Capital Account Liberalization and Aggregate Productivity: The Role of Firm Capital Allocation*

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Abstract

We study the effects of capital account liberalization on firm capital allocation and aggregate productivity in 10 Eastern European countries. First, we use aggregate data and show that opening the capital account is associated with higher aggregate total factor productivity. Second, we use a large cross-country firm-level dataset and show that capital account liberalization decreased the variance of the marginal revenue product of capital, particularly in sectors more dependent on external finance. Finally, we use a model of misallocation and find that capital account liberalization increased manufacturing productivity through a more efficient firm capital allocation by 8% to 13%.

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1 Introduction

In the last three decades, many developing countries have opened their capital accounts, lifting legal restrictions imposed on international capital transactions. There is a growing consensus that capital account liberalization leads to higher economic growth (Quinn and Toyoda, 2008). In this paper, we use a large cross-country firm-level dataset to explore the microeconomic mechanisms through which opening the capital account leads to higher economic growth. The existing literature has shown that restrictions on capital account transactions reduce the supply of capital, raise the cost of financing, and increase firms' financial constraints (Forbes, 2007b). In this paper, we show that the reduction of financial constraints induced by capital account liberalization leads to a more efficient allocation of capital across firms and to higher aggregate productivity.

We focus our analysis on the episode of capital account liberalization in 10 Eastern European countries in the late 1990s and early 2000s. The timing of these events was driven primarily by the process of accession to the European Union (EU).[1] We start our analysis using aggregate data and we show that capital account liberalization is associated with an increase in the ratio of capital inflows to GDP, an increase in the ratio of private bank credit to GDP, and a decrease in the interest rate spread between deposit and lending rates.[2] These results suggest that capital account liberalization led to capital deepening and a more efficient process of financial intermediation.

Next, we exploit the variation in the timing of the capital account opening events across countries to analyze the relationship between capital account liberalization and aggregate total factor productivity (TFP).[3] We find that capital account liberalization is associated with an increase in aggregate TFP of 13%. There are several factors that could be driving these aggregate TFP gains. In this paper, we argue that a key factor is a more efficient allocation of capital across firms.[4]

[1] Most of the countries in the sample were seeking EU membership and EU candidate countries had to fully liberalize their capital account by the time of EU accession.

[2] We define a capital account liberalization event as a jump in two units in the capital account openness index developed by Abiad et al. (2010).

[3] We estimate aggregate TFP as the Solow residual of an estimated Cobb-Douglas country production function.

[4] Alternatively, aggregate TFP could increase as the result of within-firm technological improvements.

To guide our analysis, we employ a variant of the Hsieh and Klenow (2009) model of misallocation. In the model, firms in each sector face distortions to their production choice. We assume that part of these distortions take the form of financial constraints, which are a consequence of capital account restrictions. These distortions prevent firms from equating their marginal revenue product of capital (MRPK) to the cost of capital. As a result, the MRPK is not equalized across firms operating in the same sector. A higher degree of capital misallocation, measured by the within-sector variance of the MRPK, reduces sectoral TFP. By reducing financial constraints, capital account liberalization should reduce the cross-sectional variance of the MRPK, leading to sectoral TFP gains.

Guided by the model, we use a large cross-country firm-level dataset to estimate the effect of capital account liberalization on the within-sector variance of the MRPK across firms. Previous work by Rajan and Zingales (1998) has shown that financial constraints are particularly binding for firms in sectors more dependent on external finance. We document that in fact the variance of the MRPK is systematically higher in more financially dependent manufacturing sectors.[5] We take advantage of this fact and exploit the within-country variation in external financial dependence across sectors. This identification strategy allows us to estimate the causal effect of opening the capital account on capital misallocation. We find that capital account liberalization reduced the variance of the MRPK, particularly in sectors more reliant on external finance.

Next, we use our model of misallocation to map the reduced-form estimates into aggregate TFP gains. The goal is to calculate the effects of capital account liberalization on aggregate TFP coming exclusively from a more efficient capital allocation across firms. We first use the estimated changes in the within-sector variance of the MRPK to calculate the sectoral TFP gains. Then, we aggregate all sectoral TFP gains to calculate the aggregate TFP gains. According to our calculations, capital account liberalization increased aggregate TFP through a more efficient firm capital allocation by 8% to 13%. Because manufacturing output in our sample of countries accounts for roughly one-third of total output, our results indicate that an improved firm capital allocation explains 20% to 33% of the estimated total aggregate TFP gains.

Finally, we report several additional tests that further strengthen our results. First,

[5] We define external financial dependence as the fraction of capital expenditures not financed with internal cash flows.

we construct the model-implied ratio of actual to optimal sectoral TFP, which captures the total degree of misallocation (i.e., capital and labor) in a sector. We find that capital account liberalization increased the actual-to-optimal ratio of TFP, particularly in sectors with high financial dependence. Second, because old firms have had time to accumulate internal funds, they should be less financially constrained than young firms. We show that opening the capital account decreased the difference in the MRPK of young and old firms, especially in financially dependent sectors. We also project our measure of MRPK into age and find that the entire decline in the variance of the MRPK was due to a reduction in the variance of the MRPK explained by differences in firm age. Third, we show that capital account liberalization increased the capital stock more in sectors dependent on external finance, suggesting that the policy improved both the within-sector and the across-sector allocation of capital.

Overall, our paper makes three contributions. The first contribution is to the literature on capital account liberalization and economic growth.[6] Our paper is the first to connect capital account openness and aggregate TFP through the efficiency of firm capital allocation. We can do this because we have assembled a cross-country firm-level dataset. Harrison et al. (2004) and Forbes (2007a) use micro-level data to show that restrictions on capital account transactions increase firms' financial constraints.[7] We build on their work and show that by reducing financial constraints, capital account liberalization improves the allocation of firm capital, leading to higher aggregate productivity.

Our paper also contributes to the literature on resource misallocation and aggregate productivity. We build on the work of Hsieh and Klenow (2009) and measure sectoral misallocation with the variance of the marginal product of factors. We use the same model as Hsieh and Klenow (2009) to map our reduced-form estimates into aggregate TFP changes. More recent work has analyzed the links between finance, misallocation, and aggregate productivity through the lens of quantitative models (Buera et al., 2011; Midrigan and Xu, 2014; Moll, 2014). Our paper contributes to this literature by linking a concrete policy, capital account liberalization, to changes in firm capital allocation and aggregate productivity.

[6]See, among others, Henry (2000), Bekaert et al. (2005), and Quinn and Toyoda (2008).

[7]Chinn and Ito (2006) and Alfaro et al. (2007) use aggregate data and show that capital account liberalization leads to higher financial development and higher capital inflows, respectively.

Finally, we contribute to the literature of financial markets and resource allocation. Rajan and Zingales (1998) show that sectors that are more dependent on external finance grow disproportionally faster in countries with more-developed financial markets. Wurgler (2000) documents that financially developed countries increase investment more in their growing sectors and decrease investment more in their declining sectors. Gupta and Yuan (2009) and Levchenko et al. (2009) show that financial liberalization increases output, particularly in financially dependent sectors. Because these papers use sectoral data, they can only analyze resource allocation across sectors. We contribute to this literature by using firm-level data, which allows us to go one step further and analyze the within-sector resource allocation across firms.

The remainder of the paper is structured as follows. In Section 2, we document the institutional details of the capital account opening events and explain how we measure capital account liberalization. In Section 3, we analyze the effects of opening the capital account on capital inflows, financial intermediation, and aggregate TFP. In Section 4, we lay out the analytical framework we use to guide the measurement of misallocation and its effects on aggregate TFP. Section 5 reports the main results of the paper about the effects of capital account liberalization on capital misallocation. In Section 6, we use our model to map the reduced-form estimates into aggregate TFP gains. In Section 7, we present additional results supporting our claims. Section 8 concludes.

2 Capital Account Liberalization

In this section, we describe the institutional details of capital account liberalization in Eastern Europe and explain the capital account openness index we use in the paper.

2.1 Institutional Background

Our sample consists of 10 Eastern European countries: Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Russia, and Ukraine. The composition of the sample is driven by firm-level data availability.[8] All of these 10 countries, except Russia and Ukraine, are current members of the European Union (EU). Czech Republic, Estonia, Hungary, Latvia, Lithuania, and Poland joined the

[8]The coverage of additional Eastern European countries in our firm-level dataset, Amadeus, is extremely poor.

EU in the first wave of accession in 2004. Bulgaria and Romania joined the EU in the second wave of accession in 2007.

During the 1990s, these countries were transitioning from command economies to market-based economies. As a first step, they had to establish current account convertibility (Bakker and Chapple, 2003). The Baltic States were the first to attain Article VIII status at the IMF. Prospective EU accession served as the ultimate anchor for capital account liberalization for most transition economies (Arvai, 2005). EU candidate countries had to fully liberalize their capital account by the time of EU accession, as the free movement of capital was one of the major principles of the EU.[9] The aspiration of some of the EU countries for OECD membership was also an important factor in opening the capital account. Czech Republic, Hungary, and Poland applied for OECD membership in 1993-94. Along with EU negotiations, OECD accession discussions provided the roadmap for capital account liberalization in these three countries, as they were required to specify a timetable for removing the remaining restrictions. OECD members had to eliminate restrictions on capital movements between one another, but they had the right to proceed gradually.

2.2 Capital Account Openness Index

The traditional approach to measuring capital account openness is to use the information provided by the IMF's "Annual Report on Exchange Arrangements and Exchange Restrictions" (AREAER). The AREAER reports the extent of rules and regulations affecting cross-border financial transactions. In this paper, we use the index of capital account openness developed by Abiad et al. (2010), which captures both the extent and intensity of capital account restrictions. We use this openness index because it reports data for the 10 Eastern European countries for which we have Amadeus data. Other liberalization measures, such as the ones developed by Bekaert et al. (2005) (used by Gupta and Yuan 2009) or Kaminsky and Schmukler (2008) (used by Levchenko et al. 2009), are not only available for any of the 10 countries in our sample.

The Abiad et al. (2010) openness index is constructed from the following three

[9]The EU acquis, however, do not contain procedural steps on the sequencing of capital account liberalization for candidate countries. Countries need to commit themselves to a schedule of capital account liberalization during negotiations for EU membership.

questions, each of which is assigned a 0/1 score:[10]

1. Is the exchange rate system unified?
    - Coded as 0 when a special exchange rate regime for either capital or current account transactions exists
    - Coded as 1 when the exchange rate system is unified
2. Does a country set restrictions on capital inflows?
    - Coded as 0 when significant restrictions exist on capital inflows
    - Coded as 1 when banks are allowed to borrow from abroad freely without restrictions and there are no tight restrictions on other capital inflows
3. Does a country set restrictions on capital outflows?
    - Coded as 0 when restrictions exist on capital outflows
    - Coded as 1 when capital outflows are allowed to flow freely or with minimal approval

The capital account openness index is calculated as the sum of the scores of the individual questions. It ranges from 0 (fully closed capital account) to 3 (fully liberalized capital account). A value of 1 corresponds to a partially closed capital account and a value of 2 to a largely liberalized capital account. Figure 1 plots the evolution of the capital account openness index for the 10 Eastern European countries during 1996-2005, the time period for which we have firm-level data.

