+1} - D^H_{t+1} - D^*_{t+1}) - \lambda_2(-D^*_{t+1})$$

Case 1: Closed Economy Equilibrium
If $\lambda_1 > 0$ and $\lambda_2 > 0$, equations (27) and (28) binds. The first order conditions for banks' optimal domestic lending and deposits imply that the domestic lending rate equalizes the domestic deposit rate plus the intermediation costs:

$$R^L_{t+1} = R^D_{t+1} + \mu,$$

and that the total lending equals total deposits in the domestic market:

$$L^H_{t+1} = D^H_{t+1}.$$

This is a closed-economy equilibrium, with no international financial flows, as discussed in Sections 2.1-2.3.

Case 2: Capital Inflows Equilibrium
If $\lambda_1 > 0$ and $\lambda_2 = 0$, and then $L^*_{t+1} = 0$ and $D^*_{t+1} > 0$. The first order conditions on L^H, D^H, and D^* imply that

$$L^H_{t+1} = D^H_{t+1} + D^*_{t+1},$$

which shows that banks employ both domestic and foreign savings to finance their local lending activities. The domestic lending and deposit rates are given by:

$$R^D_{t+1} = R^*_{t+1} + \tilde{\tau} \qquad \text{and} \qquad R^L_{t+1} = R^*_{t+1} + \tilde{\tau} + \mu = R^D_{t+1} + \mu$$

In this equilibrium, there are capital inflows into the economy.

Case 3: Capital Outflows Equilibrium
If $\lambda_1 > 0$ and $\lambda_2 = 0$, then $L^*_{t+1} > 0$ and $D^*_{t+1} = 0$. Banks' optimal decisions on L^H, D^H, and L^* imply that

$$L^H_{t+1} + L^*_{t+1} = D^H_{t+1}.$$

That is, banks only employ domestic deposits to finance their lending activities that orientate both to the local and foreign markets. In this equilibrium, the domestic and lending rates are given by:

$$R^L_{t+1} = R^*_{t+1} - \tilde{\tau} + \mu \qquad \text{and} \qquad R^D_{t+1} = R^*_{t+1} - \tilde{\tau}.$$

Case 4: No Equilibrium
Notice that if $\lambda_1 = 0$ and $\lambda_2 = 0$ (i.e. $L^*_{t+1} > 0$ and $D^*_{t+1} > 0$), an equilibrium does not exist, as neither $\tilde{\tau}$ and μ can take negative values in this framework.

B.3. Financial Liberalization: Comparative Statics

Proposition 1. $\frac{\partial x_{Ft}}{\partial \tau_{t+1}} < 0$ and $\frac{\partial x_{Ht}}{\partial \tau_{t+1}} < 0$. This can be directly seen from equations (4). Furthermore, $|\frac{\partial x_{Ft}}{\partial \tau_{t+1}}| < |\frac{\partial x_{Ht}}{\partial \tau_{t+1}}|$.

Proposition 2. Active domestic firm's leverage ($d/y^{post}_{Ht+1} = w_t \frac{\Gamma(x_{Ht})}{y_{Ht+1}} + \frac{k_{Ht+1}}{y_{Ht+1}}$) is given by,[33]

$$\begin{cases} (d/y)^{post}_{H\Delta t+1} & \text{with probability} \quad x_{Ht}, \\ 0 & \text{otherwise.} \end{cases}$$

Under the law of large numbers, a continuum of varieties guarantees that domestic firms' leverage equals its expected value, i.e.

$$(d/y)^{e}_{H\Delta t+1} = (d/y)^{post}_{H\Delta t+1} x_{Ht}.$$

Then, $\frac{\partial (d/y)^{e}_{H\Delta t+1}}{\partial \tau_{t+1}} < 0$.

Proposition 3. As equations (2) show, foreign firms' markups stem from two sources: the technology gap with their local competitors and the difference in financing terms. Both of them decrease in τ. To see this, consider first how the reduction in distortions in international capital markets affects the technology gap between foreign and home firms. Notice that the technology gap between foreign and home firms within a variety will be:

$$\begin{cases} \Delta + 1 & \text{with probability} \quad x_{Ft} \\ -1 & \text{with probability} \quad x_{Ht} \\ \Delta & \text{with probability} \quad (1 - x_{Ft} - x_{Ht}). \end{cases} \tag{30}$$

Under the law of large numbers, the expected technology gap between F and H firms Δ^e becomes:

$$\Delta^{e}_{t+1} = \Delta + x_{Ft} - (1 + \Delta) x_{Ht}. \tag{31}$$

As $\frac{\partial \Delta^{e}_{t+1}}{\partial \tau_{t+1}} > 0$, reductions in distortions in capital markets reduce the productivity gap between foreign and home firms. Furthermore, a foreign firm's markup will be:

$$\begin{cases} \xi^{post}_{F\Delta t+1} & \text{with probability} \quad x_{Ft}, \\ 0 & \text{with probability} \quad x_{Ht}, \\ \xi^{pre}_{F\Delta t+1} & \text{with probability} \quad (1 - x_{Ft} - x_{Ht}). \end{cases} \tag{32}$$

[33] To simplify notation I have dropped the dependence on variety j and denote each intermediate variety as a function of the productivity gap, which is the only variety-specific payoff-relevant variable (see equations (2)).

