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ESSAYS IN FINANCIAL LIBERALIZATION AND THE AGGREGATE ECONOMY

by

MAURICIO LARRAIN

A dissertation submitted in partial satisfaction of the
requirements for the degree of
Doctor of Philosophy

in

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GRADUATE DIVISION
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UNIVERSITY OF CALIFORNIA, BERKELEY

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Professor Atif Mian, Chair
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Professor Edward Miguel

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ESSAYS IN FINANCIAL LIBERALIZATION AND THE AGGREGATE ECONOMY

Abstract

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MAURICIO LARRAIN

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This dissertation consists of three essays on the effects of financial liberalization on the aggregate economy. In the first essay, I analyze empirically the effects of financial deregulation on wage inequality. To identify the causal effect of the reform, I exploit differences in external financial dependence and capital-skill complementarity across industries. I analyze two different episodes of deregulation: across countries within Europe and across states within the U.S. I provide evidence that, in both episodes, financial liberalization increases wage inequality disproportionally in industries with high financial needs and strong complementarity. I also find that the differential effect on relative wages is particularly strong in economies with rigid labor markets, while the effect on relative labor flows is stronger in economies with flexible labor markets.

In the second essay, I conduct a quantitative analysis to calculate the effect of financial liberalization on aggregate inequality. I develop a simple two-sector general-equilibrium model with capital and labor market frictions. I calibrate the model in order to match the reduced form results documented in the first essay. According to a back-of-the envelope calculation, financial liberalization explains 20% and 15% of the increase in aggregate inequality in the U.K. and the U.S. during the 1980-2000 period, respectively. The simulation also shows that financial liberalization leads to an increase in the level of wages of both types of labor.

In the third essay, co-authored with Sebastian Stumpner, we analyze empirically the effects of financial liberalization on total factor productivity (TFP) and capital misallocation. We use a large cross-country firm-level database and find that deregulation increases productivity disproportionally in industries with high financial needs and low asset tangibility. We decompose industry productivity into an average-productivity term and an allocation term, measured by the size-productivity covariance, and find that the industry TFP gains are primarily driven by a reduction in misallocation across firms.

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We also find that financial liberalization decreases the within-industry variance of the marginal product of capital and decreases the covariance between the marginal product of capital and TFP. Finally, we document that deregulation increases the market share of domestically-owned firms, which ex-ante are more financially constrained.

To Bárbara, with all my love.

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Chapter 1

Introduction

1.1 Motivation

In the past decades, the financial sector has undergone a large transformation in many countries around the world. A key factor behind these changes has been the liberalization of financial markets. Until the 1970s, the financial sector was one of the sectors where state intervention was most visible. In many countries, banks were owned or controlled by the government, the interest rates they charged were subject to ceilings, the allocation of credit was similarly regulated, and bank entry restrictions and barriers to foreign capital flows limited competition.

Since then, many countries in different regions around the world have liberalized and deregulated their financial markets (see figure 1.1). This liberalization has been characterized by a greater scope for market forces to operate in credit markets. Financial liberalization policies encompass various dimensions, including deregulation of interest rates, entry liberalization, bank privatization, reforms to financial sector supervision and regulation, among others.

[Include figure 1.1 here]

Financial deregulation policies aimed at reducing the cost of credit and broadening its availability. If we consider a cross-section of countries in 2000, we can in fact observe a positive association between the degree of financial liberalization and financial depth, measured as the ratio of private credit to GDP (see figure 1.2). Several studies have carefully shown that the liberalization of financial markets reduces financial constraints and broadens the availability of credit. For example, Laeven (2003) studies several developing countries and finds that financial liberalization reduces firms' financing constraints. Tressel and Detragiache (2008) study a larger group of countries over the last three decades

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and find that financial reform results in deeper financial markets, measured as bank credit to the private sector.

[Include figure 1.2 here]

Since financial liberalization increases financial depth, it has the potential of contributing to higher economic activity. Several studies have provided evidence that financial deregulation leads to higher economic growth (Galindo et al., 2002; Gupta and Yuan, 2009; Levchenko et al., 2009). In order to resolve causality issues, these studies have documented in detail the mechanisms through which deregulation influences growth. In particular, using the methodology proposed by Rajan and Zingales (1998), these papers use industry-level data and find that financial liberalization increases economic growth by reallocating resources towards the industries that are more financially constrained.

Although a large literature finds that financial liberalization produces faster average growth, researchers have not yet determined clearly whether deregulation benefits the whole population equally, or whether it disproportionately benefits the rich or the poor. The first two essays of this dissertation attempt to fill this gap. If we look at a cross-section of countries in 1990, we can observe a positive relationship between the degree of financial liberalization and wage inequality, measured as the relative wage between college and high-school workers (see figure 1.3). That is, countries with more deregulated financial markets tend to exhibit a higher wage gap between skilled and unskilled workers. However, this is simply a correlation and in order to state a causal statement more rigorous evidence is needed.

[Include figure 1.3 here]

In an attempt to understand in more detail the relationship between financial liberalization and economic growth, several papers have documented that deregulation increases growth primarily by boosting total factor productivity (TFP) (Levine, 2005; Levchenko et al., 2009; Bekaert et al., 2011). Figure 1.4 presents cross-sectional evidence consistent with this finding. However, since these papers use aggregate data (country or industry-level), they cannot analyze the factors leading to these TFP gains. The last essay of this dissertation attempts to fill this gap with the use of a large cross-country firm-level dataset.

[Include figure 1.4 here]

In summary, in the first two essays of this dissertation, I analyze the distributional consequences of liberalizing financial markets. I provide reduced form and quantitative

evidence that financial liberalization increases wage inequality in the economy. In the last essay, I analyze the efficiency consequences of liberalization. I provide reduced form evidence that deregulation increases TFP through a more efficient allocation of resources across firms. Below I describe in more detail the outline of this dissertation.

1.2 Outline of dissertation

In Chapter 2, I analyze empirically the effect of financial liberalization on wage inequality. In the spirit of Rajan and Zingales (1998), I use economic theory to identify the causal effect of the reform. As explained above, deregulation should reduce financing constraints faced by firms and increase capital demand. If the production functions of these firms exhibit capital-skill complementarity (CSC), liberalization should increase the aggregate demand for skilled labor relative to unskilled labor, increasing wage inequality in equilibrium. The effect should be stronger the higher the extent of financial constraints and the stronger the degree of CSC. My identification strategy therefore consists of exploiting cross-industry differences in both financial constraints and CSC.

I analyze two independent episodes of financial liberalization: deregulation of domestic financial markets across a group of countries (mostly European) and bank branch deregulation across U.S. states. I provide evidence that, in both episodes, the liberalization of financial markets increases wage inequality disproportionally in industries with high financial needs and strong complementarity. The economic magnitude of the effect is considerable, explaining 43% and 10% of the variation of inequality for the country-level and state-level reforms, respectively.

Given that wage inequality varies across industries only if there are labor market frictions preventing labor to move freely, the differential effect of deregulation on inequality should be increasing in labor market rigidity. I exploit labor rigidity across countries and states and find that the effect of liberalization on inequality across industries is higher in countries and states with more labor market regulations. The effect on relative labor flows across industries, on the other hand, is higher in economies with more flexible labor markets.

While the reduced form analysis of Chapter 2 has the benefit of achieving a clean identification of the effect of liberalization on inequality, it only allows to estimate the *differential* effect across industries. To analyze the effect on *aggregate* inequality, in Chapter 3 I simulate a financial reform using a simple two-sector general equilibrium model. The industries in the model are heterogeneous regarding financial needs and CSC. The economy exhibits frictions in both the capital and the labor market. I calibrate the model in order to match the theoretical prediction regarding the differential effect of the reform

on inequality with the results obtained in Chapter 2.

According to a back-of-the envelope calculation, the effect on aggregate wage inequality is sizable. For example, liberalization explains 20% of the increase in aggregate inequality in the U.K. during the 1980-2000 period. Likewise, bank deregulation explains 15% of the rise in U.S. inequality during the same time period. In addition, since the concept of CSC is by definition relative, the reduced form analysis can only inform about *relative* wages, not *absolute* wages. The quantitative analysis, on the other hand, can make predictions regarding absolute wages. According to the simulation, financial liberalization leads to an increase in the level of wages of both types of labor. Therefore, according to the analysis, financial liberalization is a Pareto improving policy for employees.

Finally, in Chapter 4, co-authored with Sebastian Stumpner, we estimate empirically the effect of financial liberalization on capital misallocation and TFP. We identify the effect by exploiting differences in external financial needs and asset tangibility across industries. We use a large cross-country firm-level database and find that deregulation increases productivity disproportionally in industries with high financial needs and low tangibility. After a financial reform, TFP in industries with high financial dependence (low asset tangibility) increases by 16% (29%) more than in industries with low dependence (high tangibility). Nevertheless, these TFP gains could be the result of an improved allocation of capital across firms or of firms becoming individually more productive.

To analyze the forces driving the productivity gains, we decompose industry productivity into an average-productivity term and an allocation term, measured by the size-productivity covariance. We find that the industry TFP gains are primarily driven by a reduction in misallocation across firms. Reallocation explains 71% (60%) of the differential effect of the reform on TFP across industries with different levels of external financial needs (asset tangibility).

Our model of financial frictions and misallocation implies that any improvement in the size-productivity covariance must be driven by a reduction of the covariance between productivity and the marginal product of capital. We find evidence for this mechanism in the data and also provide evidence that the reform lowers the variance of the marginal product of capital across firms. Finally, we document that deregulation increases the market share of domestically-owned firms, which ex-ante are more financially constrained. The effect is particularly strong in industries with more financial constraints.

Figure 1.1: Evolution of financial liberalization across different regions of the world

Graphs by region
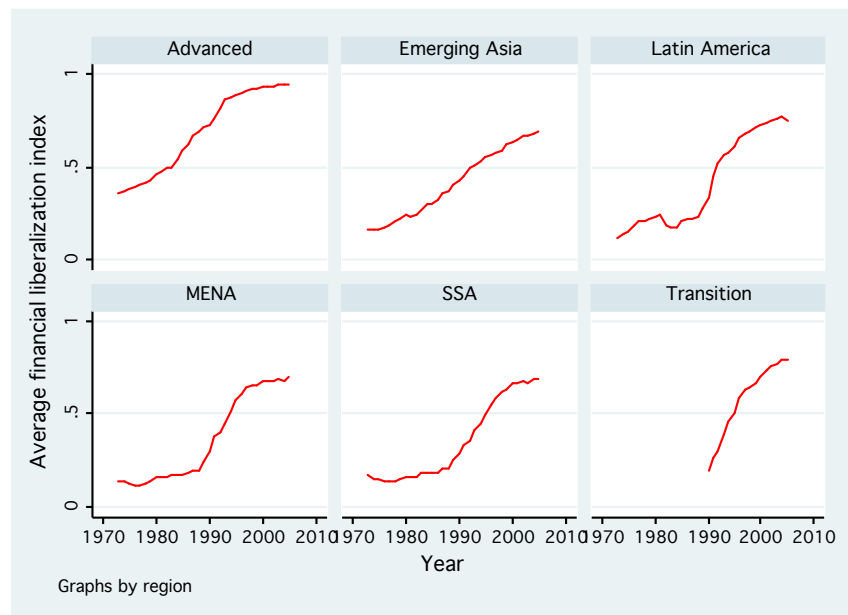
Notes: the figure plots the evolution of financial liberalization through the 1975-2005 period for six groups of countries: advanced economies, emerging Asia, Latin America, Middle East and North Africa, Sub-Saharan Africa, and transition economies. Source: own calculations based on data from Abiad et al. (2010).

Figure 1.2: Financial liberalization and financial depth in a cross-section of countries

Notes: the figure plots the relationship between the state of financial liberalization and the ratio of private credit to GDP in a cross-section of 67 countries in 2000. Source: own calculations based on data from Beck and Demirguc-Kunt (2009) and Abiad et al. (2010).

Figure 1.3: Financial liberalization and wage inequality in a cross-section of countries

Figure 1.4: Financial liberalization and TFP in a cross-section of countries

Notes: the figure plots the relationship between the state of financial liberalization and TFP in a cross-section of 55 countries in 2000. TFP is computed as the ratio between the country's TFP and US's TFP. Source: own calculations based on data from Abiad et al. (2010) and Jones and Romer (2010).