[Insert Figure 1 here]

From the figure, we can observe that half of the countries start the sample period with a fully liberalized capital account: Estonia, Hungary, Latvia, Lithuania, and Poland. These are the countries that became EU members in the first wave of accession. Czech Republic, which also joined the EU in the first accession wave, took a more cautious attitude towards capital account liberalization, because it had a relatively high external debt that made the country more vulnerable to external shocks. In May 1998, Czech Republic made an amendment to the Foreign Exchange Act, which eliminated the remaining restrictions on capital inflows.

[10] The Abiad et al. (2010) data provides information for the sum of the score of the three questions, but not for the individual scores.

The two countries that became EU members in the second wave of accession (Bulgaria and Romania), liberalized their capital accounts later on. Bulgaria passed the Foreign Exchange Law in September 1999, which eliminated all restrictions on capital inflows. Romania, took a more cautious approach and eliminated most restrictions on capital inflows in 2001 and the remaining restrictions in 2003. The figure shows that the capital openness index of Russia fell in 1999. This was the result of the introduction of capital outflow controls in response to the 1998 financial crisis. These controls were eliminated in 2001 and by 2003 Russia had a fully liberalized capital account. Finally, Ukraine is the only country in the sample that remained partially closed throughout the whole period.

3 Aggregate Evidence

In this section, we use aggregate data to analyze the effects of capital account liberalization on capital inflows and the efficiency of financial intermediation. We then estimate the effects on aggregate productivity.

3.1 Effects on Capital Inflows and Financial Intermediation

We obtain data on gross private capital inflows from the IMF's BOPS dataset (Balance of Payments Statistics). Private capital inflows are the sum of foreign direct investment, portfolio investment, and other investment. We normalize capital inflows expressed in nominal U.S. dollars by nominal GDP of the recipient economy. The average ratio of capital inflows to GDP for all countries during 1996-2005 was 9.8%, with a standard deviation of 6.2%. The data on private credit and the interest rate spread between deposit and lending rates comes from the World Bank's WDI dataset (World Development Indicators). Private credit is the domestic credit to private sector by banks, which we normalize by each country's nominal GDP. During 1996-2005, the average credit-to-GDP ratio in our sample was 25.5%, with a standard deviation of 15.5%. The interest rate spread is the difference between the interest rate charged by banks on loans and the interest rate paid for deposits. The average spread during this period was 13.9%, with a standard deviation of 28%.

To analyze the effect of capital account liberalization on these variables, we conduct a difference-in-differences test that takes advantage of the fact that the opening events occurred at different points in time:

$$\left(\frac{CapitalInflows}{GDP}\right)_{ct} = \alpha + \beta CapitalOpenness_{ct-1} + \gamma X_{ct-1} + \delta_c + \delta_t + \epsilon_{ct}, \quad (1)$$

where $\left(\frac{CapitalInflows}{GDP}\right)_{ct}$ denotes the ratio of gross capital inflows to GDP of country c in year t. We also use as dependent variables the ratio of private bank credit to GDP and the interest rate spread. $CapitalOpenness_{ct-1}$ is the lagged Abiad et al. (2010) capital account openness index. We lag the openness index by one year to capture the delays in policy implementation. The specification includes country fixed effects (δ_c) to control for time-invariant country characteristics and year fixed effects (δ_t) to control for aggregate shocks affecting all countries equally. We cluster standard errors at the country level.[11]

The coefficient of interest is β, which is identified from the cross-country, cross-time variation in the capital account opening events. It estimates the pre-post change in capital inflows in a country opening its capital account, relative to the pre-post change in countries that are not changing capital account policy. To address the possibility that other policies could be taking place at the same time than capital account liberalization, we control for the two most important pro-market policies in transition economies: privatization and trade liberalization (X_{ct-1}).[12]

Table 1 reports the results, with and without controls. We define a capital account liberalization event as an increase in two units in the capital openness index, i.e., $\Delta CapitalOpenness = 2$. According to column (2), capital account liberalization is associated with an increase in the capital inflows-to-GDP ratio of 2.8 percentage points (=2*1.4). This is a sizable effect, explaining 45% of the capital inflows standard deviation (=2.8/6.2). Column (4) shows that capital account liberalization is associated with an increase in the private credit-to-GDP ratio of 5.6 percentage points (=2*2.8), which explains 22% of the private credit variation (=5.6/25.5). From column (6), we observe that capital account liberalization is associated with a decrease in the interest rate spread of 6 percentage points (=2*3).

[11] This allows us to account for the within-country correlation of capital inflows across time.

[12] We use the privatization and trade liberalization indices developed by the European Bank of Recovery and Development (EBRD, 1999, 2005).

These results should be interpreted with caution. Because the timing of the capital account opening events was largely determined by the process of EU accession, it is unlikely that our results are driven by reverse causality. However, it is possible that the timing of these events coincided with other policies or unobserved shocks. We therefore view these results as suggestive evidence that capital account liberalization led to capital deepening and a more efficient process of financial intermediation.

[Insert Table 1 here]

3.2 Effects on Aggregate Productivity

The data to construct aggregate TFP comes from the Penn World Tables (PWTs) version 8.0. The PWTs provide data on real GDP, capital stock, and employment for the 10 countries during 1996-2005. The PWTs compute real GDP by using country-level price deflators. The capital stock for each country is computed using the perpetual inventory method. We assume that the aggregate production function is Cobb-Douglas with constant returns to scale, which is consistent with the model we develop below:[13]

$$Y_c = TFP_c\, K_c^{\gamma_c}\, L_c^{1-\gamma_c}, \tag{2}$$

where Y_c denotes aggregate output of country c, TFP is aggregate productivity, K is the aggregate capital stock, and L is aggregate labor. γ_s denotes the country-specific capital elasticity. We take logs of Equation (2) and measure aggregate TFP residually:

$$\log(TFP_c) = \log(Y_c) - \gamma_c \log(K_c) - (1-\gamma_c)\log(L_c). \tag{3}$$

To measure the country-level factor elasticities, we take advantage of the constant returns to scale assumption. This allows us to measure the labor elasticity for each country as the ratio of labor compensation to income, a variable which we obtain from the PWT. The capital elasticity is calculated residually as one minus the labor elasticity. The average log TFP for the 10 countries during 1996-2005 is 4.55, with a standard deviation of 0.45.[14]

[13] See Equation (12) of Section 4.

[14] Table A.1 of the Appendix provides detailed summary statistics of GDP, capital stock, employment, and log TFP by country during 1996-2005.

To estimate the effect of capital account liberalization on aggregate productivity, we exploit the variation in the timing of the opening events and estimate the following generalized difference-in-differences specification:

$$\log(TFP_{ct}) = \alpha + \beta CapitalOpenness_{ct-1} + \gamma X_{ct-1} + \delta_c + \delta_t + \epsilon_{ct}, \tag{4}$$

where TFP_{ct} is total factor productivity of country c in year t. The specification includes country fixed effects and year fixed effects. The coefficient of interest is β, which is identified from variation in the timing of the capital account opening events across countries. It estimates the pre-post change in aggregate TFP in a country opening its capital account, relative to the pre-post change in countries that are not changing capital account policy.

Table 2 reports the results, for different sets of country controls. The effect of capital account openness is positive, significant, and stable across specifications. According to column (3), our preferred specification, capital account liberalization is associated with an increase in aggregate TFP of 13% (=0.066*2). The magnitude of the effect is sizable, explaining almost 30% of the standard deviation of log TFP (=0.013/0.45).

[Insert Table 2 here]

4 Analytical Framework

In this section, we present a model to understand the relationship between capital misallocation and aggregate productivity. The model serves two purposes. First, we use it to identify the sector-level measures of misallocation of resources across firms. Second, in Section 6, we use the model as an accounting device to map changes in sectoral misallocation into changes in aggregate productivity.

4.1 Setup

We follow Hsieh and Klenow (2009) and assume that aggregate output is the Cobb-Douglas aggregate of sectoral output:

$$Y = \prod_s Y_s^{\theta_s},$$

where Y denotes aggregate output and Y_s is the output of sector s. $\theta_s \in (0,1)$ denotes the sectoral shares, where $\sum_s \theta_s = 1$. The demand for each sector is given by:

$$P_s Y_s = \theta_s P Y,$$

where P denotes the aggregate price index and P_s the price of sector output s. The sectoral output is the CES-aggregate of the output of M_s differentiated goods producers:

$$Y_s = \left(\sum_{i=1}^{M_s} Y_{si}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}},$$

where Y_{si} denotes output of firm i in sector s and $\sigma > 1$ denotes the elasticity of substitution within sectors. Within a sector, firms compete in a monopolistic competition setting. The demand for the output of each firm is:

$$P_{si} = \left(\frac{Y_s}{Y_{si}} \right)^{\frac{1}{\sigma}} P_s. \tag{5}$$

Finally, each firm produces output according to a constant returns to scale function, using capital K_{si} and labor L_{si}. Firms may also differ in their productivity A_{si}.

$$Y_{si} = A_{si} K_{si}^{\alpha_s} L_{si}^{1-\alpha_s},$$

where α_s denotes the capital elasticity, which is assumed to be the same for all firms in the same sector. Firms face distortions to their production choice, given by wedges τ_{si}^y and τ_{si}^k to output and capital, respectively. Consequently, profits can be written as:

$$\pi_{si} = (1 - \tau_{si}^y) P_{si} Y_{si} - w L_{si} - (1 + \tau_{si}^k) R K_{si}.$$

The wedges capture in a reduced form way the market frictions that firms may be facing. In this paper, we do not make any attempt in modeling these underlying frictions, because we only use the model as an accounting framework.

In maximizing profits, firms equate the marginal revenue products to the factor costs:

$$MRPK_{si} = \frac{(1 + \tau_{si}^k) R}{(1 - \tau_{si}^y)}$$
$$MRPL_{si} = \frac{w}{(1 - \tau_{si}^y)},$$

where $MRPK_{si}$ and $MRPL_{si}$ denote the marginal revenue product of capital and labor, respectively, and R and w denote the cost of capital and the wage rate, respectively. Thus, the presence of frictions induces dispersion in the marginal revenue products across firms in the same sector. While there are certainly many frictions that may generate dispersion in the marginal revenue products across firms, one such reason may be restrictions on capital account transactions. For instance, it is well known that small and young firms rely on financing primarily through banks, while larger and more established firms have access to additional sources of funding (Beck et al., 2006). If capital in the banking system is limited, for instance because of international capital controls, banks may charge higher lending rates and have tougher lending standards for small and young firms, while capital access for larger and more established firms might be largely unaffected.[15] This would lead to dispersion in the MRPK across firms.