Under the law of large numbers, a continuum of varieties ensures that foreign firms' markup will be equal to their expected value. More precisely,

$$\xi^{e}_{F\Delta t+1} = \tau_{t+1}\,\lambda^{\Delta+1} x_{Ft} + \tau_{t+1}\,\lambda^{\Delta}(1 - x_{Ft} - x_{Ht}). \tag{33}$$

Using equations (31) and (33), the change in foreign firms' expected markups is:

$$\frac{\partial \xi^{e}_{F\Delta t+1}}{\partial \tau_{t+1}} = \underbrace{\lambda^{\Delta}\Big(1 + x_{Ft}(\lambda - 1) - x_{Ht}\Big)\Big(1 + \tau_{t+1}\ln(\lambda)\frac{\partial \Delta^{e}_{t+1}}{\partial \tau_{t+1}}\Big)}_{>0} + \underbrace{\tau_{t+1}\lambda^{\Delta}\Big((\lambda - 1)\frac{\partial x_{Ft}}{\partial \tau_{t+1}} - \frac{\partial x_{(H,t)}}{\partial \tau_{t+1}}\Big)}_{>0} > 0.$$

Therefore, foreign firms' markups decrease following the reduction in distortions in the access to international capital markets.

Proposition 4. From equation (31), it can be directly seen that $\frac{\partial \Delta^{e}_{t+1}}{\partial \tau_{t+1} \partial \Delta} > 0$.

Proposition 5. The sign of $\frac{\partial g_{Qt+1}}{\partial \tau_{t+1}}$ results directly from proposition 1 and equation (5).

B.4. Financial Liberalization: General Equilibrium

This section conducts a numerical experiment to illustrate the model's qualitative implications of Section 2.4.2 in a general equilibrium framework. Note that this exercise does not aim to quantify the model, but to provide some insights about whether its qualitative predictions hold true in general equilibrium.

-Numerical Illustration

In this exercise, I study the impact of a reduction in capital controls on firms' innovation incentives, competition and aggregate productivity growth in general equilibrium when financial liberalization leads to capital inflows. In the model, the level of capital controls is given by $\hat{\tau}$, which represents the wedge between the domestic and international interest rate. In this experiment, I set its initial level to 3%, which was the interest rate differential between domestic and foreign firms prior to the reform (Table 1), and let this parameter go to 0, as we move from the regulated to the liberalized economy. I let the international interest rate R^* be 5.15%, which was the level of the US one-year T-bill in 2000. To better visualize the results, I consider a small wedge in the level of financial development of the country and let μ be 0.1% and keep it constant along the exercise. I let the elasticity of capital be 1/3. Following the standard literature in innovation (Acemoglu, Aghion, and Zilibotti 2006, and Acemoglu and Akcigit 2011, among others), I choose λ and the technology parameter ϕ to match the aggregate productivity growth in Hungary prior to the reform (5.8% per year, as shown in Table 12). I let then $\lambda = 1.2$ and $\phi = 0.3$. The equilibrium employment of R&D workers depends on the largest productivity gap between domestic and foreign firms, i.e. parameter d. I use the analysis in Section 5.5 to recover this parameter from the data. In particular, I compute the productivity gap as the RTFP gap between the median foreign and domestic firms within 3-digit sectors, and find that the larger gap prior to the reform was 2.5, so I set d equal to this value. The estimation of domestic firms' leverage requires considering two initial values: the level of aggregate TFP and the productivity level of the home firm. I take both values from the data, and estimate $\ln Q^{initial} = 8.716$ and $\ln q^H = 1.19$, where the latter is the mean RTFP of home firms in Table 2. Finally, the estimation of foreign firms' markups and the productivity gap within sectors require setting the value of the initial productivity gap between foreign and home firms. To better visualize the results I estimate an initial productivity gap of one.

Figure B.4.1 shows that all the model's qualitative implications hold in a general equilibrium setting (continuous line). The horizontal axis represents the level of capital controls, i.e. the parameter $\hat{\tau}$ in the model, which goes from -0.03 under capital controls to 0 in the liberalized economy. Figure B.4.1 illustrates that a reduction in capital controls raises all firms' incentives to invest in technology. In line with Proposition 1, this expansion is greater for home firms. As expected, domestic firms' leverage also increases following the liberalization of capital flows (Proposition 2). Confirming the presence of pro-competitive forces, the reduction in capital controls is also associated with a decrease in foreign firms' markups and with reductions in the productivity gap between