Chapter 2

Does Financial Liberalization Contribute to Wage Inequality? A Reduced Form Analysis

2.1 Introduction

Wage inequality, defined as the relative wage between skilled and unskilled labor, increased substantially starting in the 1980s in several OECD countries, such as the U.S., the U.K., and several others. Although the dynamics of wage inequality have been well documented, there is still disagreement about their causes. Several explanations have been proposed, including skill-biased technical change, globalization and trade liberalization, and changes in wage setting institutions. However, little attention has been paid to the role of financial markets in this process. An interesting fact is that, at the same time that inequality began to increase, many countries dramatically liberalized their financial markets. Panel (a) of figure 2.1 shows that, in a cross-section of countries, wage inequality is positively correlated with the state of financial liberalization. Panel (b) of the figure shows a case study, the U.S., where the dynamics of wage inequality closely followed the dynamics of financial liberalization. This evidence suggests that financial liberalization might have been an additional factor contributing to the increase in wage inequality, but more rigorous evidence is needed.[1]

[Include figure 2.1 here]

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[1]In this essay, I focus on inequality between skilled and unskilled workers in the non-financial sectors of the economy. For evidence on inequality between workers of the financial and non-financial sectors, see Philippon and Reshef (2011).

In this essay, I argue that the liberalization of financial markets has widened the wage gap between skilled and unskilled workers and has therefore contributed to the rise in wage inequality in many developed countries. To identify the causal effect of financial liberalization on inequality, I focus on a theoretical mechanism through which finance affects inequality. According to theory, financial liberalization should improve the efficiency of financial intermediation, alleviating firms' borrowing constraints and increasing capital demand.[2] If the production functions of firms exhibit capital-skill complementarity –meaning that capital and skilled labor are relative complements (as the evidence indicates)– the demand for skilled labor should increase by more than the demand for unskilled labor. As a result, wage inequality, which is the relative price of skilled labor, will increase in equilibrium.[3]

Financial liberalization should have particularly large effects when there is a large increase in capital demand and a large increase in the relative demand for skilled labor. Therefore, the effect of liberalization on inequality should be increasing in the extent of financial needs and in the degree of capital-skill complementarity (henceforth CSC). Given that industries are heterogeneous regarding these two dimensions, financial liberalization should have heterogeneous effects on wage inequality across industries. To estimate the causal effect of the reform on inequality, I exploit cross-industry differences in financial needs and CSC.[4] I estimate the *differential* effect of financial deregulation *across* industries within an economy. The identification assumption is that there aren't other concurrent policies or shocks that increase wage inequality *exclusively* in the subset industries with both high financial needs and strong complementarity.

The contribution of this essay is threefold. First, I provide evidence of a specific mechanism –capital-skill complementarity– by which financial liberalization affects inequality. This contributes to a better understanding of the relationship between finance and inequality, a topic that has been analyzed almost exclusively theoretically. Second, I highlight the role of financial markets in contributing to the rise in wage inequality. This allows for an improved understanding of the determinants of rising inequality in developed countries. Third, I emphasize that capital-skill complementary varies importantly

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[2]Besides enhancing financial development, financial liberalization can increase financial fragility leading to more frequent crises. In this essay, I only focus on the financial development dimension of liberalization. Ranciere et al. (2006) find that the effect of financial liberalization on growth via financial depth by far outweighs the indirect effect via a higher propensity to crisis.

[3]This mechanism should be particularly relevant for small and medium-size firms, which are bank dependent and lack good access to capital markets. See Davis et al. (1991) and Haskel (1998) for evidence on the dispersion of skilled/unskilled work and skilled/unskilled wages across small and medium-size firms in the U.S. and the U.K.

[4]I document that financial needs and CSC are uncorrelated across industries. As a result, there are industries in each of the four possible combinations (high and low) of financial needs and complementarity.

across industries. This essay provides the first systematic ranking of the complementarity between capital and skills across industries.

To estimate the effect of finance on inequality, I focus on two different episodes of financial liberalization. The first episode of reforms refers to the deregulation of domestic financial markets across a large group of countries (mostly from Europe). Starting in the 1970s, these countries moved from government control toward greater private provision of financial services under fewer operational restrictions. The second episode consists of the removal of geographic restrictions on banking across individual states of the U.S. From the 1970s through the 1990s, most states allowed banks to branch within and across state borders. Focusing on two completely independent sets of reforms increases the external validity of my results.

I identify an industry's intrinsic degree of financial needs by using the widely-used index of external financial dependence developed by Rajan and Zingales (1998). The index is defined as the difference between investments and cash generated from operations for the median firm in each industry. To identify an industry's inherent degree of CSC, I use a panel of countries across time and estimate a skilled labor share equation for each industry. From each estimation, I recover the elasticity of the share of skilled labor over the wage bill to capital intensity and use it as a proxy for that industry's degree of CSC.

The comparison of wage inequality across industries makes sense only if the economy exhibits labor market frictions that prevent labor from moving freely across industries; otherwise, relative wages would be identical in all industries. According to theory, in economies with rigid labor markets, the bulk of the adjustment of an industry labor market to a financial reform comes through relative wages. On the other hand, the adjustment with flexible labor markets comes primarily through relative labor flows. I rank countries and states according to their degree of labor rigidity and analyze how the effect of liberalization on inequality varies with different labor market institutions.[5]

I first find that financial liberalization increased capital demand particularly in industries that are heavily dependent on external finance. Next, I find that liberalization increased wage inequality disproportionally in industries with greater needs for external finance and strong CSC. The result holds for both episodes of reforms. The economic magnitude of the effect is considerable. In the country-level analysis, wage inequality in industries with high financial needs and strong complementarity increased by roughly 3% more than in the rest of the industries, which accounts for 43% of the country-level variation of inequality. In the state-level analysis, the differential effect on wage inequality

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[5]Given that labor is able to move across industries in the very long run, the time horizon for the analysis of the differential effect across industries is short to medium run. Nevertheless, the overall effect on aggregate inequality should persist in the long run.

across industries is 1%, explaining 10% of the state-level variation of inequality.

I also find that relative labor flows do not respond to financial liberalization in the country-level analysis, while they respond strongly in the state-level analysis. This finding is consistent with the fact that labor markets are more rigid in Europe than in the U.S. To analyze this systematically, I exploit labor rigidity across countries and states. I find that the effect of liberalization on inequality across industries is higher in countries and states with more labor market regulations, while the effect on relative labor flows across industries is higher in economies with more flexible labor markets. This evidence further supports the theoretical mechanism between finance and inequality highlighted in this essay.

The remainder of this essay proceeds as follows. In the next section, I relate the paper to the existing literature. In section 2.3, I describe the empirical strategy. In section 2.4, I describe the reforms and the data used. In section 2.5, I present the main reduced form results. In section 2.6, I report additional empirical results. In the final section, I present concluding remarks.

2.2   Related literature

This paper is related to several strands of the literature. First, it contributes to the recent literature on financial deregulation and inequality. Beck et al. (2010) and Jerzmanowski and Nabar (2011) use different methodologies to analyze the effect of branch deregulation on inequality in the U.S. While the former paper finds that deregulation decreased wage inequality, the latter finds the opposite result. While they both identify the effect by exploiting differences in timing of deregulation across states, I exploit differences in external finance and CSC across industries within a state (or country). Documenting evidence of a specific mechanism by which finance affects inequality provides a stronger test of causality. In addition, besides analyzing deregulation across states in the U.S., I analyze deregulation across a large group of countries. My paper also connects to the work of Philippon and Reshef (2011). While they analyze the effect of U.S. deregulation on the wage gap between employees in the financial and real sectors, I analyze the effect on the wage gap between employees with college and non-college degrees within the real sectors of the economy.

Second, this paper is also close in spirit to the recent literature on finance and labor, which argues that financial market imperfections can have significant impact on employment decisions of firms. Benmelech et al. (2011) show that financial constraints and the availability of credit play an important role in firm-level employment decisions. Pagano and Pica (2011) show that financial development is associated with greater employment

growth, particularly in countries with less developed financial markets. I contribute to this literature by arguing that improvements in financial markets affect different margins of industry-level labor markets. I argue that the relative importance of these margins depends on the labor market rigidity of the economy.

This paper adds to a growing literature studying the real effects of financial liberalization. There are several papers that have studied the effects of liberalization on economic growth using international inter-industry data (Galindo et al., 2002; Gupta and Yuan, 2009; Levchenko et al., 2009). These papers identify the effect of the reform by exploiting cross-industry differences in the need for external finance. More related to my work is Chari et al. (2009), who show that average wages increase after capital market integration. However, there is no country-industry evidence regarding the effects of financial reform on wage inequality. My paper provides the first attempt to fill this gap.

This paper in addition relates to the extensive literature on the determinants of rising wage inequality. Several explanations have been proposed to explain the shift of demand against unskilled workers. In particular: skill biased technical change (Katz and Murphy, 1992), trade liberalization (Wood, 1995), and changes in labor market institutions (DiNardo et al., 1996). My paper contributes to this line of work by highlighting the role of financial liberalization as an additional factor contributing to the increase in inequality.

Finally, this paper contributes to the literature studying the relationship between CSC and inequality. Griliches (1969) was the first to provide evidence that capital and skilled labor are more complementary as inputs than are capital and unskilled labor, the "capital-skill complementarity hypothesis". Krusell et al. (2000) show that with CSC, the rise in the stock of capital equipment can account for most of the increase in wage inequality in the last decades in the U.S. While these authors focus on technological change as the driving force behind the capital stock increase, I focus on financial liberalization. As explained above, I also contribute to the study of CSC by arguing and documenting that the degree of complementarity between capital and skilled labor varies substantially across industries.

2.3 Empirical strategy

According to the model, financial liberalization should increase wage inequality disproportionally in industries with high financial needs and strong CSC. Based on this prediction, my identification strategy for estimating the causal impact of the policy on inequality will consist of exploiting cross-industry differences in both financial needs and CSC.

2.3.1 Identification

There at least two potential threats to identification. First, there could be other policies or reforms that take place at the same time than financial liberalization and could also increase inequality (e.g. trade openness or skilled biased technological change). Secondly, the decision to deregulate could be endogenous and be triggered by a third factor that could also increase inequality (e.g. banking crisis).

My strategy of exploiting heterogeneity across industries should deal with these threats for the following reason. The model provides a very specific prediction regarding the cross-industry effects of financial liberalization: the subset of industries with high financial needs and strong complementarity should be the most affected by the policy. It is very hard to come up with a reasonable alternative story of another shock that delivers the exact same cross-industry prediction. In other words, I don't disagree that there could be other policies or shocks that could be concurrent to financial liberalization or that could trigger the decision to deregulate. Neither do I disagree that the effects of these other factors could be heterogenous across industries. The identification assumption is that these factors do not increase inequality *exclusively* in the subset of industries with both high financial needs and strong complementarity. I will go back to this topic in further detail in subsection 2.6.4. I now rank industries regarding the two cross-sectoral characteristics.

2.3.2 External financial dependence

I identify an industry's intrinsic degree of financial needs with the widely-used index of external financial dependence developed by Rajan and Zingales (1998). The index is defined as the fraction of capital expenditures not financed by cash flow from operations for the median publicly traded firm in each industry in the U.S., $EFD_i = \frac{(CAPX-CF)_i}{CF_i}$. The logic behind the index is that, for technological reasons, some industries need more external financing than others. For instance, industries that operate on large scales, with long gestation periods, high R&D, or high working capital needs tend to have relatively high financial needs.

The assumption made is that the use of finance by publicly traded firms in the U.S. allows to observe their demand for external funds. These firms are large and well established, with far better access to well-developed capital markets than small firms within the U.S. or across the world. Hence, the financial dependence index should provide a clean measure of the demand for external finance, not influenced by constraints on the supply side. Assuming that these technological differences persist across economies, I can use the external dependence of industries in the U.S. to rank industries in every economy

along this dimension.[6]

2.3.3 Capital-skill complementarity

Since different industries have different production functions, capital and skilled labor should have a stronger degree of complementarity in some industries than others. Capital will tend to strongly substitute for unskilled workers in industries where the latter carry out a very limited and well-defined set of cognitive and manual activities, which can be accomplished by following explicit rules (routine tasks). Likewise, capital will tend to strongly complement skilled workers in industries where the latter carry out problem-solving and complex communication activities (non-routine tasks).