4.2 Misallocation and Sectoral TFP

We can use the model to derive an expression for physical sectoral TFP as a function of firm-level productivities A_{si} and wedges τ^y_{si} and τ^k_{si} for all firms:

$$TFP_s = \frac{\left[\sum_{i=1}^{M_s}\left(A_{si}\left(\frac{1-\tau^y_{si}}{1+\tau^k_{si}}\frac{P_{si}Y_{si}}{P_sY_s}\right)^{\alpha_s}\left((1-\tau^y_{si})\frac{P_{si}Y_{si}}{P_sY_s}\right)^{1-\alpha_s}\right)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}}{\left(\sum_{i=1}^{M_s}\frac{1-\tau^y_{si}}{1+\tau^k_{si}}\frac{P_{si}Y_{si}}{P_sY_s}\right)^{\alpha_s}\left(\sum_{i=1}^{M_s}(1-\tau^y_{si})\frac{P_{si}Y_{si}}{P_sY_s}\right)^{1-\alpha_s}}. \tag{6}$$

In contrast, if resources were perfectly allocated within a sector, TFP would equal:

$$TFP^*_s = \left(\sum_{i=1}^{M_s} A_{si}^{\sigma-1}\right)^{\frac{1}{\sigma-1}}. \tag{7}$$

When wedges and productivity within a sector are jointly lognormally distributed, Hsieh and Klenow (2009) show that the deviation of TFP from its optimal level can be written as:[16]

$$\log(TFP_s) = \log(TFP^*_s) - \frac{\sigma}{2}\sigma^2_y + \sigma\alpha_s\sigma_{ky} - \frac{\alpha_s(1-\alpha_s)}{2}\sigma^2_k, \tag{8}$$

[15] Forbes (2007b) reviews evidence showing that controls on capital account transactions increase financial constraints particularly for small firms.

[16] This is the formula in the correction appendix of Hsieh and Klenow (2009).

where σ_y^2 denotes the variance of $\log(1-\tau_{si}^y)$, σ_k^2 is the variance of $\log(1+\tau_{si}^k)$, and σ_{ky} is the covariance between the two terms.

We further decompose Equation (8) to arrive at an equation describing the total misallocation losses of TFP as a function of observable moments in the data, i.e., the variance of log MRPK, the variance of log MRPL, and the covariance between the log MRPK and log MRPL:

$$\begin{aligned} Var\left(\log\left(MRPK_{si}\right)\right) &= \sigma_k^2 + \sigma_y^2 - 2\sigma_{ky} \\ Var\left(\log\left(MRPL_{si}\right)\right) &= \sigma_y^2 \\ Cov\left(\log\left(MRPK_{si}\right), \log\left(MRPL_{si}\right)\right) &= -\sigma_{ky} + \sigma_y^2. \end{aligned} \tag{9}$$

We can then re-express sectoral TFP as:

$$\begin{aligned} \log(TFP_s) = \log(TFP_s^*) &- \kappa_{1s} Var\left(\log\left(MRPK_{si}\right)\right) \\ &- \kappa_{2s} Var\left(\log\left(MRPL_{si}\right)\right) - \kappa_{3s} Cov\left(\log\left(MRPK_{si}\right), \log\left(MRPL_{si}\right)\right), \end{aligned} \tag{10}$$

where $\kappa_{1s}, \kappa_{2s}, \kappa_{3s} > 0$.[17] The degree of sectoral misallocation is therefore fully summarized by the variance of the MRPK, the variance of the MRPL, and the covariance between the two terms. The larger each of these measures, the larger is the degree of misallocation and the lower is sectoral TFP. In the empirical analysis of the next section, we will focus on these three measures of misallocation.

As explained above, restrictions on capital account transactions should lead to dispersion in the MRPK across firms, because these restrictions limit domestic bank lending. Because opening the capital account allows banks to borrow from abroad and to increase domestic lending, this policy should then reduce differences in the access to finance across firms. This, in turn, should lead to a reduction in the dispersion of the MRPK across firms and hence to a more efficient allocation of capital. In contrast, there is no immediate reason to believe that a capital account opening event would affect frictions in the labor market that lead to a change in the dispersion of the MRPL across firms.

Because, as explained below, we only have data on firm-level sales ($P_{si}Y_{si}$), but not on firm-level prices (P_{si}), we cannot measure physical output Y_{si} and back out

[17] The parameters κ are given by $\kappa_{1s} = \frac{1}{2}\left(\sigma\alpha_s^2 + \alpha_s(1-\alpha_s)\right)$, $\kappa_{2s} = \frac{1}{2}\left(\sigma(1-\alpha_s)^2 + \alpha_s(1-\alpha_s)\right)$, and $\kappa_{3s} = (\sigma-1)\alpha_s(1-\alpha_s)$.

physical productivity A_{si}. Therefore, we cannot use Equation (6) to measure sectoral productivity TFP_s. This means that we are not able to appreciate the full effects of capital account liberalization on aggregate productivity, which may work both through changes in misallocation and changes in within-firm productivity. In Equation (10), the latter effect would be captured by changes in TFP_s^*.

The approach we take in the paper is to estimate in a difference-in-differences setting the effects of capital account liberalization on the three measures of misallocation identified in Equation (9). We denote these estimates by $\Delta Var\left(\log(MRPK_{si})\right)$, $\Delta Var\left(\log(MRPL_{si})\right)$ and $\Delta Cov\left(\log(MRPK_{si}), \log(MRPL_{si})\right)$, respectively. Then, we use Equation (10) to map these reduced-form estimates into sectoral TFP gains. This will provide an estimate of the effects of capital account liberalization on sectoral TFP coming exclusively from a more efficient capital allocation across firms. That is, we compute:

$$\begin{aligned}\Delta \log(TFP_s)^{\text{Firm Allocation}} &= -\kappa_{1s}\Delta Var\left(\log(MRPK_{si})\right) - \kappa_{2s}\Delta\left(Var \log(MRPL_{si})\right) \\ &\quad - \kappa_{3s}\Delta Cov\left(\log(MRPK_{si}), \log(MRPL_{si})\right) \qquad (11)\end{aligned}$$

While capital account liberalization could also affect within-firm physical productivity, Equation (11) captures only the misallocation effects of the policy.

4.3 Changes in Misallocation and Aggregate TFP

The final step is to aggregate changes in sectoral TFP into changes in aggregate TFP. Aggregate output is given by:

$$Y = \prod_s \left(TFP_s K_s^{\alpha_s} L_s^{1-\alpha_s}\right)^{\theta_s} = TFP * K^{\sum_s \alpha_s \theta_s} L^{\sum_s (1-\alpha_s)\theta_s}, \qquad (12)$$

and we can express aggregate TFP as:

$$TFP = \prod_s \left(TFP_s \left(\frac{K_s}{K}\right)^{\alpha_s} \left(\frac{L_s}{L}\right)^{1-\alpha_s}\right)^{\theta_s},$$

and log TFP is therefore:

$$\log(TFP) = \sum_s \theta_s \log(TFP_s) + \sum_s \alpha_s \theta_s \log\left(\frac{K_s}{K}\right) + \sum_s (1-\alpha_s)\theta_s \log\left(\frac{L_s}{L}\right).$$

We compute the change in aggregate TFP driven by a more efficient within-sector allocation of resources as follows:

$$\Delta \log(TFP)^{\text{Firm Allocation}} = \sum_s \theta_s \Delta \log(TFP_s)^{\text{Firm Allocation}}, \tag{13}$$

where $\Delta \log(TFP_s)^{\text{Firm Allocation}}$ is obtained from Equation (11). In Section 6, we use this analytical framework to translate the reduced-form estimates of Section 5 into an estimate of the effect of capital account liberalization on aggregate TFP that is due only to a reduction in within-sector misallocation.

5 Micro Evidence

5.1 Firm-level Data

The firm-level data we use comes from Amadeus. Amadeus is a commercial dataset provided by Bureau van Dijk (BvD). It contains financial information on millions of publicly traded and private firms across Western and Eastern European countries. BvD collects data from local information providers, which in most cases are the local company registers. The firms covered by Amadeus also contain small and medium-sized enterprises (SMEs). Because financial frictions are particularly binding for smaller and younger firms, this represents a distinct advantage over datasets that only contain listed companies (e.g., Worldscope), because listed companies are typically larger and older.[18]

The dataset comes in yearly versions and each vintage includes up to 10 years of information per firm. If a firm stops filing, it remains in the dataset for four consecutive years and is then dropped. As explained in the Appendix, we overcome this survivorship bias by appending various versions of Amadeus. We follow the literature on productivity and focus exclusively on manufacturing firms. In the Appendix we explain the step-by-step data cleaning procedure. After cleaning the data, we are left with roughly 470,000 observations for 135,000 companies from 1996 to 2005. We measure the capital stock of a firm by its fixed assets (i.e., property, plant, and equipment).[19]

[18]Table A.2 of the Appendix reports the distribution of employment across firms in different size bins. The two bottom rows compare the average across countries in Amadeus with data on the universe of firms from Eurostat.

[19]Due to the nature of the filing requirements, we are unable to capture entry or exit if entrants are

Table 3 reports the firm-level summary statistics of sales, capital stock, and log MRPK by country during 1996-2005. The first column reports the number of firms for each country. The differences in the number of firms across countries is due to varied filing requirements for companies. In most cases, these filing requirements are related to size criteria or to the mode of incorporation. We can compare the coverage of firms in Amadeus with the coverage of firms in UNIDO's Industrial Statistics Database (INDSTAT), which covers the universe of manufacturing firms in each country and sector.[20] The country with the most comprehensive coverage relative to UNIDO is Romania; the country with the least comprehensive coverage is Ukraine.

In the second column of Table 3, we report average firm-level sales for each country. Note that we only have data on sales, not on firm-level prices. Thus, we cannot measure physical output and back out physical productivity directly. Instead, we will back out sectoral physical TFP indirectly using the misallocation model presented in the previous section. Finally, the last columns report the summary statistics for MRPK, which is a revenue-based measured of marginal product of capital. According to the model, sectoral physical TFP is linked precisely to the revenue marginal product of capital. From the table, we can observe substantial variation in both the level and the variance of the log MRPK across firms in each country. The standard deviation of the log MRPK ranges between 0.83 (Latvia) and 1.08 (Russia). This is comparable to Midrigan and Xu (2009) who report a standard deviation of 1.1 for Korea.