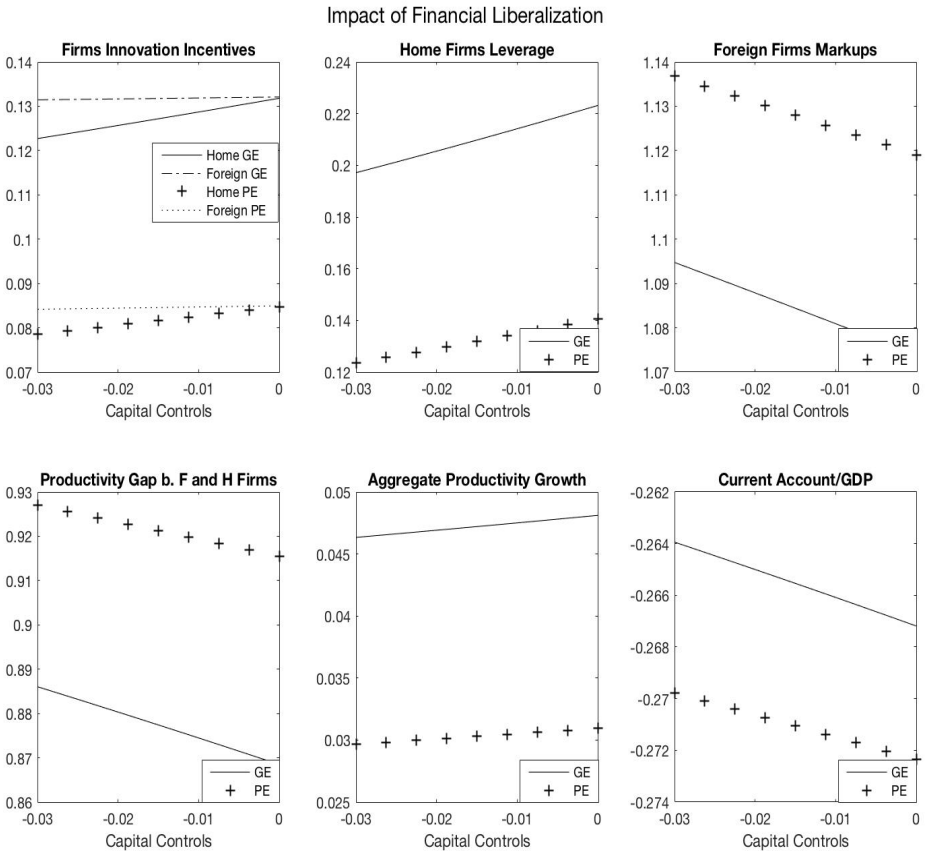


Figure B.4.1: The Impact of Financial Liberalization in GE

foreign and domestic firms (Propositions 3 and 4). Notice that the increase in aggregate productivity growth - Proposition 5 - is also valid in a general equilibrium setting. Additionally, I have included the evolution of the current account, which deterioration is in line with the increase in capital inflows following the financial liberalization. Finally, to compare the results of the general equilibrium analysis with the partial equilibrium of Section 2.4 - where wages and aggregate output were held constant - I include Figure B.4.1. This comparison highlights the two usual forces of innovation models. First, in general equilibrium the expansion in firms' innovation efforts is relatively smaller, as the increase in wages raises the innovation costs (see Atkeson and Burstein 2010). To illustrate this, following the drop in capital controls, the increase in home firms' innovation efforts is 7.3% in general equilibrium, whilst it reaches 8% in partial equilibrium (0.5% and 1% for foreign firms, respectively). Second, the absolute level of firms' innovation efforts is relatively higher when aggregate output is allowed to increase, as innovation raises the economy's market size encouraging firms to innovate more (see Aghion, Harris, and Vickers 1997).

B.5. Financial Liberalization: Capital Outflows

Consider a low level of financial development (high μ) such that the reduction in capital controls makes the deposit interest rate lower than the foreign interest rate minus the new value of the tax rate $\hat{\tau}$: $R^D_{t+1} < R^*_{t+1} - \hat{\tau}$. In this case, banks prefer to lend to foreign agents because the domestic lending rate is lower than what banks would perceive if they lend abroad:

$$R^L_{t+1} - \mu < R^*_{t+1} - \hat{\tau}. \tag{34}$$

Furthermore, banks only finance themselves employing local savings because the local deposit rate is lower than the cost of employing foreign saving ($R^D_{t+1} < R^*_{t+1} + \hat{\tau}$). Hence, under equation (34), banks finance themselves locally and use domestic savings to lend to foreign agents. Since banks use local savings to lend internationally, there are capital outflows from the economy. Lesser savings available for domestic firms increases the domestic lending rate until it equalizes the international rate minus the tax, and banks become indifferent between lending locally or abroad. In the open economy equilibrium, the domestic deposit and lending rates are exogenously determined by:

$$\bar{R}^D_{t+1} = R^*_{t+1} - \hat{\tau} \qquad \text{and} \qquad \bar{R}^L_{t+1} = R^*_{t+1} - \hat{\tau} + \mu. \tag{35}$$

It is worth noting that whether the economy experiences capital outflows depends on how the tax on foreign transactions compares with the local level of financial development (μ). In particular, the local intermediation cost creates a wedge between the domestic lending rate and the return to lend internationally. The larger is this wedge, the lower are banks' returns from lending locally and, hence, their incentives to intermediates funds domestically. Hence, as in Gertler and Rogoff (1990), Mendoza, Quadrini, and Rios-Rull (2009), and Coeurdacier, Guibaud, and Jin (2015), a low level of financial development can lead to capital outflows even in a capital-scarce economy.

Importantly, if the closed-economy lending rate satisfies equation (34), capital account liberalization leads to an increase in the costs of funds for domestic firms. Higher borrowing costs raises their marginal cost, undermining their post-innovation profits and their incentives to invest in technology. In turn, the lower competitive pressure in the product market reduces foreign firms' incentives to invest in technology. As both home and foreign firms innovate less, after the liberalization aggregate productivity grows at a lower pace. Note as well that the increase in the domestic lending rate reduces home firms' capital demands and, thus, their leverage and investment. In turn, the decline in aggregate investment leads to an improvement of the current account.

B.6. Innovation Technology

This section shows that the model's qualitative implications remain unchanged if the innovation technology uses labor and capital. To see this, consider that home and foreign firms contract R&D services from local R&D companies that operate with a Cobb-Douglas technology: $y_R = l^{\gamma} k^{1-\gamma}$, where γ is the labor share in R&D production. R&D firms are risk-neutral and produce in a perfectly competitive market.[34] As such, the price of R&D equals its marginal costs: $p_R = (\frac{w}{\gamma})^{\gamma}(\frac{R^L}{1-\gamma})^{1-\gamma}$, where the marginal cost is the weighted average of local wages and return to capital. The cost of contracting R&D services for foreign and home firms become: $p_R\,\Gamma(x_{Fjt})$ and $p_R\,\Gamma(x_{Hjt})$. Firms' optimal purchases of R&D services (x_{st}) are derived from equations (24), where the wage in the innovation cost is replaced by p_R -the price of the R&D service-, which depends both on the labor and capital costs. The rest of the model follows the same structure as in the main text.