In order to construct a CSC index, I estimate a skilled labor share equation for each industry.[7] Following Berman et al. (1994), I assume that capital is a quasi-fixed factor and that skilled and unskilled labor are variable factors. I approximate the variable cost function to a Translog function. As shown in Appendix A, cost minimization under constant returns to scale yields the following share equation for each industry:

$$\mathcal{S} = \alpha + \gamma \log(\omega) + \gamma \log(k/y), \tag{2.1}$$

where $\mathcal{S}$ denotes the share of skilled labor payment in the wage bill, i.e. $\mathcal{S} = \frac{w_s s}{w_s s + w_u u}$. A positive coefficient for γ in equation (2.1) implies capital-skill complementarity. Intuitively, when capital and skilled labor are relative complements, an increase in capital intensity leads to an increase in the relative demand for skilled labor, causing the wage bill share of skilled workers to increase. The stronger the complementarity between capital and skilled labor, the larger the increase in the skilled labor share. I therefore use the γ coefficient as a measure of industry-level CSC.

I use data from a panel of countries across time and estimate the following equation for each industry:

$$\mathcal{S}_{ct} = \alpha + \beta \log(\omega)_{ct} + \gamma \log(k/y)_{ct} + \eta_c + \eta_t + \varepsilon_{ct}, \tag{2.2}$$

where c indicates the country, t the year, and η_c and η_t are country and year fixed effects. I estimate this equation separately for each industry and recover the parameter γ from each estimation. I define the capital-skill complementarity index of industry i as $CSC_i = \gamma_i$.

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[6]Rajan and Zingales (1998) compute the index only for manufacturing industries. I extend the index to cover non-manufacturing industries as well.

[7]Another alternative is to directly estimate production functions for each industry and then recover the different elasticities of substitution. The problem with this approach is that the precision of non-linear estimation of elasticities of substitution has been proven to be low, since it is hard to adequately capture the variation in the curvature of production functions (Duffy et al., 2004).

To estimate equation (2.2), I must take into account that the variation in $\log(k/y)$ might be not be completely exogenous. For example, a skill-biased technological shock can increase both capital intensity and the relative demand for skilled labor, and hence the wage share of skilled labor. To obtain an exogenous variation of capital intensity, I use lagged values of the dependent and independent variables as internal instruments.[8] I estimate equation (2.2) in first differences:

$$\Delta \mathcal{S}_{ct} = \beta \Delta \log(\omega)_{ct} + \gamma \Delta \log(k/y)_{ct} + \Delta \eta_t + \Delta \varepsilon_{ct}, \tag{2.3}$$

where Δ denotes the time difference operator, i.e. $\Delta x = x_t - x_{t-1}$. The identification assumption to estimate the first-differences equation is that the error term in equation (2.2) is not serially correlated and that the explanatory variables are weakly exogenous (i.e., uncorrelated with future realizations of the error term). In other words, the exclusion restriction states that lagged values of capital intensity affect the wage share of skilled labor only through its effect via current capital intensity. The GMM panel estimator uses the following moment conditions to estimate the complementarity coefficient: $\mathbb{E}[z_{ct-j} \cdot \Delta \varepsilon_{ct}] = 0$ for $j \geq 2, t \geq 3$, where $z = [\mathcal{S}, \log(\omega), \log(k/y)]$.

2.4 Data

2.4.1 Financial liberalization

Country-level reforms. In the last quarter of the twentieth century, financial markets across the world moved from government ownership or control towards greater private provision of financial services under fewer operational restrictions. Abiad and Mody (2005) document that in many cases financial reforms were triggered by shocks such as a balance-of-payments crises, which destabilized cooperation among different interest groups. Other shocks that precipitated reform were falling global interest rates and participation in IMF programs. The overall trend towards liberalization also reflected pressures generated by the need to catch up with regional reform leaders.

The data on financial liberalization used in this paper comes from Abiad et al. (2010). The authors create a liberalization index that runs from 1975 to 2005 and measures the removal of government control of the financial sector. Recognizing the multifaceted nature of financial liberalization, the index is an aggregation along seven dimensions: credit controls, interest rate controls, bank entry barriers, restrictive regulations, bank privatization, controls on international financial transactions, and securities market policy.

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[8]The GMM-IV procedure with internal instruments was first introduced by Arellano and Bond (1991).

After intersecting the Abiad et al. (2010) reform data with the EU-KLEMS dataset on wage inequality, which will be explained below, I obtain a sample of 20 countries. By the nature of the EU-KLEMS dataset, the majority of the countries are European. All data details are provided in Appendix B.

To obtain precise liberalization dates, I set a threshold for the Abiad et al. (2010) index, above which a country is considered liberalized. Following the work of previous studies (Braun and Raddatz, 2007), the reform variable is defined to take the value of one when the country's normalized liberalization index is above the median of the index across all countries (which corresponds to the value of 0.7) and the value of zero when the index is less than or equal to the median.[9] Appendix B reports the dates of liberalization according to this classification. As can be seen, there are important differences in the timing of the reforms. The countries that first started liberalizing their financial markets (late 1970s) were Germany and the U.K. Eastern European countries were the last to undertake reform (late 1990s).

State-level reforms. For most of the last century, states in the U.S. imposed various restrictions on the ability of banks to branch within state borders and to operate in other states. Starting from 1970, several states relaxed these restrictions, allowing bank holding companies to consolidate bank subsidiaries into branches and permitting de novo branching statewide. This relaxation came gradually, with the last states lifting restrictions following the 1994 passage of the Riegle-Neal Interstate Banking and Branching Efficiency Act.

Kroszner and Strahan (1999) have argued that small banks fought to maintain branching restrictions, since these restrictions protected them from larger and more efficient banking organizations. Technological innovations, such as the invention of the ATM and the reduction in transportation and communication costs, allowed firms to by-pass local banks, reducing the value to the protected banks of geographical restrictions. These technological innovations interacted with preexisting state-specific differences in the power of local banks to shape the timing of deregulation across states.

I set the date of deregulation as the date in which a state permitted branching via mergers and acquisitions through the holding company structure, which was the first step in the deregulation process. Appendix B reports the dates of intra-state branch deregulation. As can be seen, 15 states deregulated before the start of my sample period. Arkansas, Iowa, and Minnesota were the last states to deregulate.

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[9]I tried different threshold values for the index, between 0.6 and 0.8, and the results remain unchanged. All results presented are robust to using the original Abiad et al. (2010) reform index, which is continuous.

2.4.2   Wage inequality

Country-level data. The data on wage inequality comes from the EU-KLEMS dataset, a statistical and analytical research project financed by the European Commission. It provides industry-level information for a group of European countries, plus a few non-European ones, on capital, labor by skill level, and labor compensation by skill level. It is a panel spanning the 1970-2005 period. Fourteen countries in the database have information on capital, labor, and compensation by skill level, and thus can be included in the estimations of the skilled labor share equations. The 20 countries listed in the previous subsection have data on labor compensation by skill level and can be included in the estimation of the effect of financial liberalization on inequality. Finally, there are 15 two-digit ISIC Rev. 3 industries providing capital and labor compensation data, for which a skilled labor share equation can be estimated. The data includes both manufacturing and non-manufacturing industries. I exclude the financial services industry to focus only on the real sectors of the economy.

EU-KLEMS provides industry information on wages total hours worked by skill level (high, medium, and low). I define skilled labor as the labor force with some tertiary education (high skill level) and unskilled labor as the labor force with less than tertiary education (medium and low skill levels).

State-level data. I use the Merged Outgoing Rotation Groups (MORG) files of the Current Population Surveys (CPS) to obtain wage inequality data. The CPS is a monthly household survey conducted by the Bureau of Labor Statistics to measure labor force participation and employment, where 60,000 households per month across the U.S. are queried.

The sample period under study is 1979-2002. I include all wage workers with ages from 25 to 64. I use a consistent variable for years of education and assign workers a consistent CIC industry code using the concordance tables provided by Autor et al. (1998). Hourly wages are defined as reported hourly earnings for those paid by the hour and usual weekly earnings divided by hours worked last week for non-hourly workers. I define skilled workers as those with 13 or more years of completed education and unskilled workers as those with 12 or fewer years of education. All results are robust to dropping the top 1%, 5%, and 10% wage earners within the high-skill group. I aggregate the wages of all workers to the industry level by using an earnings weight that is equal to the product of the CPS sampling weight and hours worked in the prior week.

2.4.3 Financial dependence and complementarity indices

External financial dependence. The index is constructed using data from COMPU-STAT. Both capital expenditures and cash flow are summed up over the relevant time period (1975-2005) to compute the firm-level external financial measure. The industry-level index is then defined as the external financial dependence of the median firm for each industry.

Column (1) of table 2.1 depicts the external financial dependence measure for the 15 industries in the sample. As can be seen, there is substantial cross-industry variation in the index. The chemicals manufacturing industry presents the highest needs for external finance, while the wholesale trade industry presents the lowest financial needs.

[Include table 2.1 here]

Capital-skill complementary. Column (2) of table 2.1 reports the CSC index for each industry, together with its 95% confidence interval. CSC is statistically different from zero in all but one industry (hotels and restaurants).[10] Capital and skilled labor are relative complements in all industries except retail trade, which is consistent with the evidence of CSC at the aggregate level (Duffy et al., 2004). All manufacturing industries exhibit CSC, which is consistent with the fact that, on average, low-skilled workers are more easily substituted by capital in manufacturing than in services, since these workers conduct more routine tasks. The industry with strongest CSC is post and telecommunications. This finding is compatible with the fact that telecommunications is an industry highly intensive in skilled labor, where computer capital strongly complements skilled workers in carrying out non-routine tasks.

It is interesting to note that the EFD and CSC indices are statistically uncorrelated. The third column of table 2.1 shows the product between both indices. Industries with high values of this product (e.g. manufacturing of chemicals and post and telecommunications) should be affected disproportionally by financial liberalization.

Stability of indices. Finally, I calculated the EFD and CSC indices for different time periods and the resulting ranking of industries remain unchanged. The ranking also remain unchanged if I estimate the indices with only pre-reform data. These findings support the assumption that the two industry characteristics are technologically determined and are therefore not affected by the reforms.

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[10]For the majority of the estimations, I cannot reject the null hypothesis of no second-order serial correlation of the differenced residual (and hence no first-order serial correlation of the original residual), which validates the instruments used.

2.5   Reduced form results

2.5.1   Country-level results

I start by analyzing the effect of country-level financial liberalization on capital demand. For this, I estimate the following generalized difference-in-differences specification:

$$\log(k)_{cit} = \beta_1 D_{ct} \cdot EFD_i + \eta_{ct} + \eta_{ci} + \varepsilon_{cit}, \tag{2.4}$$

where k_{cit} denotes capital of country c in industry i in year t. D_{ct} is the financial liberalization dummy that equals one in the year the country liberalizes and onwards, and zero otherwise. The specification includes a full set of country×year and country×industry fixed effects.[11] The ability to employ a variety of fixed effects is a major strength of the empirical analysis. The use of fixed effects is particularly powerful in a three-dimensional panel, since it allows using interacted fixed effects, which enables controlling for a wide array of omitted variables. The standard errors of this and all country-level regressions are clustered at the country level and computed using block-bootstrapping.[12]

The coefficient of interest is β_1. Financial liberalization should increase capital demand particularly in industries with high financial needs, so I expect $\beta_1 > 0$. The coefficient is identified purely from the cross-industry variation within a country. The results are reported in column (1) of table 2.2. The double-interaction term is positive and highly significant at the 1% level. To interpret the magnitude of the result, note that the differential effect of the reform on two industries with different levels of financial dependence is $\beta_1(EFD_h - EFD_l)$. The point estimate implies that liberalizing financial markets increases capital demand in the 75th-percentile industry by financial dependence by 7% more than in the 25th-percentile industry.[13] The magnitude of this effect is sizable, because the standard deviation of country-level (log) capital after accounting for fixed effects

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[11]Country×year fixed effects absorb time-varying country characteristics, such as the overall level of development, growth, and country-wide reforms. Country×industry fixed effects capture the peculiar characteristics of each industry within each country. The results are robust to the inclusion of industry×year fixed effects joint with with either country×year or country×industry fixed effects. When I include all three sets of fixed effects simultaneously, the point estimates remain unchanged but the standard errors increase substantially because the large set of fixed effects soaks up most of the variation in inequality in the sample.