[Insert Table 3 here]

5.2 Variance in Marginal Product of Factors

According to the model in the previous section, the production function of each firm in each year is $Y_{si} = A_{si} K_{si}^{\alpha_s} L_{si}^{1-\alpha_s}$. Given the assumption of constant returns to scale,

either too small to meet the filing requirements or if they start their business in a mode of incorporation that excludes them from the filing requirement. Similarly, we cannot distinguish between firms that exited the market and firms that fell below the size restrictions for filing or changed their mode of incorporation. Therefore, in this paper we are not able to provide a detailed analysis of the extensive margin of misallocation.

[20] The coverage of firms in UNIDO during our sample period is: Bulgaria: 24,836; Czech Republic: 14,409; Estonia: 6,151; Hungary: 1,471; Latvia: 2,598; Lithuania: 4,449; Poland: 21,931; Romania: 63,873; Russia: 130,788; and Ukraine: 16,819.

the MRPK is proportional to its average product:

$$MRPK_{si} = \alpha_s (PY/K)_{si}.$$

We calculate the within-sector variance of log MRPK across firms that operate in the same country, sector and year as:

$$Var(\log(MRPK_{si})) = Var(\log(PY/K)_{si}).$$

The calculations for the log MRPL and the covariance between the log MRPK and log MRPL are analogous.[21] Note that to calculate the within-sector variance of log MRPK, we do not require estimates of sector-level factor elasticities. However, we will need these estimates in Section 6, when we map the reduced-form estimates into aggregate productivity gains. We follow the approach of Hsieh and Klenow (2009) and measure factor elasticities from sectoral income shares in the U.S. We assume that the labor elasticity of each sector $(1 - \alpha_s)$ is the same across countries and measure this elasticity as the ratio of labor compensation to income. We calculate the labor share of income using data from the NBER Manufacturing Industry Productivity Database, which is based on the Census and Annual Survey of Manufacturers (ASM). Given the assumption of constant returns to scale, we calculate the capital elasticity as one minus the labor elasticity.

Table 4 reports the sector-level summary statistics of the variance of the log MRPK, variance of the log MRPL, and covariance between the log MRPK and log MRPL during 1996-2005. There are 22 two-digit manufacturing sectors in the sample (ISIC Revision 3).[22] The average variance of the MRPK is 1.17, although there is a lot of variation across sectors, ranging from 0.42 (tobacco) to 1.94 (office machinery). The average variance of the MRPK is 29% higher than the average variance of the MRPL (=1.13/0.91), suggesting a larger degree of capital misallocation in the economy relative to labor. This is in line with the findings of Midrigan and Xu (2009) for Korea. The covariance between the MRPK and MRPL is positive.

[Insert Table 4 here]

[21] That is, $Var(\log(PY/L_{si}))$ and $Cov(\log(PY/K_{si}), \log(PY/L_{si}))$.

[22] To ensure that our results are not driven by some sectors with very few observations, we restrict our analysis to only those country-sector-year cells with more than 10 observations.

5.3 External Financial Dependence

The influential work by Rajan and Zingales (1998) has shown that financial constraints are particularly binding for firms in sectors more dependent on external finance. External financial dependence is defined as the fraction of capital expenditures not financed with internal cash flows. For technological reasons, some sectors require more external finance than others. Sectors that operate in large scales or with long gestation periods will tend to be highly dependent on external finance. Rajan and Zingales (1998) construct a financial dependence index using the median of financial dependence across U.S. publicly traded firms in each manufacturing sector.[23]

With financial frictions, the degree of within-sector capital misallocation should be particularly severe in sectors with high external financial dependence. Buera et al. (2011) derive a model of two sectors in which firms face collateral constraints. The sectors differ on their dependence on external finance, which is a result of different fixed cost requirements. Even though firms have the possibility to self-finance their investments over time, the authors show that capital misallocation (measured as the variance of the MRPK) is more severe in the sector that is more dependent on external finance. By alleviating financial constraints, capital account liberalization should reduce capital misallocation particularly in sectors more dependent on external finance.

The last column of Table 4 reports the external financial dependence index for the 22 manufacturing sectors in the sample. Sectors with low financial dependence include tobacco and textiles; sectors with high dependence include machinery and professional equipment. In this paper, we extrapolate the U.S.-based financial dependence measure to Eastern European countries based on the assumption that the sectoral technological differences persist across countries. We do not require each country to have the same value of financial dependence in each sector. Our assumption is that the ranking of financial dependence across sectors is the same in each country.

Figure 2 shows the relationship between the variance of log MRPK and external financial dependence in the cross-section of sectors.[24] The figure depicts a strong

[23]Publicly traded companies in the U.S. are large and well-established, with better access to external finance than firms in other countries. As a result, the external dependence index should provide a measure of the demand for external finance, not influenced by supply side constraints.

[24]To arrive at an average sectoral measure of $Var(\log(MRPK))$, we average all observations across countries and time, i.e., $\frac{1}{N_s}\sum_c \sum_t Var(\log(MRPK_{cst}))$.

positive relationship between the two measures: capital misallocation is more severe in sectors that rely more heavily on external finance. We take advantage of this fact and in the empirical analysis below, we analyze the effects of capital account liberalization on sectors with different dependence on external finance.

[Include Figure 2 here]

5.4 Effects on the Variance of Marginal Products

To estimate the effect of capital account liberalization on the variance of marginal revenue products, we exploit the within-country variation in external financial dependence across sectors. We estimate the following generalized difference-in-differences specification:

$$\begin{aligned} Var\left(\log(MRPK_{cst})\right) = \alpha &+ \beta CapitalOpenness_{ct-1} * FinDep_s + \gamma X_{ct-1} * FinDep_s \\ &+ \delta_{ct} + \delta_{cs} + \epsilon_{ct}, \end{aligned} \tag{14}$$

where $Var\left(\log(MRPK_{cst})\right)$ denotes the variance of log MRPK of country c in sector s in year t. We also use as dependent variables the variance of log MRPL and the covariance between log MRPK and log MRPL. $FinDep_s$ is the external financial dependence index of sector s. The specification includes country-year fixed effects (δ_{ct}) to control for time-variant country shocks and country-sector fixed effects (δ_{cs}) to control for country-specific sectoral characteristics. Note that because $CapitalOpenness$ varies at the country-year level, its effect will be absorbed by the country-year fixed effects. The coefficient of interest is β, which is identified from the within-country, cross-sectoral variation in financial dependence. It estimates the pre-post change in variance of MRPK in sectors with high financial dependence in a country opening the capital account, relative to the pre-post change in sectors with low dependence within the same country. To address the possibility that other policies could affect differentially sectors with different financial dependence, we control for the interaction between privatization and trade liberalization and the financial dependence index.

When we estimated the effect of capital account liberalization on aggregate TFP, our main concern was that the timing of the capital account opening events might have coincided with some other pro-market policies. As long as these other policies had a similar effect on sectors with different needs for external finance, our cross-sectoral comparison would cancel out their effects. As a result, the identification strategy of exploiting within-country variation in financial dependence across sectors allows us to estimate the causal effects of capital account policy.

Table 5 reports the results. Column (1) shows that capital account liberalization decreased the variance of MRPK, particularly in sectors with high needs for external finance. To understand the magnitude of the effect, consider two sectors: one at the 75th-percentile of the financial dependence index (motor vehicles) and one at the 25th-percentile (dressing of leather). The differential effect of the policy across sectors with high and low financial dependence is $\beta * 2 * (FinDep_{75th} - FinDep_{25th})$. The point estimate in column (1) is -0.135. This implies that the variance of the MRPK decreased by 0.07 units more in sectors with high versus low financial dependence (=-0.135*2*(0.46-0.2)). This is a sizable effect, accounting for 15% of the variation of the variance of MRPK (=0.07/0.485).

[Insert Table 5 here]

According to column (2), the effect on the variance of MRPL is not statistically significant. This implies that the extent of misallocation of labor across firms was unaffected by the changes in capital account policy. Finally, column (3) shows that there is no significant effect on the covariance between MRPK and MRPL.

6 The Role of Firm Capital Allocation for Aggregate TFP

In this section, we use the model developed in Section 4 to map the reduced-form estimates reported in Section 5 into aggregate TFP gains.

Note that the coefficient β of the reduced-form Equation (14) estimates the differential effect of capital account liberalization across sectors with different dependence on external finance. That is, empirically we can identify:

$$\begin{aligned} &\Delta Var\left(\log(MRPK_{cst})\right) - \Delta Var\left(\log(MRPK_{crt})\right) \\ &= \beta(FinDep_s - FinDep_r) * \Delta CapitalOpenness_{ct-1}, \end{aligned}$$

for any two sectors s and r.

To the extent that capital account liberalization affected the variance of the MRPK in all sectors, we cannot identify its effect empirically. This level effect of the policy is absorbed by the country-year fixed effects. We make the assumption that the level effect is zero for the sector with the lowest need for external financial dependence:

$$\Delta Var\left(\log(MRPK_{c0t})\right) = 0,$$

where $s = 0$ denotes the sector with the lowest value of external financial dependence (i.e., tobacco). We consider this assumption as conservative, because there is no immediate reason to believe why capital account liberalization may have increased the variance of the MRPK in the sector with lowest finance dependence. If anything, the variance of the MRPK in this sector was likely reduced. If this was the case, our estimate of the contribution of a more efficient firm capital allocation on aggregate TFP will provide a lower bound of the true contribution.

Using this assumption, we can then compute the level effect for any sector s as:

$$\Delta Var\left(\log(MRPK_{cst})\right) = \beta(EFD_s - EFD_0) * \Delta CapitalOpenness_{ct-1}.$$

We use Equation (13) to calculate the effect of capital account liberalization on aggregate TFP through a more efficient allocation of resources. To do so, we need a value for the elasticity of substitution σ. From Equation (10), we can see that TFP losses from misallocation are increasing in σ. We follow Hsieh and Klenow (2009) and for our benchmark calculation, we assume a conservative value of $\sigma = 3$. However, we also consider how our results vary with alternative values of this parameter.