To check whether the model's qualitative predictions hold true when R&D technology also employs capital, I undertake a numerical experiment. I follow the same set of parameters discussed in Appendix B.4 and study the effect of the financial liberalization when a reduction in capital controls leads to capital inflows (as in Section 2.4.2). I set the labor share of the R&D production function (γ) to 0.7, which is the labor share in innovation activities reported by the OECD. Figure B.6.1 shows that the five qualitative implications of the model (on home and foreign firms' innovation incentives, home firms' leverage, foreign firms' markups, productivity gap within sectors and aggregate productivity growth) hold true when including capital in the innovation technology. Furthermore, the evolution of the current account deteriorates as predicted in Section 2.4.2.

[34]The setting that there is a pool of risk-neutral and perfectly competitive companies that provide R&D services is standard in innovation models (see for example Jones 1995, Acemoglu 2009 and Aghion and Howitt 2009). It is broadly employed as it helps separating the study of firms' *pure* incentives to invest in technology from optimal debt contracts.

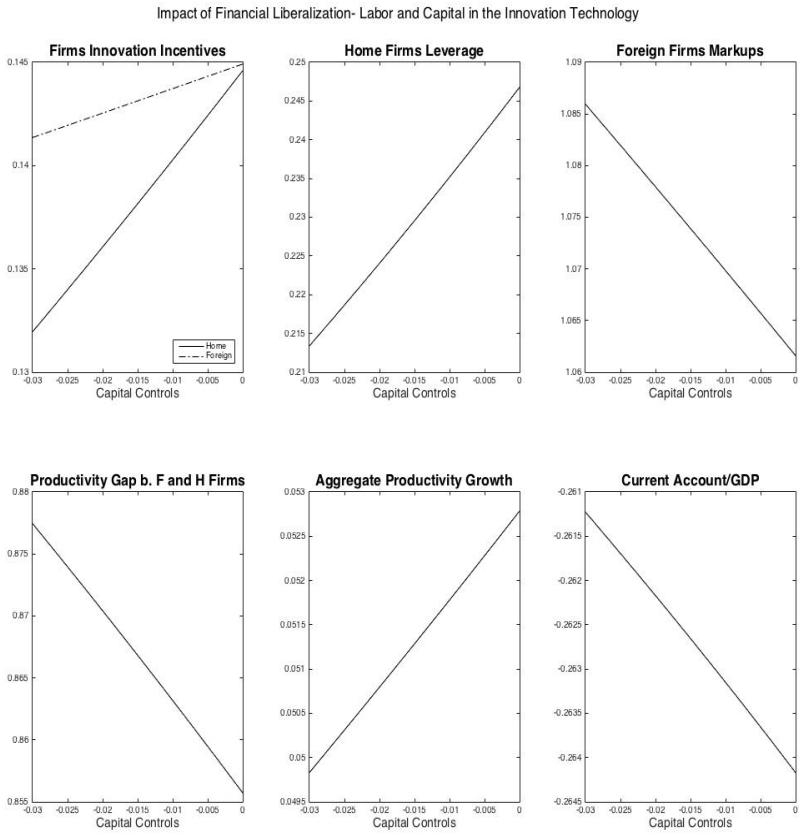


Figure B.6.1: The Impact of Financial Liberalization- Capital in the Innovation Technology

B.7. Pro-Competitive Effects in Cournot Competition

This section analyses whether the pro-competitive effects implied in Bertrand competition following financial liberalization are also valid in other oligopolistic frameworks. To analyze this, I build a model in the spirit of Devereux and Lee (2001), Atkeson and Burstein (2008) and Edmond, Midrigan, and Xu (2015), who study the effects of trade liberalization in Cournot competition. I adapt these models to the case of financial liberalization, and extend it to the case of endogenous innovation and asymmetries in the access to international capital markets across firms. I show that, in this setting, financial liberalization also turns on pro-competitive forces that lead all firms to invest more in technology. Previously discriminated home firms invest more in technology because they face better financing terms. Non-discriminated firms also invest more in technology because they face deeper competition.

-Setup

This model follows the same timing as in the main text. In the first period, intermediate firms make two types of decisions: first, they choose their optimal innovation efforts; next, after learning the result of the innovation process, they decide whether to produce in their second period. To produce in $t+1$, firms need to invest in physical capital in t. As in the main text, firms finance their expenditures in capital and technology with external funds, and take the innovation efforts of other agents and factor prices as given. To keep the analysis simple and, since the purpose of this exercise is to illustrate the pro-competitive forces in a Cournot setting, I focus on a partial equilibrium economy. I describe the setup and present later then qualitative implications of the model.

Final Good

There is a final good composed by a continuum of measure one of j intermediate varieties:

$$Y_{t+1} = \left(\int_0^1 y_{jt+1}^{\frac{\theta-1}{\theta}} dj \right)^{\frac{\theta}{\theta-1}}, \tag{36}$$

where $\theta > 1$ is the elasticity of substitution across varieties j. The aggregate price index is $P_{t+1} = \left(\int_0^1 p_{jt+1}^{1-\theta} dj \right)^{\frac{1}{1-\theta}}$. For simplicity, I let each intermediate variety to be composed by two firms: home and foreign, and the intermediate output be given by:

$$y_{jt+1} = \left(\beta \, y_{Hjt+1}^{\frac{\gamma-1}{\gamma}} + (1-\beta) \, y_{Fjt+1}^{\frac{\gamma-1}{\gamma}} \right)^{\frac{\gamma}{\gamma-1}}, \tag{37}$$

where $\gamma > \theta$ is the elasticity of substitution across goods within a particular variety. The variety price index is: $p_{jt+1} = \left(\beta \, p_{Hjt+1}^{1-\gamma} + (1-\beta) \, p_{Fjt+1}^{1-\gamma} \right)^{\frac{1}{1-\gamma}}$. Given equations (36) and (37), the final

good producer's optimal demand functions are:

$$y_{Hjt+1} = \left(\frac{p_{Hjt+1}}{p_{jt+1}}\right)^{-\gamma}\left(\frac{p_{jt+1}}{P_{t+1}}\right)^{-\theta} Y_{t+1} \qquad \text{and} \qquad y_{Fjt+1} = \left(\frac{p_{Fjt+1}}{p_{jt+1}}\right)^{-\gamma}\left(\frac{p_{jt+1}}{P_{t+1}}\right)^{-\theta} Y_{t+1}. \quad (38)$$