[12]Clustering at the country level yields standard errors that are consistent in the presence of any intraclass correlation across industries within a country and any serial correlation within a country across time (Bertrand et al., 2004). Since there are relatively few countries, I use block bootstrapping to get unbiased standard errors.

[13]The 75th and 25th-percentile industries by financial dependence are real estate activities and health and social work.

is 50%. Put differently, the differential effect explains 15% of the variation of capital in the sample.[14]

[Include table 2.2 here]

To analyze the effect of financial liberalization on wage inequality, I estimate the following generalized triple difference-in-differences specification:

$$\log(\omega)_{cit} = \beta_1 D_{ct} \cdot EFD_i + \beta_2 D_{ct} \cdot CSC_i + \beta_3 D_{ct} \cdot EFD_i \cdot CSC_i + \eta_{ct} + \eta_{ci} + \varepsilon_{cit} \quad (2.5)$$

The coefficient of interest is β_3. Financial liberalization should increase wage inequality disproportionally in industries with high financial needs and strong complementarity, so I expect $\beta_3 > 0$. The results of the estimation are reported in column (2) of table 2.2. The triple-interaction term is positive and highly significant at the 1% level. The differential effect of the policy on two industries with different levels of financial dependence and complementarity is $\beta_3(EFD_h - EFD_l)(CSC_h - CSC_l)$. Financial liberalization therefore increases wage inequality in the 75th-percentile industry by financial dependence and complementarity by 2.7% more than in the 25th-percentile industry.[15] The differential effect is large in magnitude, and accounts for 43% of the variation of country-level (log) wage inequality after accounting for fixed effects.

I also analyze the effect of the reform on relative labor, defined as the ratio of skilled to unskilled working hours. I re-estimate equation (2.5) using relative labor as the dependent variable. Results are reported in column (3) of table 2.2. As can be seen, even though the triple-interaction term is positive, it is estimated imprecisely and is not statistically different from zero. This result is consistent with the fact that my sample is composed of mostly European countries, which have rigid labor markets and therefore low industry labor mobility.

As discussed above, the effect on wage inequality across industries should be increasing in the degree of labor market rigidity. I study how my results vary according to different labor market institutions. I use the Botero et al. (2004) labor regulation index to measure country-level labor rigidity.[16] The index is the sum of four job-security variables: grounds for dismissal protection, protection regarding dismissal procedures, notice and severance payments, and protection of employment. The index is reported in Appendix B. Some

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[14]The bottom lines of all tables show the differential effect across industries and the fraction of the variation of the dependent variable that this differential effect can explain.

[15]The 75th and 25th-percentile industries by the product between financial dependence and CSC are manufacturing of coke products and retail trade.

[16]The results are robust to using different labor rigidity indices, such as the Forteza and Rama (2006) index.

countries have quite rigid labor markets (e.g. France and Portugal) while others more flexible labor markets (e.g. U.K. and Ireland).

I divide the sample into countries with labor rigidity above and below the median of the index across all countries. The dispersion of wage inequality across industries is higher in the subset of countries with high labor rigidity, which is consistent with the idea that more rigidity is associated with less industry mobility.[17] I then re-estimate equation (2.5) for each group of countries separately. The results are reported in columns (1) and (2) of table 2.3. While the effect on inequality in both groups is significant, the magnitude of the effect for high-rigidity countries is almost twice as large as that for low-rigidity countries. I nest both estimations in one single estimation and reject the hypothesis of equal coefficients across country groups at the 10% level.

[Include table 2.3 here]

Next, I conduct the same exercise as above except for relative labor. Columns (3) and (4) of table 2.3. As can be seen, the triple-interaction coefficient is not statistically different from zero in countries with high labor rigidity, while in countries with low rigidity it is high in magnitude and statistically significant. A test of equality of coefficients across country groups is strongly rejected at the 1% level. Summing up, the results show that in high-rigidity countries the adjustment to the reform is done primarily through relative wages, whereas in countries with flexible labor markets the adjustment is done through relative quantities.

2.5.2 State-level results

I do not analyze the effect of bank deregulation on capital demand since I lack data on U.S. physical capital at the industry level. However, Cetorelli and Strahan (2006) have shown that bank deregulation in the U.S. increased the number of establishments, and hence capital demand, particularly in industries dependent on external finance.

To analyze the effect of state-level deregulation on wage inequality, I estimate a generalized triple difference-in-differences specification:

$$\log(\omega)_{sit} = \beta_1 D_{st} \cdot EFD_i + \beta_2 D_{st} \cdot CSC_i + \beta_3 D_{st} \cdot EFD_i \cdot CSC_i + \eta_{st} + \eta_{si} + \varepsilon_{sit}, \ (2.6)$$

where ω_{sit} denotes wage inequality of state s in industry i in year t. D_{st} is the banking deregulation dummy that equals one in the year state s deregulates and onwards, and

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[17]In 1995, the standard deviation of (log) wage inequality across industries in the group of countries above the median was 22% higher than for the group below the median.

zero otherwise. The estimation includes state×year and state×industry fixed effects. The standard errors of all state-level regressions are clustered at the state level.

The results are shown in column (1) of table 2.4. The triple-interaction term is positive and significant at the 10% level. According to the point estimate, banking deregulation increases inequality in the 75th-percentile by financial dependence and CSC by 1% more than in the 25th-percentile industry. This differential effect explains 10% of the variation in state-level (log) wage inequality after accounting for fixed effects. Note that the fraction of variation of state-level inequality explained by deregulation is lower than what was found in the country-level analysis. This is consistent with the fact that the U.S. has relatively mode flexible labor markets. Column (2) of table 2.4 shows the results of estimating equation (2.6) using relative labor as the dependent variable. The effect of deregulation on relative labor, unlike what was found in the country-level analysis, is now highly significant and large in magnitude. The differential effect across industries is 1.5%, which accounts for roughly 20% of the variation in relative labor after controlling for fixed effects. Hence, the adjustment of the U.S. labor market to the banking reforms is done through both relative wages and relative quantities.

[Include table 2.4 here]

Even though the U.S. is a country with flexible labor markets when compared to Europe, there is still heterogeneity in labor institutions across states. One particular law that varies across states is the right to work law (RTW). A RTW law guarantees that no person can be compelled, as a condition of employment, to join or pay dues to a labor union. These statutes are enforced in twenty-two U.S. states (mainly from the South), allowed under provisions of the Taft-Hartley Act. Given that there are union wage differentials across workers within an industry and union membership varies across industries, relative wage differentials are expected to prevail more in states with more unionization. Since the evidence shows that RTW laws strongly reduce the extent of unionization (Moore, 1998), I use these laws as a proxy for labor market flexibility.[18]

I divide the sample into the states that don't have RTW laws and the ones that do and re-estimate equation (2.6) for each of the two subsamples. Results are reported in table 2.5. As can be observed from columns (1) and (2), the effect of deregulation is large and significant for the no-RTW states, while it is not statistically different from zero for the RTW states. Even though the point estimate is 40% larger for the states with no RTW laws, I cannot reject the hypothesis of equal coefficients across both groups of

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[18]In 1995, the standard deviation of (log) wage inequality across industries in states with no RTW laws was 12% higher than in states with those laws, which is consistent with the no-RTW states having less labor mobility across industries.

states. Columns (3) and (4) repeat the analysis for relative labor. The effect is large and significant for the RTW states, whereas the triple-interaction coefficient is not statistically different from zero for the no-RTW states. A test of equality of coefficients across both groups is strongly rejected at the 1%.

[Include table 2.5 here]

2.6 Additional empirical results

2.6.1 Dynamics

Next, I examine the dynamics of the relationship between country-level financial liberalization and wage inequality. I include a series of dummy variables in regression (2.5) to trace out the year-by-year effects of liberalization on inequality:[19]

$$\log(\omega)_{cit} = \sum_{j \in \mathcal{J}} \beta_1^j D_{ct}^{j-11} \cdot EFD_i + \sum_{j \in \mathcal{J}} \beta_2^j D_{ct}^{j-11} \cdot CSC_i + \sum_{j \in \mathcal{J}} \beta_3^j D_{ct}^{j-11} \cdot EFD_i \cdot CSC_i + \eta_{ct} + \eta_{ci} + \varepsilon_{cit},$$

where $\mathcal{J} = \{1, \ldots, 26\} \setminus \{11\}$ and the liberalization dummies equal zero, except as follows: D^{-j} equals one for countries in the jth year before liberalization, while D^{+j} equals one for countries in the jth year after liberalization. I exclude the year of liberalization, thus estimating the dynamic effect on inequality relative to the year of liberalization. Figure 2.2 plots the series of coefficients $\{\beta_3^j\}_{j \in \mathcal{J}}$ and the corresponding 95% confidence intervals after centering the estimates on the year of the reform. As can be seen, innovations in wage inequality did not precede liberalization, since the coefficients on the liberalization dummies are not significantly different from zero before the reform. The impact on inequality materializes after the third year of the reform. Finally, the effect shows strong persistence, growing for about six years after liberalization, then leveling off, and finally starting to dissipate after 13 years. Thus, even though the differential effect of the policy should disappear in the very long run, there is a very persistent effect during the transition.

[Include figure 2.2 here]

2.6.2 College enrollment

Until now, I have implicitly assumed that the aggregate supply of both types of labor is inelastic. However, if financial liberalization leads to higher wage inequality, higher

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[19]See Beck et al. (2010) for a similar exercise.

education should increase as the result of agents taking advantage of the higher returns to skill. In the previous section I estimated the differential effect of financial liberalization on inequality across industries. Given that countries and states differ in their industrial composition, the effect of the reform on aggregate inequality will differ as well. As a result, higher education should increase particularly in countries and states with a large proportion of production in the industries that are most affected by the reform.

To test this hypothesis, I create an aggregate index indicating the exposure of a country or a state to the industries most affected by the reform. I define the exposure index as a weighted average of the product of both sectoral indices, i.e. $Exp_m = \sum_i \overline{\omega}_{im} \cdot (EFD_i \cdot CSC_i)$ for $m \in \{c, s\}$. Here $\overline{\omega}_{ic}$ ($\overline{\omega}_{is}$) denotes the average share of production of industry i in overall production of country c (state s). The index will achieve its maximum value if all production is allocated to the industry with the highest combination of financial needs and CSC (post and telecommunications).

I estimate the effect of financial liberalization on college enrollment using a generalized difference-in-differences specification:

$$\log(E)_{mt} = \beta_1 D_{mt} + \beta_2 D_{mt} \cdot Exp_m + \eta_m + \eta_t + \varepsilon_{mt} \quad \text{for} \quad m \in \{c, s\}, \qquad (2.7)$$

where E_{ct} (E_{st}) denotes college enrollment of country c (state s) in year t. The coefficient of interest is β_2, which is identified from the cross-country (cross-state) variation in financial liberalization. I expected that $\beta_2 > 0$.

The results for the country-level analysis are shown in column (1) of table 2.6. As can be seen, the interaction term is large and significant at the 5% level. The estimate implies that liberalizing financial markets increases college enrollment in the 75th-percentile country by exposure index (Germany) by 7% more than in the 25th-percentile country (Poland). In other words, financial liberalization explains about 15% of the variation of country-level (log) college enrollment after controlling for fixed effects. Column (2) shows the results for the case of U.S. bank deregulation. The effect is also positive and significant. According to the results, college enrollment in a deregulating state at the 75th-percentile of the exposure index (Texas) increases by 3% more than a state at the 25th-percentile (South Carolina). This means that deregulation explains 40% of the variation of state-level (log) college enrollment after controlling for fixed effects.

[Include table 2.6 here]

Given that this analysis has been conducted at the aggregate level, instead of exploiting differences across industries, the results should not be necessarily given a causal interpretation. Nevertheless, they are consistent with the idea that financial liberalization is increasing the returns to skill, and agents are taking advantage of this by increasing college attendance.

2.6.3 Contract enforcement

To further support the results found in the paper, I analyze how the effect of financial liberalization on wage inequality varies according to a country's contracting institutions. Since financial liberalization increases financial depth particularly in countries with solid contracting institutions (Galindo et al., 2002), the effect on inequality should be increasing in contract enforcement strength.