According to our empirical analysis, capital account liberalization had a significant effect on $Var(\log(MRPK))$, but no significant effect on either $Var(\log(MRPL))$ or $Cov(\log(MRPK), \log(MRPL))$. Therefore, from Equation (11), we have that:

$$\Delta \log(TFP_s)^{\text{Firm Allocation}} = -\kappa_{1s}\Delta Var\left(\log(MRPK_s)\right).$$

We use this expression together with Equation (13) to compute the aggregate TFP gains as follows:

$$\begin{aligned}\Delta \log(TFP)^{\text{Firm Allocation}} &= \sum_s \theta_s * -\kappa_{1s}\Delta Var\left(\log(MRPK_s)\right) \\ &= \Delta CapitalOpenness \sum_s \theta_s * -\kappa_{1s}\beta(EFD_s - EFD_0).\end{aligned}$$

As before, we consider the effect of a capital account opening event of size $\Delta Capital$ $Openness = 2$. We report the results in Table 6. The magnitude of the effect depends on two parameters: the elasticity of substitution σ and the sectoral distribution $\theta_s = (P_sY_s)/Y$. In the upper panel of Table 6, we calculate the effect for the average initial sectoral distribution of the 10 countries.[25] For the benchmark elasticity of substitution $\sigma = 3$, the magnitude of the effect is 10.7%. Because TFP losses from misallocation are increasing in σ, the effect of capital account opening on aggregate TFP is also increasing in σ. When we set $\sigma = 2$, the effect decreases to 8%; and when we set $\sigma = 4$, the effect increases to 13.4%. Overall, capital account liberalization increased aggregate TFP through a more efficient firm capital allocation by 8% to 13%.

[Insert Table 6 here]

In the lower panel of Table 6, we calculate the effect for the initial sectoral distributions of the individual countries. The effect on aggregate TFP will be stronger for the countries more specialized in sectors with high external financial dependence. For our benchmark value of 3 for the elasticity of substitution, TFP gains range from 9.5% for Czech Republic to 12.6% for Russia. In the same panel, we report the effects for different values of the elasticity of substitution.

Finally, recall that in Section 3 we found that capital account liberalization was associated with an increased aggregate TFP of 13%. This effect was calculated for the whole economy, including manufacturing and non-manufacturing sectors. The results of our calibration, on the other hand, correspond only to manufacturing sectors. Because manufacturing output in our sample countries accounts for roughly one-third of total output, our calculations indicate that an improved firm capital allocation explains between 20% $(= 8\% * 1/3 * 1/13\%)$ to 33% $(= 13.4\% * 1/3 * 1/13\%)$ of the estimated total aggregate TFP gains. This is likely an underestimate of the true contribution of improved firm allocation for three reasons. First, it assumes that the policy had no effect on firm allocation in the non-manufacturing sectors. Second, we have assumed that the level effect on the sector with the lowest degree of finance dependence was zero. Third, the reduced-form aggregate estimate might be overestimating the true effect of capital account liberalization on aggregate TFP.

[25] We consider the pre-2000 sectoral distribution as the initial sectoral distribution.

7 Additional Results

This section provides three additional tests that further strengthen our results. First, we study the behavior of the model-based ratio of actual to optimal TFP in response to a capital account opening event. Next, we explore differences in firm age, to show that the effects of capital account liberalization are working through reduced financial constraints. Finally, we analyze the effect of capital account liberalization on the sectoral capital stock.

7.1 Ratio of Actual and Optimal Sectoral TFP

An alternative measure to study misallocation is the ratio of actual to optimal TFP. This ratio summarizes the total degree of misallocation in a sector, with no need of the lognormality assumption. To compute this measure, however, we need to make an assumption about the elasticity of substitution σ, an assumption that we did not have to make when computing the variances of the marginal revenue products. We compute the ratio as follows. First, we infer physical output from sales and an assumed elasticity of substitution. Using the firm-level demand Equation (5), we can write:

$$\tilde{Y}_{si} = (P_{si}Y_{si})^{\frac{\sigma}{\sigma-1}},$$

where $\tilde{Y}_{si} = z_s Y_{si}$ and the sector-level variable z_s is given by $z_s = \frac{(P_s Y_s)^{\frac{\sigma}{\sigma-1}}}{Y_s}$. Using this expression, we can identify a term that is proportional to physical productivity:

$$\tilde{A}_{si} = \frac{\tilde{Y}_{si}}{K_{si}^{\alpha_s} L_{si}^{1-\alpha_s}}.$$

Because the factor of proportionality z_s is constant across all firms in a sector, it cancels out when we compute the ratio of TFP_s from Equation (6) and TFP_s^* from Equation (7).[26]

The penultimate column of Table 4 presents descriptive statistics for this ratio assuming an elasticity of substitution of $\sigma = 3$. The average ratio across all sectors is 0.468, which means that actual sectoral TFP amounts to roughly half of optimal TFP.

[26]Notice that we can only compute the ratio $\frac{TFP_s}{TFP_s^*}$, but we cannot calculate TFP_s and TFP_s^* individually. A normalization of z_s to a constant would not be appropriate because z_s depends on sector-level sales and real output, which presumably vary over time.

However, the ratio varies substantially across sectors, ranging from 0.295 (radio) to 0.723 (tobacco). In Figure 3, we plot the relationship between the ratio of actual and optimal TFP and external financial dependence in the cross-section of sectors. The figure shows a strong negative relationship between the two measures. This means that misallocation is more severe in sectors that depend highly on external finance, consistent with the results in Figure 2.

[Insert Figure 3 here]

Next, we re-estimate Equation (14), using $\log\left(\frac{TFP}{TFP^*}\right)$ as dependent variable. Table 7 reports the results. It shows that capital account liberalization increased the ratio of actual to optimal TFP, particularly in highly financially dependent sectors. The point estimate implies that the ratio of actual to optimal TFP increased by 13% more in highly financially dependent relative to less financially dependent sectors (=0.253*2*(0.46-0.2)).

[Insert Table 7 here]

7.2 Identifying the Channel: Role of Age

Because old firms have had time to accumulate internal funds, they should be less financially constrained than young firms. In this section, we build on previous work that show that a firm's age is an important predictor for its access to capital (Midrigan and Xu, 2014). If capital account liberalization facilitates access to capital for firms, we would expect this capital to flow particularly to previously constrained, young firms. We thus analyze how the effect of the policy varies according to firm age. To do so, we first separate our sample into young and old firms by their year of foundation. The median foundation year across all firms in the sample is 1994, so we define young firms as those founded in 1994 or later and old firms as those founded prior to 1994.

The key outcome we focus on is the value of the marginal revenue product of capital of a firm. If young firms are more financially constrained than old firms, then on average, they should have a higher MRPK. Moreover, the difference in the MRPK between young and old firms should be particularly large in sectors more dependent on external finance.

Figure 4 shows that this pattern holds in our data. The figure plots for each sector the average difference in the MRPK between young and old firms against the external finance dependence index. From the figure, we can see that this difference is greater than zero in almost all sectors, indicating that young firms have a higher MRPK than old firms. Moreover, the figure shows a positive slope which means that young firms are more constrained than old firms particularly in high-financial-dependence sectors.

If capital account liberalization alleviated financial constraints especially for young firms, we would expect young firms to reduce the value of their MRPK relative to old firms in the same sector, particularly in sectors where firms are more reliant on external finance. To test for this channel, we estimate the following triple difference-in-differences equation at the firm-level:

$$\begin{aligned} \log(MRPK_{csit}) = \alpha &+ \beta_1 CapitalOpenness_{ct-1} * FinDep_s \\ &+ \beta_2 CapitalOpenness_{ct-1} * Young_i \\ &+ \beta_3 CapitalOpenness_{ct-1} * FinDep_s * Young_i \\ &+ \gamma X_{ct-1} * FinDep_s + \delta_{ct} + \delta_i + \epsilon_{csit}, \end{aligned} \tag{15}$$

where $MRPK_{csit}$ is the marginal revenue product of capital of firm i in sector s in country c in year t and $Young_i$ is a dummy variable indicating young firms as defined above. The specification includes country-year fixed effects (δ_{ct}) and firm fixed effects (δ_i).[27] The coefficient of interest is β_3, which estimates the pre-post change in the difference of the MRPK across young and old firms in sectors with high financial dependence, relative to the pre-post change in the same difference in sectors with low financial dependence

Table 8 reports the results. The coefficient β_3 is negative, indicating that young firms reduced their MRPK relative to old firms, particularly in highly financially dependent sectors. The magnitude of the effect indicates that the differential reduction in the MRPK of young and old firms was 1% higher in a sector at the 75th percentile of financial dependence compared to a sector at the 25th percentile of financial dependence (=-0.019*2*(0.46-0.2)).

[27] Notice that the effects of $FinDep_s$, $Young_i$, and $FinDep_s * Young_i$ are all absorbed by the firm fixed effects.

[Insert Table 8 here]

The results also provide information regarding the average differential effect of capital account liberalization on young versus old firms. This differential effect is given by $(\beta_2 + \beta_3 * FinDep_s) * 2$. First, notice that the estimates imply that the effect is negative for every sector in the sample, ranging in absolute value from 3% (Tobacco) to 8% (Office Machinery). This suggests that the policy reduced financial constraints in all sectors, even in the less financially dependent ones. With an average value of the external financial dependence index of 0.3, the estimates implies that on average, opening the capital account reduced the MRPK of young firms by 6% more than for old firms (=(-0.025-0.019*0.3)*2). Given that the average difference between the MRPK of young and old firms is roughly 20%, the effect closes almost one third of the difference in the MRPK between young and old firms.

7.3 Variance of MRPK adjusted by age

Next, we further decompose the variance of the marginal revenue product of capital across firms. In particular, we focus on the part of the variance of the MRPK that is explained by differences in firm age, which should capture the variance of the MRPK due to financial constraints. We project the MRPK of each firm on a full set of age dummies. For each country-sector-year cell in the data, we estimate the following fully saturated model (Midrigan and Xu, 2014):

$$\log(MRPK_i) = \sum_{a=1}^{A} \beta_a I(Age_i = a) + \nu_i, \tag{16}$$

where $I(Age_i = a)$ is a dummy variable that is equal to one if firm i's age equals a and ν_i is an error term. The term A denotes the age of the oldest firm in the country-sector-year cell. We then obtain the predicted values of the estimation:

$$\log(\widehat{MRP}K_i) = \sum_{a=1}^{A} \hat{\beta}_a I(Age_i = a).$$

Due to the OLS orthogonality condition, we can write:

$$Var(\log(MRPK)) = Var(\log(MRPK)|Age) + Var(\hat{\nu}), \tag{17}$$

for each country-sector-year cell. The term $Var(\log(MRPK)|Age)$ denotes the variance of $\log(\widehat{MRPK})$, which is the part of the variation in the MRPK that is explained by age. On average, the ratio of $Var(\log(MRPK)|Age)$ to $Var(\log(MRPK))$ is 0.32, which indicates that age explains roughly one-third of the variation in the MRPK across firms.

Table 9 reports the results using the three terms in Equation (17) as dependent variables in Equation (14). The sample size is slightly lower than in Table 5, because of some missing values in firm age. The results indicate that the entire decline in the variance of the MRPK across firms was due to a reduction in the variance of the MRPK explained by differences in firm age.