Intermediate varieties

Capital Markets. Capital markets follow the same structure as in the main text. I assume that the economy is subject to capital controls, such that only local banks can intermediate foreign funds. However, banks have to pay a tax for unit of $ of foreign borrowing or lending, i.e. $\tilde{\tau}$. This tax is then rebated as a lump sum to the domestic household. The intermediate financial sector is perfectly competitive, but incurs a higher intermediation costs -μ- than the rest of the world. There are asymmetries in the access to international capital markets across firms: whereas domestic firms can only borrow from local banks at a rate R^L, foreign firms have direct access to international funds and borrow at R^*. I follow the exercise of Section 2.4.2, where the economy is capital scarce and experiences capital inflows upon financial liberalization.

Production. Intermediate firm producers operate using a Cobb-Douglas production function $y_{sj} = q_{sj}k_{sj}^{\alpha}l_{sj}^{1-\alpha}$, where $s = \{H, F\}$, q, k, l represent physical productivity, capital and labor, and $\alpha \in (0, 1)$. Capital fully depreciations upon production.

Competition. In each intermediate variety, firms engage in Cournot competition and choose quantities (y_{sjt+1}) taking as given the quantity decisions of their variety competitor.

Technology and Innovation. I let firms' productivity evolve in a quality ladder, with increases measured by λ. Research technology implies that innovation is stochastic and depends on firms' innovation efforts. In particular, R&D technology is such that if a firm aims an innovation intensity of x_{sj}, it has to hire Γ units of labor; in particular, $\Gamma_{sjt} = \frac{1}{\phi}\frac{x_{sjt}^2}{2}$.

-Firms' Optimal Behavior

I solve firms' optimal strategies by backward induction. Recall that new firms are heterogeneous in their initial productivity level, but they innovate to get a frontier technology. After learning the result of the innovation process, they decide whether to produce in the second period. Accordingly, I first compute the profits that they would obtain if they produce in $t+1$, and then their optimal innovation efforts in t.

Firms maximize profits by choosing their optimal quantities, given the outcome of the innovation technology and taking as given the wage and the interest rate. In particular,

$$Max_{y_{sjt+1}} (p_{sjt+1} - c_{sjt+1})y_{sjt+1}$$

$$\text{st equation (38)},$$

where c_{sjt+1} represents firm s marginal cost.[35] The first order condition implies the following optimal price,

$$p_{sjt+1} = \frac{\varepsilon_{sjt+1}}{\varepsilon_{sjt+1} - 1} c_{sjt+1},$$

where $\varepsilon_{sjt+1} > 1$ and represents the endogenous demand elasticity and is given by

$$\varepsilon_{sjt+1} = \left(\frac{1}{\theta} \omega_{sjt+1} + \frac{1}{\gamma} [1 - \omega_{sjt+1}] \right)^{-1}, \tag{39}$$

where $\omega_{sjt+1} = \frac{p_{sjt+1} y_{sjt+1}}{p_{jt+1} y_{jt+1}}$ represents firm s market share in $t+1$.

In the first period, firms choose their optimal innovation efforts x_{sjt} to maximize their expected profits net of innovation costs. In particular,

$$\text{Max}_{x_{sjt}} \;\; x_{sjt} \, \Pi^{post}_{sjt+1} + (1 - x_{Fjt} - x_{Hjt}) \, \Pi^{pre}_{sjt+1} - R^{s'}_{t+1} [w_t \frac{1}{\phi} \frac{x^2_{sjt}}{2}],$$

where Π^{post}_{sjt+1} denotes the end-of-the period profits if the firm s succeeds in innovating and climbing one step ahead in the quality ladder, and Π^{pre}_{sjt+1} are the profits if innovation is unsuccessful and the firm keeps its initial productivity level. Therefore, home and foreign firms' optimal innovation efforts are:

$$x_{Hjt} = \phi \frac{[\Pi^{post}_{Hjt+1} - \Pi^{pre}_{Hjt+1}]}{w_t \, R^L_{t+1}} \qquad \text{and} \qquad x_{Fjt} = \phi \frac{[\Pi^{post}_{Fjt+1} - \Pi^{pre}_{Fjt+1}]}{w_t \, R^*_{t+1}}. \tag{40}$$

Equation (40) shows that firms' innovation efforts depend on the incremental benefit from innovating (i.e. the difference between their pre- and post- innovation profits) relative to their innovation costs.

-Numerical Exploration

To see whether the pro-competitive forces implied by the Bertrand setting are also present under Cournot competition, I conduct a numerical exploration. This exercise does not aim to quantify the model, but to check whether the direction of the results goes in the same line as in the paper. More precisely, whether the decrease in the capital controls leads home firms to invest more in technology, and the deeper competition encourages foreign firms to innovate more as well.