I use the index created by Djankov et al. (2008) as a measure of country-level debt enforcement. Insolvency practitioners from several countries describe how debt enforcement proceeds against an identical firm about to default on its debt.[20] Appendix B reports the index for my sample of countries.

I divide the sample into countries with the enforcement index above and below the median of the index across all countries. I then re-estimate equation (2.5) for each of the two sub-samples. The results are reported in columns (1) and (2) of table 2.7. While the triple interaction term is highly significant for the group of high-enforcement countries (column (1)), it is not significant for the low-enforcement group (column (2)). The coefficients of both sub-samples are statistically different from each other. The evidence is thus consistent with financial liberalization being complementary to contract enforcement institutions.

[Include table 2.7 here]

2.6.4 Endogeneity

As explained in subsection 2.3.1, a potential threat to identification would be that other policies concurrent to financial liberalization could be driving the results. To be a real threat, these potential confounding factors would necessarily have to increase inequality exclusively in the subset of industries with both high financial needs and strong complementarity. In this section I argue that this is highly unlikely.

Consider first consider skilled-biased technological change (SBTC). SBTC is a shift in the production technology that favors skilled relative to unskilled labor by increasing its relative productivity. Since SBTC increases the relative demand for skilled labor, it should also increase wage inequality. The effect might be particularly strong in industries with high CSC. Nevertheless, there is not reason to expect that the effect should be disproportionally large in industries heavily dependent on external finance. Moreover, the

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[20]The authors use the data on time, cost, and the likely disposition of the assets to construct a measure of the efficiency of debt enforcement in each country.

effect of SBTC on inequality is expected to be independent of the level of debt enforcement of an economy. As a result, the finding that the effect of the reform on inequality is increasing in the level of enforcement is inconsistent with SBTC causing the rise in inequality.

I next analyze trade liberalization. According to the Stolper-Samuelson Theorem, trade opening increases the relative price of a country's abundant factor. Given that most countries in my sample are skill-abundant, one concern is that simultaneous changes in trade policy might be increasing the relative wage of skilled labor. However, there is no evidence that the tariffs were reduced particularly in industries with high needs for external finance and strong complementarity. Furthermore, even though the countries in my sample have made some free-trade agreements in the last three decades, the bulk of tariff and non-tariff reductions took place at least a decade before financial deregulation (Wacziarg and Welch, 2008).

Outsorcing, which means the import of intermediate inputs by domestic firms, can also contribute to the increase in wage inequality. If firms respond to import competition from low-wage countries by moving unskilled-intensive activities abroad, then trade can lead to an increase in the relative demand for skilled workers in developed economies. However, the industries that show the highest propensity to outsorce are not the ones that exhibit both high financial needs and strong CSC (Feenstra and Hanson, 1996).

I also consider changes in creditor rights. When a country improves the laws that protect the legal right of investors, savers are more willing to finance firms and thus financial markets flourish. This could increase wage inequality in industries with high finance needs and strong CSC and present a threat to my identification. To deal with this issue, I explicitly control for these reforms by using the time-varying creditor rights index developed by Djankov et al. (2007). I add to regression (2.5) a triple-interaction term between the creditor rights reforms and the two sectoral indices (plus the two-way interaction terms). The results are shown in column (3) of table 2.7. The triple-interaction term corresponding to creditor rights reforms is not statistically different from zero and the triple-interaction term corresponding to financial liberalization remains unchanged.

Finally, another threat to identification is that a third factor that increases inequality could be triggering the decision to deregulate. In the case of the state-level reforms, this factor could be a technological shock that improved telecommunications; for the country-level reforms, it could be a balance of payment crisis. In either case, while these shocks could increase wage inequality, there is no reason to expect that inequality increased exclusively in the subset of industries with both high financial needs and strong complementarity.

2.6.5   Robustness checks

I also conduct a series of robustness checks to analyze the validity of my results. First, instead of using the original industry indices (which are continuous) I use binary indices, which impose less structure for the estimating equation (2.5). In particular, I re-define the external financial dependence and CSC index as binary variables that are equal to one if the original index is above the median of the index across all industries and zero otherwise. The treatment group now consists of industries with both indices above their respective median values; the remaining industries make up the control group. Results are presented in column (1) of table 2.8. The triple interaction remains significant at the 1% level. The reform increases inequality in the treatment group by 4% more than in the control group.

[Include table 2.8 here]

Second, I use an alternative industry measure of financial vulnerability. As argued by Braun (2003) and Claessens and Laeven (2003), firms might find it easier to raise outside capital in industries that employ more tangible assets that can serve as collateral. These papers construct an industry asset tangibility index as the share of net plant, property, and equipment in total assets for the median publicly-traded firm in an industry in the U.S.[21] The results are shown in column (2) of table 2.8. The triple-interaction term is negative and significant at the 1% level. This means that a financial reform increases inequality particularly in industries with low asset tangibility and strong CSC, as expected.

Next, I use the original Abiad et al. (2010) financial liberalization index, which is a continuous measure of reform, as opposed to the binary measure used in the main part of the paper. As can be seen in column (3) of table 2.8, the triple-interaction term remains positive, large, and highly significant at the 1% level. In addition, I use an alternative financial reform index, developed by Kaminsky and Schmukler (2008). The index has been used previously to study the effects of financial liberalization on economic growth (Levchenko et al., 2009). It is the composite of three subcomponents: liberalization in the stock market, the banking system, and freedom of international transactions. Using this reform index reduces the sample to 12 countries. Results are shown in column (4) of table 2.8. Again, the triple-interaction term remains positive and significant at the 1% level. The magnitude of the effect actually increases by 40%.

Finally, I analyze whether the results change if I modify the composition of countries in the sample. To study a more homogenous group of countries, I focus only on European

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[21]Using COMPUSTAT data, I extend the index to include both manufacturing and non-manufacturing industries.

countries, excluding Australia, Korea, and Japan from the analysis. The results are shown in column (5) of table 2.8. The effect remains highly significant and the magnitude does not change.

2.7   Conclusions

The development of financial markets can affect both economic growth and income inequality. While economists have studied thoroughly the effects of financial sector policies on growth, the potentially enormous impact of such policies on inequality has been under appreciated. As documented by Demirguc-Kunt and Levine (2009), the three volumes of the *Handbook of Income Distribution* do not mention any possible connections between inequality and formal financial sector policies. In this essay, I argue that the deregulation of financial markets has contributed to the rise in wage inequality observed in the last three decades in several developed countries.

I focus on a particular mechanism through which improvements in financial markets can affect wage inequality. According to theory, financial liberalization reduces borrowing constraints and increases capital demand. If capital and skilled labor are relative complements, the relative demand for skilled labor should increase, enlarging the wage gap between skilled and unskilled workers in equilibrium. The higher the extent of financial needs and the higher the degree of CSC, the stronger the effect on inequality. The effect should be particularly strong in industries with both high needs for external finance and strong complementarity. I rank industries in these two dimensions by using a standard measure of financial needs and constructing a novel measure of the industry-level degree of CSC. I then analyze the differential effect of liberalization on inequality across industries.

I focus on two distinct episodes of financial liberalization: country-level financial deregulation across a large group of countries and state-level bank deregulation across states in the U.S. I find that, in both episodes, liberalization led to a disproportional increase of wage inequality in industries with high financial needs and strong CSC. I also find that while the differential effect on relative wages is increasing in labor market rigidity, the differential effect on relative labor flows is increasing in labor flexibility.

This essay contributes to a broader research agenda seeking to understand the relationship between finance and inequality. In this particular work, I have focused on the effects of a permanent improvement of financial markets on inequality. For future work, it could be interesting to analyze the distributional consequences of a transitory deterioration of financial markets, like for example a financial crisis. This would improve our knowledge of the finance and inequality nexus at both low and high frequencies.

In this research, I have analyzed the effect of financial liberalization on wage inequality

by focusing on changes on the relative demand for skilled labor. However, if investment in human capital is subject to borrowing constraints, financial development might ease these constraints as well (Galor and Zeira, 1993). This could lead to an increase in the relative supply of skilled labor, which could drive wage inequality down. While there is abundant evidence that financial liberalization alleviates borrowing constraints for physical capital investment (Laeven, 2003; Correa, 2008), there is no equivalent evidence for human capital investment. Nevertheless, the joint analysis of these two effects could lead to interesting results and is left for future research.

Finally, in this essay I have analyzed only one dimension of income inequality, namely the wage difference between skilled and unskilled workers. Financial liberalization can have different effects on other dimensions of inequality, such as on inequality of opportunities or on intergenerational persistence of relative income differences. Analyzing the effects of financial reform on these different dimensions of inequality could represent an interesting opportunity for further research.

Figure 2.1: Financial liberalization and wage inequality in a cross-section of countries and in the U.S. time series

(a) State of financial liberalization and wage inequality in a cross-section of countries
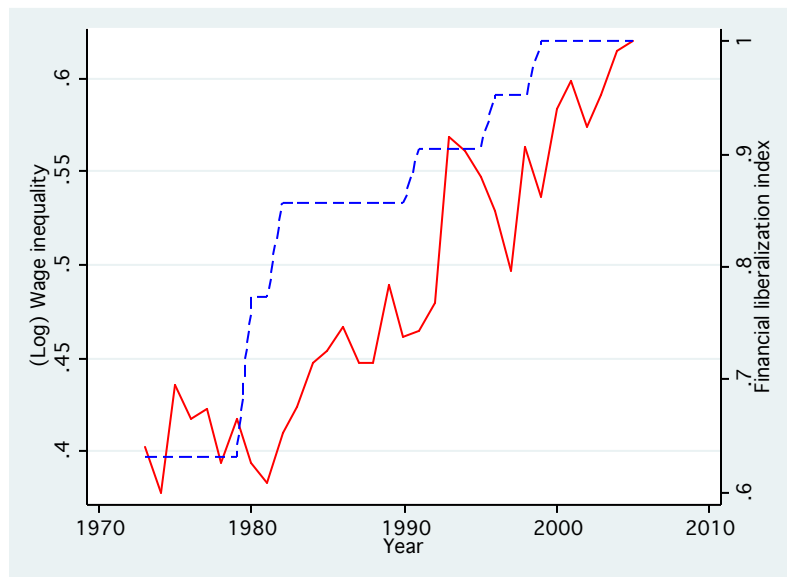
(b) Dynamics of financial liberalization and wage inequality in the U.S. (Solid line: wage inequality, dashed line: financial liberalization)

Notes: Panel (a) plots the relationship between the state of financial liberalization and wage inequality in a cross-section of 44 countries in 1990. Wage inequality is measured as the residual of an OLS regression between the (log) relative wage of skilled to unskilled labor and country income group (high, medium-high, medium-low, low). Source: own calculations based on data from Caselli and Coleman (2006) and Abiad et al. (2010). Panel (b) plots the evolution of financial liberalization and wage inequality in the U.S. during the 1975-2005 period. Source: own calculations based on data from EU-KLEMS and Abiad et al. (2010).

Figure 2.2: Dynamic effect of country-level financial liberalization on wage inequality
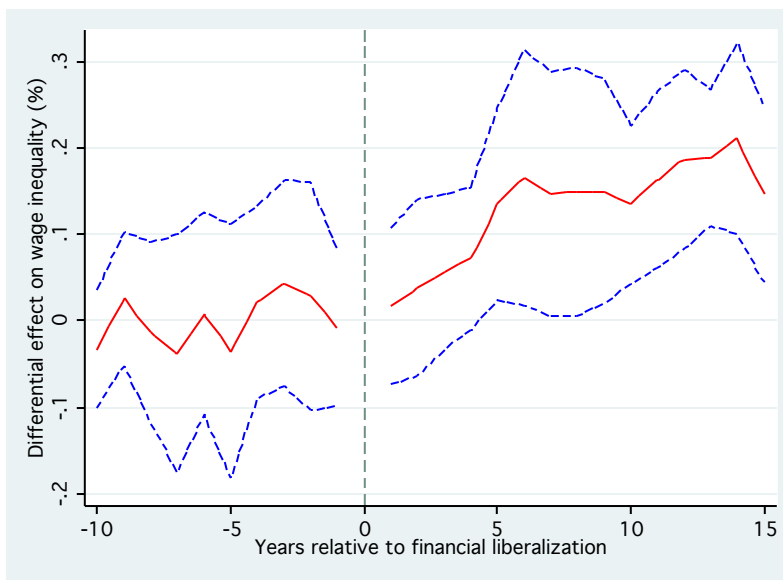
Notes: the figure plots the dynamic impact of country-level financial liberalization on wage inequality. A 25-year window is considered, spanning from 10 years before liberalization until 15 years after liberalization. The dashed lines represent 95% confidence intervals. Source: own calculations.