[Insert Table 9 here]

7.4 Sectoral Capital Stock

In this paper, we have studied the effect of capital account liberalization on the within-sector allocation of capital across firms. In this final section, we also analyze the effect on the allocation of capital across sectors. To do so, we re-estimate Equation (14) using sectoral capital stock as the dependent variable, which we compute by summing the fixed assets of firms operating in that sector. Columns (1)-(3) of Table 10 report the results. Capital account liberalization increased the capital stock in high-financially-dependent sectors by 15% more than in low-financially-dependent sectors (= 0.288*2*(0.46-0.20)).

In principle, we can also estimate this regression using sectoral data from the UNIDO database, which covers the universe of manufacturers in each country and sector. One issue is that for most of the countries in the sample, the time series of investment available in UNIDO is very short, which prevents us from constructing a meaningful measure of capital stock using the perpetual inventory method. Instead, we follow the work of Gupta and Yuan (2009) and estimate the effect on sectoral investment directly (columns (4)-(6) of Table 10). We find that capital account liberalization increased capital investment, particularly in sectors more dependent on external financial dependence.

In sum, after a country opens its capital account, capital flows towards the sectors with highest needs for external finance, which is consistent with the findings of

Gupta and Yuan (2009) and Levchenko et al. (2009). This suggests that capital account liberalization improved both the within-sector and the across-sector allocation of capital.

[Insert Table 10 here]

8 Conclusions

In this paper, we use a large cross-country firm-level dataset to analyze the effects of capital account liberalization on firm capital allocation and aggregate productivity. We focus our analysis on 10 Eastern European countries that lifted restrictions on capital account transactions in the late 1990s and early 2000s. We show that by reducing financial constraints, capital account liberalization led to a more efficient allocation of capital across firms and higher aggregate total factor productivity (TFP). Our paper is the first to connect capital account openness and aggregate TFP through the efficiency of firm capital allocation.

We start the analysis by using aggregate data to estimate the effect of capital account liberalization on aggregate productivity. We exploit the variation in the timing of the capital account opening events across countries and find that capital account liberalization is associated with an increase in aggregate TFP of 13%. To explore the role of firm capital allocation, we use firm-level data and measure capital misallocation with the within-sector variance of the marginal revenue product of capital (MRPK) across firms. We exploit the within-country variation in external financial dependence across sectors and find that capital account liberalization decreased the variance of the MRPK in sectors with high financial dependence more than in sectors with low dependence.

Finally, we use a variant of the Hsieh and Klenow (2009) model of misallocation to map the reduced-form estimates of the variance of MRPK into aggregate TFP gains. According to our calculations, capital account liberalization increased aggregate TFP through a more efficient capital allocation by 8% to 13%. This implies that a more efficient firm capital allocation explains between 20% to 33% of the estimated total aggregate TFP gains.

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Figure 1: Evolution of Capital Account Openness Index by Country

The figure plots the evolution of the Abiad et al. (2010) capital account openness index for the 10 countries in our sample during 1996-2005. The index consists of the sum of the individual scores of the following three questions: (1) is the exchange rate system unified?, (2) does a country set restrictions on capital inflows?, (3) does a country set restrictions on capital outflows? Each question is assigned a 0/1 score, so the index ranges from 0 to 3.

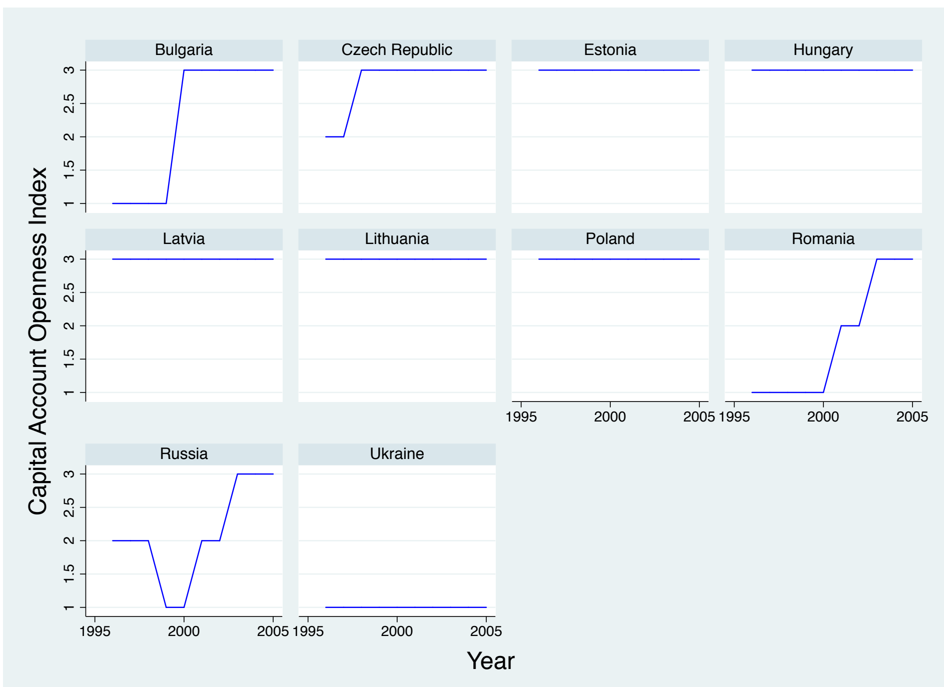

Figure 2: Variance of the Marginal Revenue Product of Capital and External Financial Dependence

The figure plots the variance of the marginal revenue product of capital (MRPK) in each sector against the Rajan and Zingales (1998) external finance dependence index of that sector. The variance of the MRPK is calculated by first computing the variance of the log MRPK in each country-sector-year cell and then averaging the variance across all countries and years for that sector. We take the average across the 10 countries in our sample during 1996-2005. The figure includes the 22 two-digit manufacturing sectors in our sample.

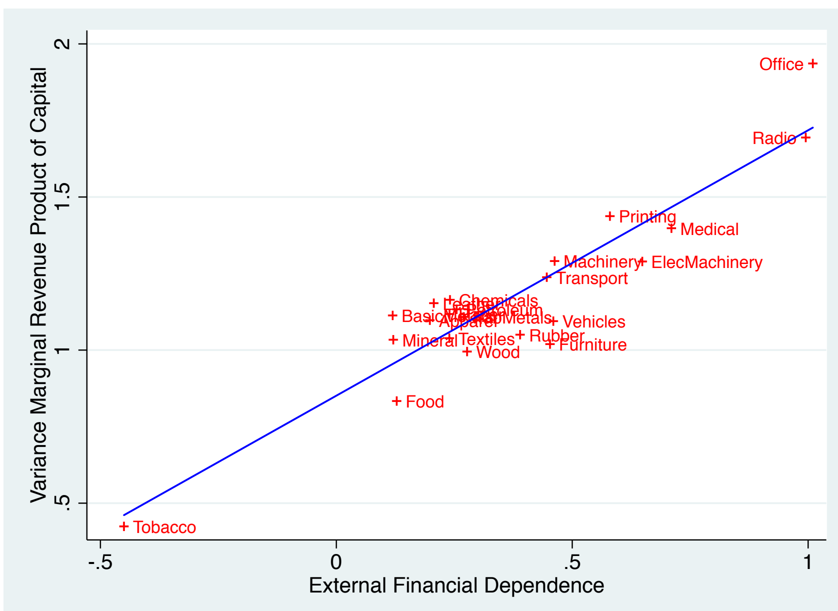

Figure 3: Ratio of Actual and Optimal TFP and External Financial Dependence

The figure plots the model-based ratio between actual an optimal TFP in each sector against the Rajan and Zingales (1998) external finance dependence index of that sector. TFP denotes total factor productivity. The ratio is computed using Equations (6) and (7) and setting the elasticity of substitution equal to 3. The figure includes the 22 two-digit manufacturing sectors in our sample.

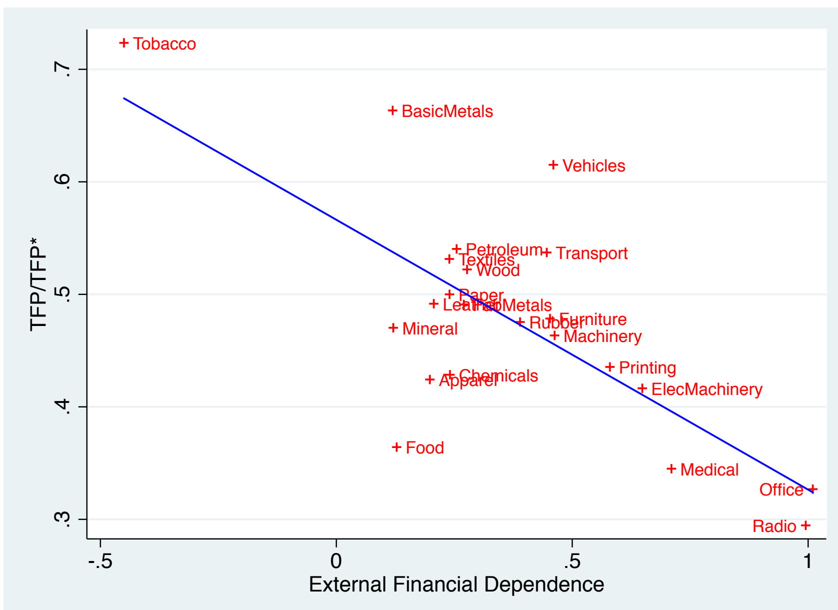

Figure 4: Relative MRPK of Young vs. Old Firms and External Financial Dependence

The figure plots the difference between the average log marginal revenue product of capital (MRPK) of all young and old firms in a sector against the Rajan and Zingales (1998) external finance dependence index of that sector. Young firms are defined as firms founded in 1994 or later (the median founding year across all firms). The figure includes the 22 two-digit manufacturing sectors in our sample.