To study how firms' innovation incentives change when passing from an economy with capital controls to a fully liberalized economy, I need first to set an initial level of capital controls. In the model, this is represented by $\tilde{\tau}$, which denotes the wedge between the domestic and the foreign interest rates. I set its initial level to 3%, which was the interest rate differential between domestic

[35] In particular, $c_{sjt+1} = \left(\frac{R^{s'}_{t+1}}{\alpha} \right)^{\alpha} \left(\frac{w_{t+1}}{1-\alpha} \right)^{1-\alpha} \frac{1}{q_{sjt+1}}$, where $R^{s'}$ would be the domestic lending rate R^L for home firms, and the international rate R^* for foreign firms.

and foreign firms prior to the reform (Table 1), and let this parameter go to 0, as we move from the regulated to the liberalized economy. I let the international interest rate R^* be 5.15%, which was the level of the one year T-bill in 2000. To better visualize the results, I consider a small wedge in the level of financial development in the country and let μ be 0.1%, and keep it constant along the exercise. I take $\alpha = 1/3$. For simplicity, I assume that home and foreign firms have equal initial productivity, which I normalize to one. Following the literature in innovation (Acemoglu, Aghion, and Zilibotti 2006; Acemoglu and Akcigit 2011; among others), I set the technology parameters to $\lambda = 1.2$ and $\phi = 0.3$, which are the values used in Appendix B.4 and match the aggregate productivity growth in Hungary prior to the reform (5.8% per year). Results remain unaffected if these parameters change, for example, to: $\lambda = 1.05$, $\lambda = 1.35$, $\phi = 1$ or $\phi = 5$. As in Devereux and Lee (2001), Atkeson and Burstein (2008) or Edmond, Midrigan, and Xu (2015), I choose the parameters of the within-variety and across-variety elasticities of substitution such that $\gamma > \theta$, i.e. the within-variety effects dominate the across-variety effects, and the firm's demand elasticity is lower the greater is its share on the variety output. As in Atkeson and Burstein (2008), I choose θ close to one ($\theta = 1.01$) to keep the expenditure of the composite good in each variety roughly stable. It is difficult to choose a parameter for γ, the within-variety elasticity of substitution between home and foreign firms' products. I follow Atkeson and Burstein (2008) and choose a benchmark $\gamma = 10$, which implies a high elasticity of substitution between these goods. I next check the sensitivity of the analysis for $\gamma = 5$ and $\gamma = 20$. Finally, I consider a value for $\beta = 0.5$.

Figure B.7.1 displays the results. The horizontal axis represents the level of capital controls ($\tilde{\tau}$), which goes from -0.03 under capital controls to 0 in the fully liberalized economy. It shows that a reduction of capital controls fosters all firms' innovation efforts. Just like in the Bertrand setting, the innovation efforts of home firms increase relatively more. To provide further evidence about the two forces driving the results, I also plot the evolution of home firms' leverage and foreign firms' markups. As expected, the reduction in financing terms leads home firms to increase their leverage and their competitive pressure. This deeper competition raises foreign firms' endogenous demand elasticity and reduces their markups, accordingly.

Figure B.7.2 plots the sensitivity analysis for $\gamma = 5$ and $\gamma = 20$. When $\gamma = 5$ and the elasticity of substitution between home and foreign firms' products is low, asymmetries in the access to international capital markets still have a large impact on firms' innovation efforts. However, when $\gamma = 20$ and competition between home and foreign firms' products is very intense, capital controls create a small distortion in firms' innovation intensities. The intuition for this result is that when the degree of product substitutability is very high, firms' profits and innovation efforts are low and, hence, the distortion caused by the asymmetry in the access to capital markets is low. In this way, capital market distortions affect firms' innovation efforts when firms enjoy some degree of market power over their products.

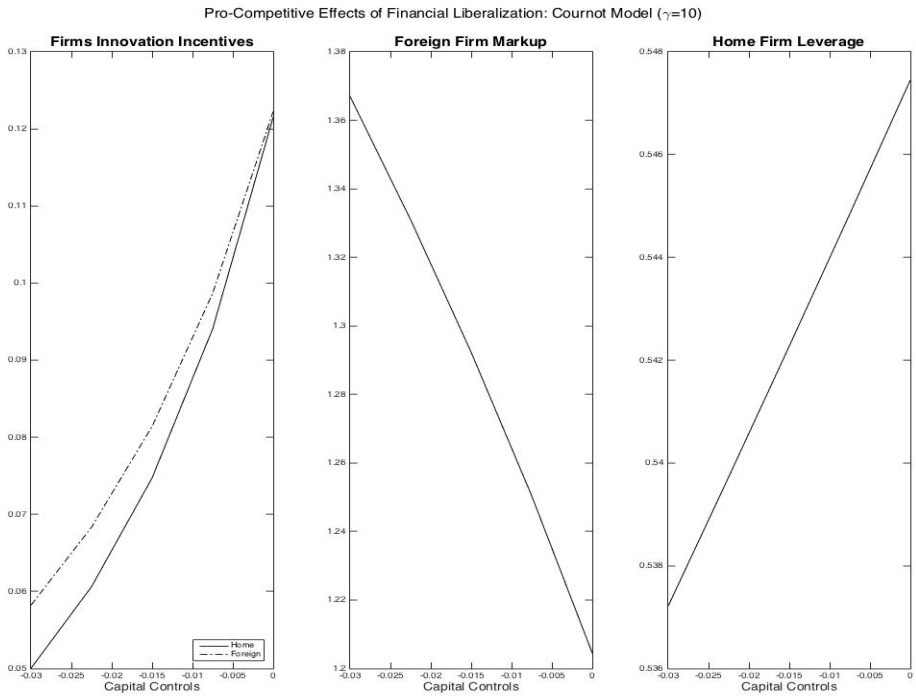


Figure B.7.1: Pro-Competitive Effects of Financial Liberalization under Cournot Competition