Table 2.1: External financial dependence and capital-skill complementarity indices

		(1)	(2)		(3)
Industry	ISIC	EFD index	CSC index	[95% C.I.]	EFD·CSC index
Manuf. of wood	20	0.036	0.212	[0.137 , 0.288]	0.008
Manuf. of coke, refined petroleum	23	0.486	0.147	[0.099 , 0.195]	0.071
Manuf. of chemicals	24	1.726	0.313	[0.221 , 0.405]	0.540
Manuf. of rubber, plastics	25	0.011	0.464	[0.369 , 0.559]	0.005
Manuf. of other non-met. mineral prod.	26	-0.045	0.300	[0.221 , 0.380]	-0.014
Manuf. of machinery and equipment	29	-0.059	0.303	[0.237 , 0.370]	-0.018
Construction	45	-0.092	0.266	[0.166 , 0.366]	-0.024
Wholesale trade and commission trade	51	-0.308	0.330	[0.229 , 0.432]	-0.102
Retail trade, except of motor vehicles	52	0.130	-0.220	[-0.306 , -0.13]	-0.029
Hotels and restaurants	55	0.399	-0.017	[-0.112 , 0.07]	-0.007
Post and telecommunications	64	0.679	0.956	[0.804 , 1.108]	0.649
Real estate activities	70	0.312	0.243	[0.088 , 0.399]	0.076
Education	80	-0.295	0.073	[0.040 , 0.105]	-0.022
Health and social work	85	-0.127	0.077	[0.024 , 0.130]	-0.010

Notes: the table reports the external financial dependence index (column (1)), the capital-skill complementarity index with its 95% confidence interval (column (2)), and the product of both indices (column (3)), for the 15 industries in the sample. Financial dependence is defined as the fraction of capital expenditures not financed by cash flow from operations (Rajan and Zingales, 1998). Complementarity is defined as the elasticity of the share of skilled labor in the wage bill to capital intensity (see equation (2.2)).

Table 2.2: Effect of country-level financial liberalization on capital, wage inequality, and relative labor

	(1) Capital	(2) Wage inequality	(3) Relative labor
Financial liberalization · EFD	0.184***	-0.086***	0.013
	(0.065)	(0.021)	(0.078)
Financial liberalization · CSC		-0.015	0.311**
		(0.024)	(0.138)
Financial liberalization · EFD · CSC		0.171***	0.181
		(0.038)	(0.280)
Differential effect across industries	7.36%	2.74%	0.00%
Fraction of variation explained	14.72%	43.43%	0.00%
Country×year fixed effects	yes	yes	yes
Country×industry fixed effects	yes	yes	yes
Observations	5,100	6,975	6,975
R-squared	0.449	0.940	0.979

Notes: the table presents the estimates of the effect of country-level financial liberalization on capital (column (1)), wage inequality (column (2)), and relative labor (column (3)). EFD stands for external financial dependence and CSC for capital-skill complementarity. The differential effect measures the relative impact of the reform on industries at the 75th and 25th-percentile of the EFD index (column (1)) and at the 75th and 25th-percentile of the product between the EFD and CSC indices (columns (2) and (3)). The fraction of variation explained is the ratio between the differential effect across industries and the standard deviation of the (log) dependent variable, after controlling for fixed effects. Standard errors in parentheses are clustered at the country level using block-bootstrapping. ***, **, * denote statistical significance at 1%, 5%, and 10%.

Table 2.3: Labor market rigidity and the effect of country-level reforms on wage inequality and relative labor

	—— Wage inequality ——		—— Relative labor ——	
	(1) High rigidity countries	(2) Low rigidity countries	(3) High rigidity countries	(4) Low rigidity countries
Financial liberalization · EFD	-0.107***	-0.062***	0.166*	-0.159**
	(0.035)	(0.015)	(0.093)	(0.077)
Financial liberalization · CSC	-0.007	-0.023***	0.473**	0.130*
	(0.046)	(0.007)	(0.210)	(0.076)
Financial liberalization · EFD · CSC	0.215***	0.122***	-0.372	0.797***
	(0.059)	(0.035)	(0.285)	(0.306)
Differential effect across industries	3.44%	1.95%	0.00%	12.75%
Fraction of variation explained	54.60%	30.98%	0.00%	68.56%
Country×year fixed effects	yes	yes	yes	yes
Country×industry fixed effects	yes	yes	yes	yes
Observations	3,540	3,435	3,540	3,435
R-squared	0.935	0.947	0.978	0.979

Notes: the table presents the estimates of the effect of country-level financial liberalization on wage inequality (columns (1) and (2)) and relative labor (columns (3) and (4)) for the subsample of countries with high labor rigidity (columns (1) and (3)) and low labor rigidity (columns (2) and (4)). EFD stands for external financial dependence and CSC for capital-skill complementarity. The differential effect measures the relative impact of the reform on industries at the 75th and 25th-percentile of the product between the EFD and CSC indices. The fraction of variation explained is the ratio between the differential effect across industries and the standard deviation of the (log) dependent variable, after controlling for fixed effects. Standard errors in parentheses are clustered at the country level using block-bootstrapping. ***, **, * denote statistical significance at 1%, 5%, and 10%.

Table 2.4: Effect of state-level bank deregulation on wage inequality and relative labor

	(1) Wage inequality	(2) Relative labor
Bank deregulation · EFD	-0.014	-0.073***
	(0.021)	(0.020)
Bank deregulation · CSC	-0.015	-0.132***
	(0.012)	(0.010)
Bank deregulation · EFD · CSC	0.054*	0.096***
	(0.031)	(0.030)
Differential effect across industries	0.96%	1.54%
Fraction of variation explained	9.65%	19.20%
State×year fixed effects	yes	yes
State×industry fixed effects	yes	yes
Observations	15,401	15,401
R-squared	0.340	0.295

Notes: the table presents the estimates of the effect of bank branch deregulation in the U.S. on wage inequality (column (1)) and relative labor (column (2)). EFD stands for external financial dependence and CSC for capital-skill complementarity. The differential effect measures the relative impact of the reform on industries at the 75th and 25th-percentile of the product between the EFD and CSC indices The fraction of variation explained is the ratio between the differential effect across industries and the standard deviation of the (log) dependent variable, after controlling for fixed effects. Standard errors in parentheses are clustered at the state level. ***, **, * denote statistical significance at 1%, 5%, and 10%, respectively.

Table 2.5: Right-to-work laws and the effect of state-level reforms on wage inequality and relative labor

	—— Wage inequality ——		—— Relative labor ——	
	(1)	(2)	(3)	(4)
	No RTW	RTW	No RTW	RTW
	states	states	states	states
Bank deregulation · EFD	-0.016	0.002	0.248	-0.080
	(0.023)	(0.024)	(0.165)	(0.075)
Bank deregulation · CSC	-0.004	0.010	-0.214*	-0.058
	(0.014)	(0.013)	(0.118)	(0.039)
Bank deregulation · EFD · CSC	0.060*	0.044	-0.253	0.150**
	(0.035)	(0.036)	(0.159)	(0.072)
Differential effect across industries	0.96%	0.00%	0.00%	2.40%
Fraction of variation explained	7.38%	0.00%	0.00%	30.00%
State×year fixed effects	yes	yes	yes	yes
State×industry fixed effects	yes	yes	yes	yes
Observations	8,775	6,626	8,775	6,626
R-squared	0.265	0.256	0.300	0.141

Notes: the table presents the estimates of the effect of bank branch deregulation in the U.S. on wage inequality (columns (1) and (2)) and relative labor (columns (3) and (4)) for the subsample of states with no right-to-work laws (columns (1) and (3)) and those with right-to-work laws (columns (2) and (4)). EFD stands for external financial dependence and CSC for capital-skill complementarity. The differential effect measures the relative impact of the reform on industries at the 75th and 25th-percentile of the product between the EFD and CSC indices The fraction of variation explained is the ratio between the differential effect across industries and the standard deviation of the (log) dependent variable, after controlling for fixed effects. Standard errors in parentheses are clustered at the state level. ***, **, * denote statistical significance at 1%, 5%, and 10%.

Table 2.6: Effect of country-level and state-level reforms on college enrollment

	(1) Country-level analysis	(2) State-level analysis
Financial deregulation	0.079	-0.014
	(0.051)	(0.019)
Financial deregulation · Exposure	2.871**	0.534*
	(1.424)	(0.291)
Differential effect across countries	7.36%	2.70%
Fraction of variation explained	14.72%	39.70%
Country (state) fixed effects	yes	yes
Year fixed effects	yes	yes
Observations	352	1,127
R-squared	0.905	0.944

Notes: the table presents the estimates of the effect of country-level financial liberalization (column (1)) and state-level bank deregulation (column (2)) on aggregate college enrollment. Exposure denotes the share of production allocated to industries with high needs for finance and strong complementarity. The differential effect measures the relative impact of the reform on countries at the 75th and 25th-percentile of the exposure index. The fraction of variation explained is the ratio between the differential effect across countries and the standard deviation of (log) enrollment, after controlling for fixed effects. Standard errors in parentheses are clustered at the country (column (1)) and state (column (2)) level. ***, **, * denote statistical significance at 1%, 5%, and 10%.

Table 2.7: Effect of country-level financial liberalization on wage inequality, additional results

	(1) High enforcement countries	(2) Low enforcement countries	(3) Controlling creditor rights reforms
Financial liberalization · EFD	-0.070***	-0.103*	-0.082***
	(0.018)	(0.052)	(0.025)
Financial liberalization · CSC	-0.009	-0.081*	-0.017
	(0.015)	(0.038)	(0.027)
Financial liberalization · EFD · CSC	0.162***	0.215	0.166***
	(0.042)	(0.174)	(0.044)
Creditor rights reforms · EFD			0.020
			(0.013)
Creditor rights reforms · CSC			-0.011
			(0.035)
Creditor rights reforms · EFD · CSC			-0.025
			(0.062)
Differential effect across industries	2.59%	0.00%	2.66%
Fraction of variation explained	41.14%	0.00%	42.16%
Country×year fixed effects	yes	yes	yes
Country×industry fixed effects	yes	yes	yes
Observations	3990	2985	6975
R-squared	0.935	0.774	0.940

Notes: the table presents additional results for the relationship between country-level financial liberalization and wage inequality. Column (1) includes the subsample of countries with high debt enforcement, column (2) includes countries with low enforcement, and column (3) controls for creditor rights reforms. EFD stands for external financial dependence and CSC for capital-skill complementarity. The differential effect measures the relative impact of the reform on industries at the 75th and 25th-percentile of the product between the EFD and CSC indices. The fraction of variation explained is the ratio between the differential effect across industries and the standard deviation of (log) wage inequality, after controlling for fixed effects. Standard errors in parentheses are clustered at the country level using block-bootstrapping. ***, **, * denote statistical significance at 1%, 5%, and 10%.

Table 2.8: Effect of country-level financial liberalization on wage inequality, robustness checks

	(1) Binary indices	(2) Asset tangibility	(3) Continuous reform	(4) Kaminsky-Schmukler reform	(5) European countries
Fin Lib · EFD_{Bin}	-0.057*** (0.010)				
Fin Lib · CSC_{Bin}	-0.039*** (0.008)				
Fin Lib · EFD_{Bin} · CSC_{Bin}	0.042*** (0.010)				
Fin Lib · Tang		-0.049*** (0.014)			
Fin Lib · CSC		0.073*** (0.021)			-0.012 (0.034)
Fin Lib · EFD · Tang		-0.367*** (0.079)			
Fin Lib_{Cont} · EFD			-0.243*** (0.042)		
Fin Lib_{Cont} · CSC			-0.030 (0.019)		
Fin Lib_{Cont} · EFD · CSC			0.205*** (0.042)		
Fin Lib_{KS} · EFD				-0.117*** (0.030)	
Fin Lib_{KS} · CSC				-0.005 (0.042)	
Fin Lib_{KS} · EFD · CSC				0.248*** (0.040)	
Fin Lib · EFD					-0.094*** (0.028)
Fin Lib · EFD · CSC					0.178*** (0.050)
Country×year fixed effects	yes	yes	yes	yes	yes
Country×industry fixed effects	yes	yes	yes	yes	yes
Observations	6975	6975	6480	4725	5625
R-squared	0.939	0.939	0.946	0.926	0.942

Notes: the table reports robustness checks for the relationship between country-level financial liberalization and wage inequality. Column (1) uses binary definitions of industry indices, column (2) uses asset tangibility as the industry index of financial vulnerability, column (3) uses the original continuous Abiad et al. (2010) reform index, column (4) uses the Kaminsky and Schmukler (2008) reform index, and column (5) includes only European countries. Standard errors in parentheses are clustered at the country level using block-bootstrapping. ***, **, * denote statistical significance at 1%, 5%, and 10%.