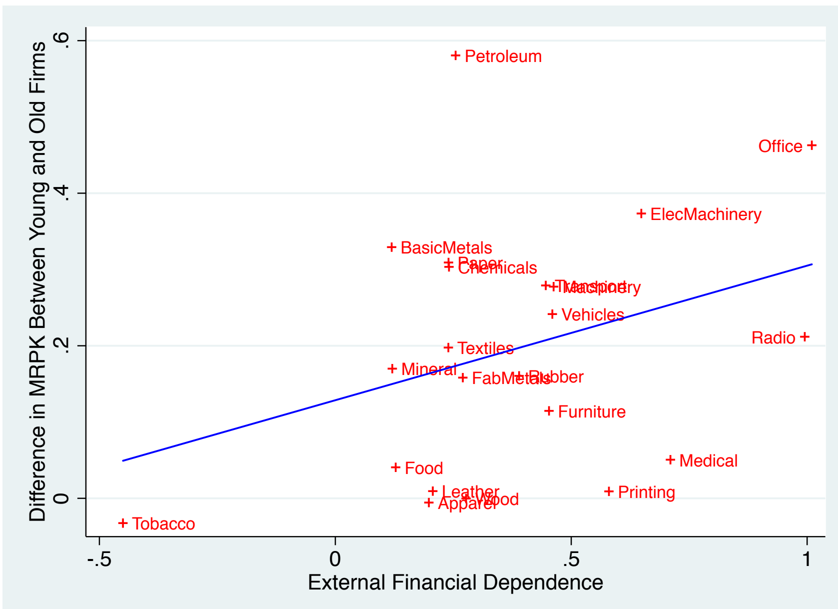

Table 1: Effect of Capital Account Liberalization on Capital Inflows and Financial Intermediation

The table reports the results from the following regression:

$$Y_{ct} = \alpha + \beta CapitalOpenness_{ct-1} + \gamma X_{ct-1} + \delta_c + \delta_t + \epsilon_{ct},$$

where Y_{ct} denotes either the ratio of capital inflows to GDP, the ratio of private bank credit to GDP, or the interest rate spread between deposit and lending rates of country c in year t. $CapitalOpenness_{ct-1}$ is the lagged capital account openness index, and X_{ct-1} is a vector of time-varying country controls. The specification includes a full set of country (δ_c) and year fixed effects (δ_t). The sample includes 10 countries during 1996-2005. The standard errors are clustered at the country level.

	Capital Inflows to GDP		Private Credit to GDP		Interest Rate Spread	
	(1)	(2)	(3)	(4)	(5)	(6)
Capital Account Openness	0.017**	0.014*	0.032**	0.028**	-0.033**	-0.030***
	(0.007)	(0.007)	(0.012)	(0.012)	(0.012)	(0.009)
Privatization		0.001		0.018		-0.007
		(0.009)		(0.012)		(0.006)
Trade Openness		0.014		-0.021		0.045
		(0.017)		(0.025)		(0.023)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	100	100	100	100	100	100
R-squared	0.742	0.745	0.673	0.695	0.671	0.701

Table 2: Effect of Capital Account Liberalization on Aggregate TFP

The table reports the results from the following regression:

$$\log(TFP_{ct}) = \alpha + \beta CapitalOpenness_{ct-1} + \gamma X_{ct-1} + \delta_c + \delta_t + \epsilon_{ct},$$

where TFP_{ct} is total factor productivity of country c in year t, $CapitalOpenness_{ct-1}$ is the lagged capital account openness index, and X_{ct-1} is a vector of time-varying country controls. The specification includes a full set of country (δ_c) and year fixed effects (δ_t). The sample includes 10 countries during 1996-2005. The standard errors are clustered at the country level.

	(1)	(2)	(3)
Capital Account Openness	0.065**	0.078**	0.066*
	(0.025)	(0.027)	(0.034)
Privatization		-0.028	-0.025
		(0.026)	(0.027)
Trade Openness			0.059
			(0.065)
Country Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Observations	100	100	100
R-squared	0.977	0.979	0.979

Table 3: Summary Statistics of Main Firm-Level Variables by Country

The table reports the summary statistics of the main firm-level variables for each of the 10 countries in our sample during 1996-2005. The first column reports the number of firms available in Amadeus. Sales and capital stock are measured in millions of 2000 U.S. dollars. The capital stock is measured as fixed assets (i.e., property, plant, and equipment). Employment is measured as the number of employees. The bottom row reports the average of the statistics across all countries. The marginal revenue product of capital (MRPK) of each firm is computed as the firm's sectoral capital elasticity times its average product of capital.

	Number	Sales (Millions U.S.$)			Capital Stock (Millions U.S.$)			Log(MRPK)		
	of Firms	Mean	StdDev	Median	Mean	StdDev	Median	Mean	StdDev	Median
Bulgaria	9787	995.4	1844.6	211.7	791.5	1422.6	158.2	0.761	1.046	0.646
Czech Republic	7039	4358.9	2819.5	4133.5	2958.2	2079.0	2705.0	0.787	0.939	0.655
Estonia	4840	975.5	1783.2	241.6	574.9	1192.3	111.0	1.009	0.950	0.957
Hungary	432	2835.4	2654.3	1872.0	1823.9	1918.2	955.5	0.847	0.897	0.812
Latvia	838	3422.5	2654.6	2521.6	2229.5	1912.5	1475.0	0.731	0.831	0.675
Lithuania	1710	3184.9	2720.9	2192.4	2336.3	2028.0	1542.8	0.629	0.891	0.527
Poland	6844	5581.8	2424.4	7439.7	3665.1	1852.9	4420.0	0.821	0.865	0.737
Romania	58046	716.9	1632.6	701.0	477.6	1165.1	258.6	0.979	0.996	0.931
Russia	41163	1729.6	2424.1	523.0	1164.1	1727.7	290.0	1.032	1.078	1.014
Ukraine	4933	2785.4	2740.7	1569.9	2277.8	1981.6	1489.1	0.331	0.909	0.124
All Countries	135632	1562.8	2451.2	280.9	1067.8	1740.2	158.7	0.928	1.013	0.865

Table 4: Summary Statistics of Main Sector-level Variables by Sector

The table reports the summary statistics of the main sector-level variables for each of the 22 two-digit manufacturing sectors in our sample during 1996-2005. The first column reports the ISIC revision 3 code of each sector. Capital is the average fixed assets (i.e., property, plant, and equipment) of all firms operating in each sector. The variance of MRPK is the average variance of the log marginal revenue product of capital (MRPK) across all firms in the sector. The variance of MRPL is defined analogously, for labor. Cov(MRPK,MRPL) denotes the average covariance between MRPK and MRPL in the sector. TFP/TFP* denotes the ratio of actual to optimal TFP, computed using Equations (6) and (7) and setting the elasticity of substitution equal to 3. The final column reports the Rajan and Zingales (1998) external finance dependence index of each sector. The bottom row reports the average of the statistics across all sectors.

	ISIC	Var(MRPK)		Var(MRPL)		Cov(MRPK,MRPL)		TFP/TFP*		External
	code	Mean	StdDev	Mean	StdDev	Mean	StdDev	Mean	StdDev	FinDep
Food	15	0.834	0.326	0.874	0.313	0.108	0.136	0.364	0.193	0.128
Tobacco	16	0.424	0.229	0.971	0.655	-0.035	0.346	0.723	0.099	-0.450
Textiles	17	1.039	0.388	0.777	0.387	0.131	0.153	0.531	0.136	0.240
Apparel	18	1.097	0.378	0.839	0.300	0.219	0.137	0.424	0.131	0.198
Leather	19	1.153	0.486	0.872	0.403	0.145	0.170	0.492	0.163	0.207
Wood	20	0.995	0.377	0.839	0.319	0.130	0.202	0.522	0.091	0.277
Paper	21	1.118	0.406	1.013	0.420	0.157	0.245	0.500	0.169	0.240
Printing	22	1.437	0.454	0.756	0.355	0.179	0.154	0.435	0.134	0.580
Petroleum	23	1.133	0.523	1.434	0.623	0.188	0.316	0.540	0.270	0.255
Chemicals	24	1.164	0.318	1.004	0.362	0.231	0.223	0.429	0.176	0.241
Rubber	25	1.050	0.344	0.857	0.372	0.211	0.148	0.475	0.157	0.390
Mineral	26	1.034	0.467	0.966	0.331	0.118	0.204	0.470	0.141	0.121
Basic Metals	27	1.113	0.479	0.983	0.339	0.199	0.229	0.663	0.107	0.119
Fab. Metals	28	1.108	0.335	0.722	0.271	0.197	0.176	0.491	0.110	0.270
Machinery	29	1.291	0.382	0.743	0.272	0.321	0.250	0.463	0.100	0.463
Office	30	1.936	0.751	1.817	0.723	0.889	0.608	0.327	0.149	1.010
Elec. Machinery	31	1.289	0.387	1.047	0.355	0.347	0.220	0.416	0.113	0.649
Radio	32	1.694	0.598	1.310	0.407	0.543	0.284	0.295	0.125	0.995
Medical	33	1.398	0.418	0.975	0.505	0.423	0.265	0.345	0.138	0.710
Vehicles	34	1.094	0.457	0.720	0.284	0.208	0.166	0.615	0.152	0.460
Transport	35	1.238	0.477	0.596	0.284	0.144	0.209	0.537	0.154	0.446
Furniture	36	1.019	0.413	0.748	0.342	0.223	0.187	0.478	0.154	0.453
All Sectors	.	1.169	0.485	0.908	0.436	0.234	0.270	0.468	0.168	.

Table 5: Effect of Capital Account Liberalization on Within-Sector Revenue Variance of Marginal Products

The table reports the results from the following regression:

$$Z_{cst} = \alpha + \beta CapitalOpenness_{ct-1} * FinDep_s + \gamma X_{ct-1} * FinDep_s + \delta_{ct} + \delta_{cs} + \epsilon_{cst},$$

where Z_{cst} is either the variance of log marginal revenue product of capital (MRPK), the variance of log marginal revenue product of labor (MRPL), or the covariance between log MRPK and log MRPL of country c in sector s in year t. $CapitalOpenness_{ct-1}$ is the lagged capital account openness index, $FinDep_s$ is the external financial dependence index, and X_{ct-1} is a vector of lagged time-varying country controls. The specification includes a full set of country-year (δ_{ct}) and country-sector fixed effects (δ_{cs}). The standard errors are clustered at the country level.

	(1) Var(MRPK)	(2) Var(MRPL)	(3) Cov(MRPK, MRPL)
Capital Account Openness * FinDep	-0.135**	-0.005	-0.063
	(0.056)	(0.047)	(0.035)
Privatization * FinDep	0.183	-0.089	0.049
	(0.266)	(0.089)	(0.067)
Trade Openness * FinDep	-0.391	-0.580**	-0.403
	(0.424)	(0.198)	(0.233)
Country-year Fixed Effects	Yes	Yes	Yes
Country-sector Fixed Effects	Yes	Yes	Yes
Observations	1,448	1,448	1,448
R-squared	0.780	0.838	0.778

Table 6: Effect of Capital Account Liberalization on Aggregate TFP through a Reduction in Capital Misallocation

The table reports the effect of capital account liberalization on aggregate TFP through a more efficient within-sector capital allocation, using the model presented in Section 4. The effect is computed from Equation (13). The upper panel computes the effect using the average initial sectoral distribution (θ_s) of the 10 countries. The columns reports the results for different values of the elasticity of substitution (σ). The lower panel computes the effect for the initial sectoral distribution of each of the 10 countries, for different values of the elasticity of substitution.