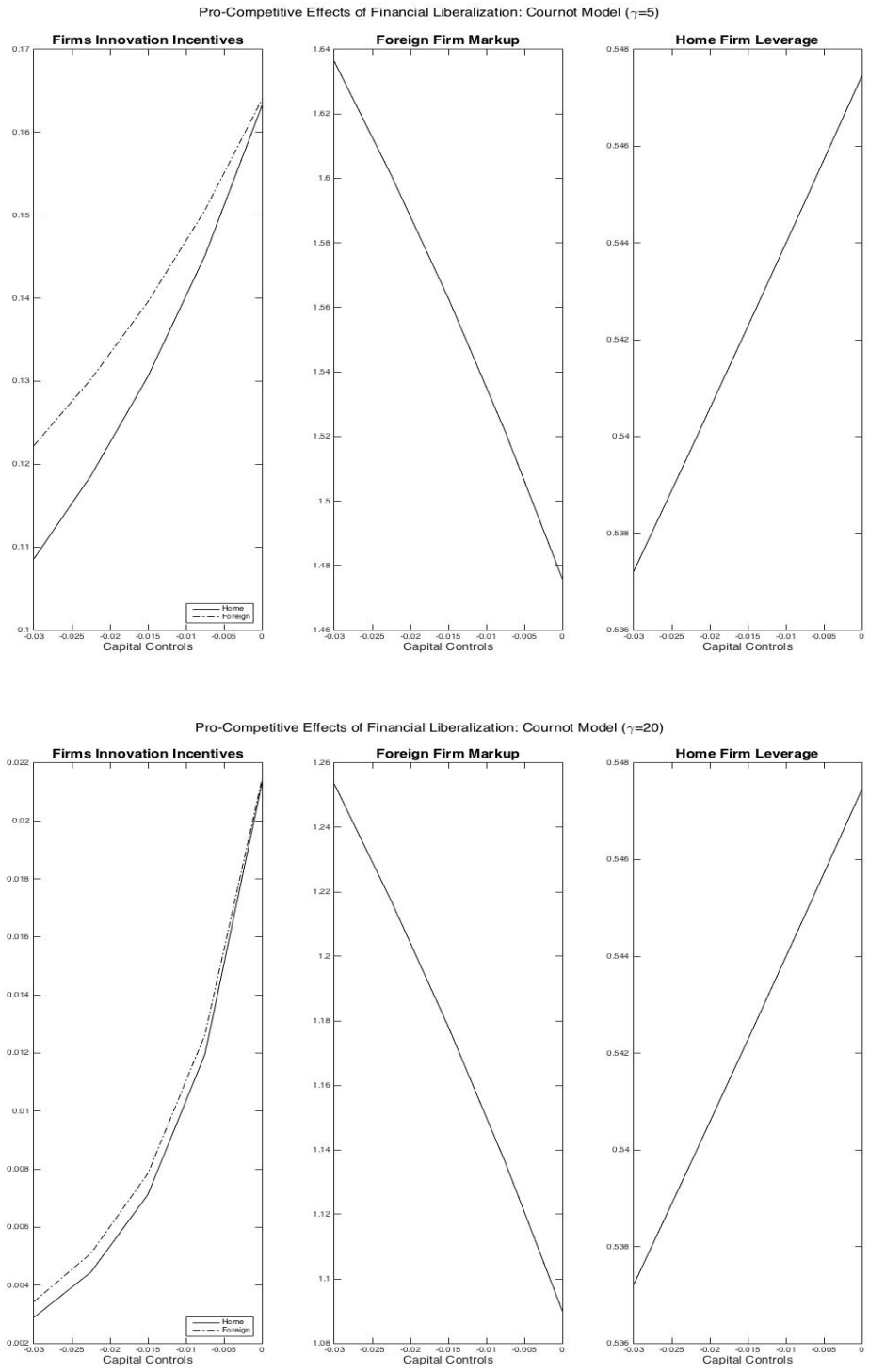


Figure B.7.2: Pro-Competitive Effects of Financial Liberalization under Cournot Competition (Sensitivity Analysis)

B.8. Firms' Innovation Costs

In the model, I have assumed that more productive firms enjoyed lower innovation costs. In particular, I have let the innovations of foreign firms be easier when their technological advantage was greater. In this section, I remove this assumption and show that the model's predictions remain true when home and foreign firms have equal innovation costs. Let firms' innovation costs be determined by:

$$\Gamma(x_{Fjt}) = \frac{1}{\phi}\frac{x_{Fjt}^2}{2} \quad \text{and} \quad \Gamma(x_{Hjt}) = \frac{1}{\phi}\frac{x_{Hjt}^2}{2}.$$

Home and foreign firms' optimal innovation intensities are:

$$x_{F\Delta t} = \frac{\phi}{\tau_{t+1}\lambda^{\Delta}}\frac{(1-\lambda^{-1})}{w_t}\frac{Y_{t+1}}{R^*_{t+1}} \qquad \text{and} \qquad x_{Ht} = \frac{\phi}{\tau_{t+1}^{1/\alpha}}(1-\tau_{t+1}\,\lambda^{-1})\frac{Y_{t+1}}{R^*_{t+1}}, \tag{41}$$

where foreign firms' innovation efforts depend now on the technology gap with the local competitors. Notice that the greater the initial technology gap between foreign and domestic firms, the lower are foreign firms' innovation efforts.

Proposition 1: Innovation intensities. A reduction in the asymmetric access to international capital markets (τ) encourages all firms to increase their innovation intensities. Notably, the innovation efforts of home firms rise relatively more.