Appendix A Derivation of skilled share equation

Assuming that capital is a quasi-fixed factor, the variable cost function of an industry is defined as $c = w_s s + w_u u$. The log of the variable cost function can be approximated to a Translog function by taking a second order Taylor expansion in the logs of output and inputs, yielding:

$$
\begin{aligned}
\log(c) &= \alpha_s \log(w_s) + \alpha_u \log(w_u) + \alpha_k \log(k) + \alpha_y \log(y) + 1/2[\gamma_{ss} \log(w_s)^2 + \gamma_{su} \log(w_s) \log(w_u) \\
&+ \gamma_{us} \log(w_u) \log(w_s) + \gamma_{uu} \log(w_u)^2 + \gamma_{kk} \log(k)^2 + \gamma_{yy} \log(y)^2] + \gamma_{sk} \log(w_s) \log(k) \\
&+ \gamma_{uk} \log(w_u) \log(k) + \gamma_{sy} \log(w_s) \log(y) + \gamma_{uy} \log(w_u) \log(y) + \gamma_{ky} \log(k) \log(y) \quad (2.8)
\end{aligned}
$$

Due to cost minimizing, the conditional demand for skilled labor can be written using Shepard's Lemma as $s = \frac{\partial c}{\partial w_s}$. It then follows that the share of skilled labor in the variable cost function (i.e. wage bill) can be derived as follows:

$$
\mathcal{S} = \frac{w_s s}{c} = \frac{\partial \log(c)}{\partial \log(w_s)} \quad (2.9)
$$

Combining equations (2.8) and (2.9) yields the share of skilled labor in the variable cost function as:

$$
\mathcal{S} = \alpha_s + \gamma_{ss} \log(w_s) + \gamma_{su} \log(w_u) + \gamma_{sk} \log(k) + \gamma_{sy} \log(y)
$$

Linear homogeneity in input prices means that for a fixed level of output total cost increases proportionally when all prices increase proportionally. As a result, $\gamma_{ss} + \gamma_{su} = 0$. Constant returns to scale, on the other hand, implies that $\gamma_{sk} + \gamma_{sy} = 0$. The imposition of linear homogeneity and constant returns to scale yields equation (2.1) of the main text.

Appendix B Data details

Countries in sample: Australia, Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Korea, Netherlands, Poland, Portugal, Spain, Sweden, and U.K.

States in sample: All states except Delaware and South Dakota. Consistent with the literature, I drop these states because the structure of their banking systems was heavily affected by laws that made them centers for the credit card industry.

Countries included in CSC estimation: Australia, Austria, Czech Republic, Denmark, Finland, Germany, Italy, Japan, Korea, Netherlands, Portugal, Slovenia, Sweden, and U.K.

Industries in sample: Manufacturing of wood, manufacturing of coke and refined petroleum, manufacturing of chemicals, manufacturing of rubber and plastics, manufacturing of other non-metallic mineral products, manufacturing of machinery and equipment, construction, sale-maintenance-repair motor vehicles, wholesale trade and commission trade, retail trade, hotels

and restaurants, post and telecommunications, real estate activities, education, and health and social work.

Skill levels country-level analysis: Skill levels are defined according to the ISCED one-digit classification. Low skill corresponds to primary or lower secondary education (ISCED 1 or 2), medium skill to upper secondary education (ISCED 3 or 4), and high skill to tertiary education (ISCED 5 or 6).

Time coverage state-level analysis: The coverage begins in 1977 because prior to this year it is difficult to identify state of residence in the data. It ends in 2002 because the composition of industries changed substantially in this year, so any comparison of industries before and after this date is not possible without major adjustments.

Industry classification: I use the ISIC Rev. 3 industry classification of EU-KLEMS. I use standard concordance tables to match the CIC classification used in CPS with the ISIC Rev. 3 classification. I also use standard concordance tables to match the NAICS 1997 classification of COMPUSTAT with the ISIC Rev. 3 classification.

External financial dependence in COMPUSTAT: Capital expenditures correspond to line #128 . Cash flow from operations is defined as cash flow from operations plus changes in payables minus changes in receivables plus changes in inventories, and is computed as the sum of lines #123, 125, 126, 106, 213, and 217, for format code 7.

Higher education enrollment data: Data on country-level college enrollment comes from the World Development Indicators (WDI) of the World Bank. Data on state-level enrollment is obtained from the Digest of Education Statistics of the National Center for Education Statistics (NECS).

Dates of country-level financial liberalization: Australia: 1988, Austria: 1994, Belgium: 1991, Czech Republic: 1996, Denmark: 1988, Finland: 1988, France: 1987, Germany: 1975, Greece: 1993, Hungary: 1996, Ireland: 1986, Italy: 1993, Japan: 1991, Korea: 1995, Netherlands: 1980, Poland: 1997, Portugal: 1992, Spain: 1989, Sweden: 1986, U.K.: 1981.[22]

Dates of U.S. state-level bank branch deregulation: Alabama: 1981, Alaska: 1960, Arizona: 1960, Arkansas: 1994, California: 1960, Colorado: 1991, Connecticut: 1980, District of Columbia: 1960, Florida: 1988, Georgia: 1983, Hawaii: 1986, Idaho: 1960, Illinois: 1988, Indiana: 1989, Iowa: 1999, Kansas: 1987, Kentucky: 1990, Louisiana: 1988, Maine: 1975, Maryland: 1960, Massachusetts: 1984, Michigan: 1987, Minnesota: 1993, Mississippi: 1986, Missouri: 1990, Montana: 1990, Nebraska: 1985, Nevada: 1960, New Hampshire: 1987, New Jersey: 1977, New Mexico: 1991, New York: 1976, North Carolina: 1960, North Dakota: 1987, Ohio: 1979, Oklahoma: 1988, Oregon: 1985, Pennsylvania: 1982, Rhode Island: 1960, South

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[22]Financial liberalization data for the U.K. comes from Kaminsky and Schmukler (2008).

Carolina: 1960, Tennessee: 1985, Texas: 1988, Utah: 1981, Vermont: 1970, Virginia: 1978, Washington: 1985, West Virginia: 1987, Wisconsin: 1990, Wyoming: 1988.

Cross-country labor market rigidity index: Australia: 0.352, Austria: 0.501, Belgium: 0.513, Czech Republic: 0.521, Denmark: 0.573, Finland: 0.737, France: 0.744, Germany: 0.702, Greece: 0.519, Hungary: 0.377, Ireland: 0.343, Italy: 0.649, Japan: 0.164, Korea: 0.446, Netherlands: 0.726, Poland: 0.639, Portugal: 0.809, Spain: 0.745, Sweden: 0.741, U.K.: 0.282.

States with right-to-work laws: Alabama, Arizona, Arkansas, Kansas, Florida, Georgia, Idaho, Iowa, Kansas, Louisiana, Mississippi, Nebraska, Nevada, North Carolina, North Dakota, Oklahoma, South Carolina, Tennessee, Texas, Utah, Virginia, Wyoming.

Cross-country debt enforcement index: Australia: 0.878, Austria: 0.78, Belgium: 0.908, Czech Republic: 0.407, Denmark: 0.767, Finland: 0.924, France: 0.541, Germany: 0.57, Greece: 0.538, Hungary: 0.467, Ireland: 0.899, Italy: 0.453, Japan: 0.955, Korea: 0.881, Netherlands: 0.949, Poland: 0.697, Portugal: 0.823, Spain: 0.82, Sweden: 0.86, U.K.: 0.923.

Chapter 3

Does Financial Liberalization Contribute to Wage Inequality? A Quantitative Analysis

3.1 Introduction

In the previous essay, I estimated the effect of financial liberalization on wage inequality using a reduced form approach. While the reduced form analysis has the benefit of achieving a clean identification of the effect of liberalization on inequality, it only allows to estimate the *differential* effect across industries.

In this essay, I conduct a quantitative analysis in order to measure the effect of liberalizing financial markets on *aggregate* inequality. I simulate a financial reform using a simple two-sector general equilibrium model. The industries in the model are heterogeneous regarding financial needs and capital-skill complementarity (CSC). The economy exhibits frictions in both the capital and the labor market market. I calibrate the model in order to match the theoretical prediction regarding the differential effect of inequality with the results obtained in Chapter 2.

According to a back-of-the envelope calculation, the effect on aggregate wage inequality is sizable. For the country-level reforms, I find that financial liberalization increases aggregate inequality for the average country by 1.6%. For the U.S. state-level reforms, financial deregulation increases aggregate inequality by 1.5%. As a result, liberalization explains 20% of the increase in aggregate inequality in the U.K. during the 1980-2000 period. Likewise, bank deregulation explains 15% of the rise in U.S. inequality during the same time period.

Since the concept of CSC is by definition relative, the reduced form analysis can only

inform about *relative* wages, not about *absolute* wages. The quantitative analysis, on the other hand, allows analyzing the effect on absolute wages. After simulating a financial reform in the model, I find that the absolute wages of both skilled and unskilled workers increase in absolute levels. For the country-level analysis, the wages of unskilled workers increase by 6.4%. For the state-level analysis, unskilled wages increase by 4.1%.

Finally, I conduct a counterfactual exercise to analyze how the effect of the reform on aggregate wage inequality varies under different labor market institutions. I find that the effect is monotonically increasing, although at a decreasing rate, in the degree of labor market flexibility of the economy.

This essay is structured as follows. In section 3.2, I outline the theoretical model. In section 3.3, I estimate and calibrate the structural parameters of the model. In sections 3.4 and 3.5, I calculate the effect of financial liberalization on aggregate wage inequality and absolute wages, respectively. In section 3.6 I analyze the effect on inequality under alternative labor market institutions. Section 3.7 concludes.

3.2 The model

3.2.1 Environment

Consider an economy that produces two goods (1 and 2) using three productive factors: capital (k), skilled labor (s), and unskilled labor (u). There are three types of agents in the economy: firms, skilled workers, and unskilled workers. All workers supply inelastically one unit of labor. The aggregate supplies of skilled and unskilled labor are S and U. The skilled and unskilled wage rates are denoted by w_s and w_u. Firms in both industries have the same capital endowment, equal to A. The economy is small and open and takes the relative price of goods (p_1/p_2) and the rental rate of capital (r) as given.[1]

Production functions in both industries exhibit constant returns to scale and are strictly quasi-concave:

$$y_i = f_i(k_i, s_i, u_i) \qquad \text{for} \quad i \in \{1, 2\}$$

The elasticities of substitution between capital and skilled labor and capital and unskilled labor in industry i are denoted by σ_i^{ks} and σ_i^{ku}. Industry i is said to exhibit CSC if $\sigma_i^{ku} > \sigma_i^{ks}$. It is useful to note that $f_i(\cdot)$ exhibits CSC if and only if $\frac{\partial (f_s/f_u)}{\partial k} > 0$. Intuitively, when the production function exhibits CSC, an increase in the capital stock

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[1] Alternatively, I could assume that capital is supplied inelastically in the context of a dynamic economy. A financial reform would lead only to reallocation of capital across industries. However, since wages increase, there are more savings, which increase the capital stock of the next period. I could therefore compare the steady states of the economy before and after the reform.

increases the marginal product of skilled labor by more than the marginal product of unskilled labor.