	$\sigma = 3$	$\sigma = 2$	$\sigma = 4$
Average Effect	10.73%	7.95%	13.40%
Effect by Sectoral Distribution of Each Country			
Bulgaria	10.94%	8.02%	13.87%
Czech Republic	9.56%	7.16%	11.95%
Estonia	10.04%	7.49%	12.59%
Hungary	11.69%	8.58%	14.79%
Latvia	10.16%	7.50%	12.83%
Lithuania	11.19%	8.26%	14.13%
Poland	11.30%	8.35%	14.26%
Romania	9.75%	7.25%	12.24%
Russia	12.64%	9.42%	14.86%
Ukraine	10.01%	7.51%	12.50%

Table 7: Effect of Capital Account Liberalization on Ratio of Actual and Optimal Sectoral TFP

The table reports the results from the following regression:

$$\log\left(\left(\frac{TFP}{TFP^*}\right)_{cst}\right) = \alpha + \beta CapitalOpenness_{ct-1} * FinDep_s + \gamma X_{ct-1} * FinDep_s + \delta_{ct} + \delta_{cs} + \epsilon_{cst},$$

where $\left(\frac{TFP}{TFP^*}\right)_{cst}$ is the model-based ratio of actual and optimal TFP of country c in sector s in year t. It is computed using Equations (6) and (7) and setting the elasticity of substitution equal to 3. $CapitalOpenness_{ct-1}$ is the lagged capital account openness index, $FinDep_s$ is the external financial dependence index, and X_{ct-1} is a vector of lagged time-varying country controls. The specification includes a full set of country-year (δ_{ct}) and country-sector fixed effects (δ_{cs}). The standard errors are clustered at the country level.

	(1)	(2)	(3)
Capital Account Openness * FinDep	0.272***	0.248***	0.253**
	(0.064)	(0.061)	(0.082)
Privatization * FinDep		0.098	0.099
		(0.197)	(0.197)
Trade Openness * FinDep			-0.024
			(0.151)
Country-year Fixed Effects	Yes	Yes	Yes
Country-sector Fixed Effects	Yes	Yes	Yes
Observations	1,448	1,448	1,448
R-squared	0.584	0.584	0.584

Table 8: Effect of Capital Account Liberalization on Firm-level MRPK, by Age

The table reports the results from the following regression:

$$\begin{aligned} \log(MRPK_{csit}) &= \alpha + \beta_1 CapitalOpenness_{ct-1} * FinDep_s + \beta_2 CapitalOpenness_{ct-1} * Young_i \\ &+ \beta_3 CapitalOpenness_{ct-1} * FinDep_s * Young_i + \gamma X_{ct-1} * FinDep_s + \delta_{ct} + \delta_i + \epsilon_{csit}, \end{aligned}$$

where $MRPK_{csit}$ is the the marginal revenue product of capital of firm i in country c in sector s in year t. $CapitalOpenness_{ct-1}$ is the lagged capital account openness index, $FinDep_s$ is the external financial dependence index, $Young_i$ is an indicator variable for firms born in or after 1994 (the median year of foundation across firms), and X_{ct-1} is a vector of lagged time-varying country controls. The specification includes a full set of country-year (δ_{ct}) and firm fixed effects (δ_i). The standard errors are clustered at the country level.

	Log(MRPK)
Capital Account Openness * FinDep	-0.097***
	(0.016)
Capital Account Openness * Young	-0.025***
	(0.006)
Capital Account Openness * Young * FinDep	-0.019***
	(0.006)
Privatization * FinDep	0.252***
	(0.061)
Trade Openness * FinDep	0.356***
	(0.036)
Country-year Fixed Effects	Yes
Firm Fixed Effects	Yes
Observations	361,452
R-squared	0.787

Table 9: Effect of Capital Account Liberalization on Within-Sector Variance of MRPK Accounting for Age

The table reports the results from the following regression:

$$Z_{cst} = \alpha + \beta CapitalOpenness_{ct-1} * FinDep_s + \gamma X_{ct-1} * FinDep_s + \delta_{ct} + \delta_{cs} + \epsilon_{cst},$$

where Z_{cst} is either the variance of (log) marginal revenue product of capital (MRPK), the variance of the projection of log MRPK on age, or the variance of the residual of the projection of log MRPK on age, of country c in sector s in year t. The projection of log MRPK on age is computed as the predicted values of a regression of log MRPK on a full set of age dummies, separately for each country-sector-year cell. $CapitalOpenness_{ct-1}$ is the lagged capital account openness index, $FinDep_s$ is the external financial dependence index, and X_{ct-1} is a vector of lagged time-varying country controls. The specification includes a full set of country-year (δ_{ct}) and country-sector fixed effects (δ_{cs}). The standard errors are clustered at the country level.

	(1) Var(MRPK)	(2) Var(MRPK|Age)	(3) Var(Residual)
Capital Account Openness * FinDep	-0.143**	-0.159*	0.016
	(0.044)	(0.071)	(0.077)
Privatization * FinDep	0.599***	0.293*	0.306***
	(0.153)	(0.148)	(0.072)
Trade Openness * FinDep	-0.450	-0.039	-0.412
	(0.552)	(0.166)	(0.426)
Country-year Fixed Effects	Yes	Yes	Yes
Country-sector Fixed Effects	Yes	Yes	Yes
Observations	1,419	1,419	1,419
R-squared	0.763	0.772	0.810

Table 10: Effect of Capital Account Liberalization on Sectoral Capital Stock and Investment

The table reports the results from the following regression:

$$\log(Z_{cst}) = \alpha + \beta CapitalOpenness_{ct-1} * FinDep_s + \gamma X_{ct-1} * FinDep_s + \delta_{ct} + \delta_{cs} + \epsilon_{cst},$$

where Z_{cst} is either the capital stock measured with Amadeus data or capital investment measured with UNIDO data of country c in sector s in year t. $CapitalOpenness_{ct-1}$ is the lagged capital account openness index, $FinDep_s$ is the external financial dependence index, and X_{ct-1} is a vector of lagged time-varying country controls. The specification includes a full set of country-year (δ_{ct}) and country-sector fixed effects (δ_{cs}). The standard errors are clustered at the country level.

	Capital Stock (Amadeus data)			Capital Investment (UNIDO data)		
	(1)	(2)	(3)	(4)	(5)	(6)
Capital Account Openness * FinDep	0.245**	0.253**	0.288**	0.181**	0.217**	0.155*
	(0.078)	(0.109)	(0.123)	(0.071)	(0.084)	(0.094)
Privatization * FinDep		-0.033	-0.028		-0.060	-0.084
		(0.167)	(0.150)		(0.076)	(0.077)
Trade Openness * FinDep			-0.180			0.057
			(0.256)			(0.039)
Country-year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Country-sector Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,448	1,448	1,448	1,315	1,315	1,315
R-squared	0.968	0.968	0.968	0.946	0.946	0.946

Appendix

Amadeus dataset details

The dataset comes in yearly versions and each vintage includes up to 10 years of information per firm. The Amadeus variables are available in current U.S. dollars. We deflate all series to 2000 U.S. dollars using producer price indices. If a firm has stopped filing, it is kept in the dataset for four subsequent years and then deleted. This creates a survivorship bias. For our study, it is essential to follow firms for consecutive years. We overcome this bias by appending two versions (2006 and 2002) of the dataset. Firms that exited prior to 2002 and were deleted in the 2006 version of the dataset are reported in the 2002 vintage and are, therefore, included in our appended dataset.

We clean the dataset based on our main variables of interest, firm TFP and MRPK, and their respective growth rates. First, we delete all observations with clearly wrong values, i.e., observations with negative values for assets, revenue, or employment. Second, we pool all data and trim the 1st and 99th percentile of the four variables. If data quality varies across countries, this step will produce cleaner data for those countries with more outliers. Next, we repeat this procedure within each country-year cell, to ensure that we do not miss outliers in countries with relatively higher quality data. Finally, we delete all observations with missing data for any of these four variables.

Table A.1: Summary Statistics of Main Country-Level Variables

The table reports the summary statistics of the main country-level variables for each of the 10 countries in our sample during 1996-2005. GDP and capital stock are measured in millions of 2005 U.S. dollars, adjusted by PPP. Employment is measured as the number of employees (in millions). Log TFP is calculated as the Solow residual of an estimated Cobb-Douglas country production function (see Equation (3)). The bottom row reports the average of the statistics across all countries.

	GDP (Millions U.S.$)		Capital Stock (Millions U.S.$)		Employment (Millions)		Log TFP	
	Mean	StdDev	Mean	StdDev	Mean	StdDev	Mean	StdDev
Bulgaria	63750.09	11261.27	1.5e+05	15877.91	3.48	0.15	3.84	0.16
Czech Republic	1.9e+05	16796.91	6.4e+05	78762.49	4.90	0.10	4.74	0.03
Estonia	16574.91	3487.17	38504.34	10022.43	0.60	0.02	4.93	0.11
Hungary	1.4e+05	18445.02	3.9e+05	69635.80	4.20	0.07	5.20	0.06
Latvia	24414.77	3894.81	63823.67	8483.11	1.00	0.04	4.37	0.08
Lithuania	39569.86	6726.34	82223.88	12000.65	1.38	0.06	4.45	0.11
Poland	4.6e+05	42462.51	1.3e+06	78097.81	14.23	0.61	5.19	0.08
Romania	1.7e+05	29599.52	4.7e+05	58385.17	10.11	0.95	4.31	0.18
Russia	1.3e+06	3.2e+05	7.2e+06	1.0e+06	65.39	1.37	4.34	0.25
Ukraine	2.2e+05	47463.40	1.5e+06	52102.25	21.69	0.50	4.16	0.19
All Countries	2.6e+05	3.8e+05	1.2e+06	2.1e+06	12.70	18.80	4.55	0.45

Table A.2: Employment Distribution Across Different Size Bins in Amadeus

The table reports the employment distribution across different size bins for the 10 countries in the Amadeus dataset in our sample during 1996-2005. Emp stands for employment. The table also compares the Amadeus average employment distribution with the Eurostat distribution, which covers the universe of firms.

Country	1<Emp<9	10<Emp<49	50<Emp<249	Emp>250
Bulgaria	2.3%	10.0%	26.4%	61.3%
Czech Republic	0.8%	7.1%	28.7%	63.4%
Estonia	7.7%	25.1%	37.0%	30.2%
Hungary	0.4%	4.4%	36.0%	59.1%
Latvia	0.3%	5.8%	39.9%	54.1%
Lithuania	0.4%	9.8%	34.7%	55.1%
Poland	0.2%	3.3%	29.5%	67.0%
Romania	5.9%	13.9%	27.0%	53.2%
Russia	2.1%	6.2%	19.4%	72.2%
Ukraine	0.1%	1.0%	15.1%	83.8%
Average Amadeus	2.0%	8.7%	29.4%	60.0%
Average Eurostat	7.6%	17.6%	31.2%	43.6%