From equations (41), it is straightforward to see that $\frac{\partial x_{F\Delta t)}}{\partial \tau_{t+1}} < 0$ and $\frac{\partial x_{Ht}}{\partial \tau_{t+1}} < 0$. In addition, $|\frac{\partial x_{F\Delta t}}{\partial \tau_{t+1}}| < |\frac{\partial x_{Ht}}{\partial \tau_{t+1}}|$. Note that the greater the technology gap between foreign and home firms, the lower is foreign firm's increase in innovation.

Proposition 2: Leverage. A reduction in τ increases home firms' leverage.

That is, $\frac{\partial (d/y)^e_{H\Delta t+1}}{\partial \tau_{t+1}} < 0$, where $(d/y)^e_{H\Delta t+1}$.

Proposition 3: Markups. A decrease in τ leads to reductions in foreign firms' markups.

The proof is similar as in the main text. Under the law of large number, a continuum of varieties ensures that the foreign firms will be equal to its expected value. More precisely,

$$\xi^e_{F\Delta t+1} = \tau_{t+1}\,\lambda^{\Delta+1}x_{F\Delta t} + \tau_{t+1}\,\lambda^{\Delta}(1 - x_{F\Delta t} + x_{Ht}),$$

and $\frac{\partial \xi^e_{F\Delta t+1}}{\partial \tau_{t+1}} > 0$.

Proposition 4: Productivity gap. Reductions in τ decrease the productivity gap between home and

foreign firms. In particular, this drop is greater in sectors where foreign firms were technologically far ahead of their local competitors.

From proposition 1, as home firms invest more in technology, the technology gap with their foreign competitors drops, i.e. $\frac{\partial \Delta^e_{t+1}}{\partial \tau_{t+1}} > 0$. Furthermore, this fall is larger, the greater the initial gap with their foreign rivals $\frac{\partial \Delta^e_{t+1}}{\partial \tau_{t+1} \partial \Delta} > 0$.

Proposition 5: Aggregate productivity growth. A decrease in the asymmetry in the access to international borrowing (τ) increases aggregate productivity growth.

Aggregate productivity growth is given by:

$$g_{Qt+1} = \log(\lambda) \sum_{i=1}^{\infty} \mu_{it+1}(x_{Ht} + x_{F\Delta t}) = \log(\lambda)(\mu_{1t+1} x_{Ht} + \sum_{i=1}^{\infty} \mu_{it+1}\, x_{F\Delta t}).$$

As now foreign firms' innovation efforts depend on the initial technology gap with their local competitors (equations (41)), aggregate productivity growth depends on the distribution of technology gaps in the economy, i.e. $\sum_{i=1}^{\infty} \mu_{it+1}$. It can be shown that $\frac{\partial g_{Qt+1}}{\partial \tau_{t+1}} < 0$, i.e. the decrease in the distortion in the access to international capital markets raises aggregate productivity growth. What is new here is that the increase in aggregate productivity growth stems from two sources. First, similar as before, as both home and foreign firms invest more in technology (proposition 1), productivity increases. Second, the decrease in the dispersion of the distribution of productivity gap raises aggregate productivity growth. To be more precise, as home firms undertake greater innovation efforts than their foreign competitors, the amount of sectors where foreign firms were technologically far ahead local firm decreases; i.e. μ_{1t+1} increases. Since the innovation efforts of foreign firms in technologically dispersed sectors were lower (equations (41)), the lower scale of those sectors in the economy raises aggregate productivity growth. This can be directly seen from the distribution of productivity gaps:

$$\dot{\mu} = \begin{cases} -\mu_{1t+1} x_{F1t} + x_{Ht}(1 - \mu_{1t+1}) & \Delta = 1, \\ (x_{F\Delta t} + x_{Ht})\mu_{\Delta t+1} + x_{F\Delta t}\mu_{\Delta-1,t+1} & \Delta \geq 2 \end{cases}$$

For the distribution to be stationary, $\dot{\mu} = 0$ and therefore $\mu_1 = \frac{x_H}{x_{F1} + x_H}$. As $\frac{\partial \mu_1}{\partial \tau} < 0$, a decrease in the distortion in the access to capital markets raises the fraction of μ_1 sectors, and decreases the fraction of sectors where foreign firms were technologically far ahead of their local competitors.

Appendix C Financial System's Supervisory Framework

In Hungary, the deregulation of the foreign exchange market implied the amendment of other complementary laws in order to guarantee the stability and well-functioning of the financial system. In the new open economy regime, some earlier regulations became obsolete and needed to be adjusted to the new forms of capital flows.

To be more precise, one of the changes introduced the FX Act XCIII was the liberalization of cross-border securities in foreign currency (as derivatives). The use of these securities needed some regulation, as these are key tools in the risk management of banks and, hence, in the stability of the financial system. The amendment of the Capital Market Act (Act CXX of 2001) filled in this gap and regulated the scope of these instruments for financial institutions. Additionally, the deregulation of the FX market requested the regulation on clearing houses trading foreign currency, which thereafter were allowed to enter the market. This regulation was also included in the amendment to the Capital Market Act (see Capital Market Act 2001). Another challenge posed by the financial liberalization was the adjustment of the supervisory framework of financial institutions, as thereafter they could trade foreign currency instruments and, hence, be exposed to the currency risk in various ways. Financial institutions' exposure was regulated in the amendments to the Capital Market Act and Credit Institution Act (CXII of 1996), which introduced consolidated reporting and limited the overall currency exposure of financial groups (IMF 2002). The use of financial derivatives in the insurance sector also requested the amendment of the insurance act, which "address[ed] the need for internal controls of the use of derivatives" of insurance companies (IMF 2002, p.36).