Assumption 1. *Capital complements skilled labor more strongly in industry 1 than in industry 2, i.e.:*

$$\frac{\sigma_1^{ku}}{\sigma_1^{ks}} > \frac{\sigma_2^{ku}}{\sigma_2^{ks}}$$

3.2.2 Markets

Capital market. The capital rental market in the economy is imperfect. There is a financial friction that has an asymmetric effect across industries. Firms in each industry can borrow (b) only a multiple $\theta - 1$ of their capital endowment at the international rental rate:

$$b_i \leq (\theta_i - 1)A \qquad \text{with} \quad \theta_i \geq 1 \tag{3.1}$$

The multiple θ_i is separated into two components, $\theta_i = \theta + \epsilon_i$. The parameter θ captures the degree of financial repression in the economy. The parameter ϵ_i measures the asymmetry of the financial friction across industries.

Assumption 2. *The financial friction is more binding in industry 1 than in industry 2, i.e.:*

$$\epsilon_1 < \epsilon_2$$

This formulation of the capital market imperfection is analytically convenient. The parameter θ captures the degree of financial repression of the economy.[2] By varying it, I can trace out all degrees of capital market efficiency. $\theta \to \infty$ corresponds to a perfect capital market while $\theta = 1 - \epsilon_i$ means that the capital market is completely shut down. I assume that θ is low enough so that the constraint (3.1) binds in both industries.

Finally, I make the assumption that industry 2 has both low financial needs and low complementarity, relative to industry 1, just for simplicity. The result that financial liberalization increases wage inequality more in industry 1 than in industry 2 would still hold had I assumed that industry 2 has high financial needs and weak complementarity or low financial needs and strong complementarity.

Labor market. In order to introduce wage inequality differentials across industries, I assume that there are labor market regulations that prevent labor from freely moving across industries. Given that labor regulations are more binding for unskilled workers, for

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[2]The constraint (3.1) can be microfounded by introducing an asymmetric information problem in the model.

simplicity I assume that, while skilled labor can freely move across industries, unskilled labor can move only imperfectly.[3] This means that $w_{s1} = w_{s2}$ and $w_{u1} \neq w_{u2}$. Wage inequality in industry i is defined as:

$$\omega_i = \frac{w_s}{w_{ui}}$$

As a result of the labor friction, in general $\omega_1 \neq \omega_2$. To simplify the analysis, I assume that the elasticity of unskilled labor mobility is constant (Casas, 1984):

$$\frac{u_1}{u_2} = \left(\frac{w_{u1}}{w_{u2}}\right)^{\psi}, \tag{3.2}$$

where $\psi \geq 0$ denotes the elasticity of unskilled labor mobility and represents the degree of labor market rigidity in the economy.[4] This specification allows for a flexible modeling of imperfect mobility, spanning economies where unskilled labor is completely immobile ($\psi = 0$) to economies where it's perfectly mobile ($\psi \to \infty$).

Finally, labor markets within an industry are competitive. This means that the marginal product of each type of labor is equalized to its respective wage in each industry.

3.2.3 Optimal behavior and equilibrium

Given that constraint (3.1) binds in both industries, capital demand in each industry will be proportional to the capital endowment:

$$k_i = b_i + A = \theta_i A \tag{3.3}$$

Skilled and unskilled labor in each industry will be demanded until the point where the marginal product of labor equals the relevant wage rate:

$$\begin{aligned}
\frac{\partial f_i(\cdot)}{\partial s} &= \frac{w_s}{p_i} \\
\frac{\partial f_i(\cdot)}{\partial u} &= \frac{w_{ui}}{p_i}
\end{aligned} \tag{3.4}$$

---

[3]Assuming that skilled labor is just as immobile as unskilled labor would not alter the predictions of the model. I only require that *relative* labor be imperfectly mobile.

[4]Rigidity in the model should be interpreted broadly, representing labor frictions such as hiring costs and unions.

The flexibility of wage rates ensures that total labor demand equals the supply of each type of labor:

$$s_1 + s_2 = S \qquad (3.5)$$
$$u_1 + u_2 = U$$

Finally, since the production functions exhibit constant returns to scale, the payment to all factors must equal the value of production in each industry:

$$k_i r_i + s_i w_s + u_i w_{ui} = p_i y_i, \qquad (3.6)$$

where $r_i = r + \lambda_i$ denotes the marginal product of capital in each industry. The variable λ_i is the Lagrange multiplier corresponding to the borrowing constraint.

As shown in Appendix A, equations (3.2) to (3.6) can be log-linearized to yield a closed-form solution for the percentage change of wage inequality across industries.

3.2.4   Financial liberalization

Now, suppose that the government undertakes financial liberalization with the ultimate goal of fostering credit markets. A reform in the model consists of an increase in the parameter θ, which makes the borrowing constraint (3.1) less binding. The underlying logic is that financial liberalization improves the efficiency of financial intermediation, which improves banks' ability of screening and monitoring loans. The effects of financial liberalization are outlined below.

Proposition 1. *Capital demand in industry 1 increases more than in industry 2,* $\frac{\partial (\widehat{k_1/k_2})}{\partial \widehat{\theta}} > 0$.

Proof. From equation (3.8) of the appendix, one knows that $\widehat{k}_1 = \widehat{\theta}$ and $\widehat{k}_2 = \delta \widehat{\theta}$. Thus $\widehat{(k_1/k_2)} = (1 - \delta)\widehat{\theta}$. Since $\delta < 1$, it is immediate that $\frac{\partial (\widehat{k_1/k_2})}{\partial \widehat{\theta}} > 0$. $\qquad \square$

Financial liberalization alleviates the borrowing constraint in the economy. Since the borrowing constraint in industry 1 is more binding than in industry 2, industry 1 will benefit relative more from the reform. As a result, capital demand will increase relatively more in industry 1.

Proposition 2. *Wage inequality in industry 1 increases more than in industry 2,* $\frac{\partial (\widehat{\omega_1/\omega_2})}{\partial \widehat{\theta}} > 0$.

Proof. Given that $\Omega(\cdot) > 0$, I get directly from equation (3.12) that $\frac{\partial (\widehat{\omega_1/\omega_2})}{\partial \widehat{\theta}} = \Omega(\cdot) > 0$. $\qquad \square$

The increase in capital demand in both industries is accompanied by an increase in the demand for both skilled and unskilled labor. Since the production functions exhibits CSC, the relative demand for skilled labor increases, leading to an increase in the relative wage of skilled labor. Given that borrowing constraints and CSC are stronger in industry 1 than in industry 2, wage inequality will increase relatively more in industry 1. This will produce an instantaneous outflow of relative skilled labor from industry 2 towards industry 1, in search for the higher returns to skill. However, given that labor is not perfectly mobile, the movement will be less than that required to equalize relative wages across industries. As a result, wage inequality will increase by more in industry 1 than in industry 2.

Proposition 3. *The differential effect of wage inequality across industries is decreasing in the degree of labor market flexibility, $\frac{\partial^2 (\widehat{\omega_1/\omega_2})}{\partial \widehat{\theta} \partial \psi} < 0$.*

Proof. From the previous proof, I know that $\frac{\partial^2 (\widehat{\omega_1/\omega_2})}{\partial \widehat{\theta} \partial \psi} = \frac{\partial \Omega(\cdot)}{\partial \psi}$. Note also that $\frac{\partial \Omega(\cdot)}{\partial \psi} = \frac{\partial \frac{\Theta}{\Lambda}}{\partial \psi}$. Given that $\frac{\partial \alpha_3}{\partial \psi}, \frac{\partial \beta_3}{\partial \psi}, \frac{\partial \gamma_3}{\partial \psi} > 0$, I get that $\frac{\partial \Theta}{\partial \psi} \Lambda(\psi) - \Theta(\psi) \frac{\partial \Lambda}{\partial \psi} > 0$ and therefore $\frac{\partial \frac{\Theta}{\Lambda}}{\partial \psi} > 0$. Hence, $\frac{\partial^2 (\widehat{\omega_1/\omega_2})}{\partial \widehat{\theta} \partial \psi} > 0$. $\qquad \square$

As explained above, after a reform relative labor flows from industry 2 towards industry 1. The more it can flow, the larger the adjustment of labor, and thus the lower the differential change of relative wages across industries. If unskilled labor were fully mobile, then relative labor would flow until wage inequality in both industries is equalized. As a result, the reform would increase wage inequality in both industries by the same rate. If, at the other extreme, unskilled labor were fully immobile, the differential change of inequality across industries would be maximized. In other words, the higher the degree of labor rigidity, the more inelastic the relative labor supply of each industry. As a result, the increase in relative labor demand would be reflected primarily through an increase in relative wages, not in relative quantities.

3.3   Estimation and calibration

I collapse my sample of industries into two groups. The first group is conformed by all industries for which the product between the external financial and CSC index is above the median value of the product across all industries. The remaining industries constitute the second group.

To conduct the quantitative exercise, I must measure the size of the shock, $\widehat{\theta}$, and, as shown in Appendix A, the following list of parameters : $\psi, (\lambda_{si}, \lambda_{ui})_{i \in \{1,2\}}, (\theta_{ki}, \theta_{si}, \theta_{ui})_{i \in \{1,2\}}$,

$(\sigma_i^{ks}, \sigma_i^{ku}, \sigma_i^{su})_{i \in \{1,2\}}, \delta$. I will calibrate the size of the shock and estimate the parameters directly. I will conduct the exercise for both the country-level and the state-level reforms.

I start by estimating the parameters. I conduct the estimation using only pre-reform data. Consider first the labor market rigidity parameter ψ. I take logs of equation (3.2), collapse the data into two sub-group of industries, and estimate the following equation for the country-level and state-level reforms:

$$\log \left(\frac{u_1}{u_2} \right)_{mt} = \psi \log \left(\frac{w_{u1}}{w_{u2}} \right)_{mt} + \eta_m + \eta_t + \varepsilon_{mt} \quad \text{for} \quad m \in \{c, s\}$$

This equation delivers immediately an estimate of the labor market friction parameter. The estimates of this and the rest of the parameters are presented in table 3.1. As expected, labor market mobility is much higher in the U.S. than in Europe.

To estimate the factor allocative shares across industries, note that by definition, $\lambda_{j1} = j_1/(j_1 + j_2)$ and residually $\lambda_{j2} = 1 - \lambda_{j1}$, for $j \in \{s, u\}$. The shares are calculated as an average across countries (states) and time for each group of industries. To estimate the cost of different factors within an industry, note that by definition $\theta_{ki} = rk_i/(rk_i + w_s s_i + w_{ui} u_i)$, $\theta_{si} = w_s s_i/(rk_i + w_s s_i + w_{ui} u_i)$, and residually $\theta_{ui} = 1 - \theta_{ki} - \theta_{si}$, for $i \in \{1, 2\}$.

To estimate the elasticities of substitution among the three factors, I approximate the cost function in each industry to a Translog function and obtain the following system of share equations for each industry:

$$\mathcal{S}_h = \alpha_h + \beta_{hy} \log(y) + [\gamma_{hk} \log(r) + \gamma_{hs} \log(w_s) + \gamma_{hu} \log(w_u)] \quad \text{for} \quad h \in \{k, s, u\}$$

I estimate this system for each group of industries using Zellner's seemingly unrelated regressions (SUR) procedure to ensure consistency among factor cross-price elasticities. I then recover the Allen-Uzawa elasticity of substitution between factors $h, m \in \{k, s, u\}$ as follows:

$$\sigma_{hm} = \frac{\gamma_{hm}}{\mathcal{S}_h \cdot \mathcal{S}_m} + 1$$

I conduct the estimation only for the country-level reforms, since I lack the relevant data for the U.S. case. I will assume that the elasticities of substitution are the same in Europe and the U.S. As can be seen from table 3.1, the elasticity of substitution between capital and unskilled labor is higher than the elasticity between capital and skilled labor in the first group of industries, which is expected because this group of industries exhibits strong CSC. In the second group of industries, both elasticities are of similar magnitude.[5]

---

[5]All elasticities of substitution estimated in this section are of similar magnitude to those reported in the micro literature (Hamermesh, 1993).

To estimate the parameter δ, which summarizes the asymmetry of the financial friction across industries, note that in the model $\widehat{k}_1 - \widehat{k}_2 = (1 - \delta)\widehat{\theta}$. From the reduced form analysis, the differential effect on capital demand is 7%, i.e. $\widehat{k}_1 - \widehat{k}_2 = 7\%$. As a result, I set $\delta = 1 - \frac{7\%}{\widehat{\theta}}$. Since I have no data on capital for the U.S. reforms, I assume again that this parameter is equal for both sets of reforms.

Finally, I calibrate the size of the shock $\widehat{\theta}$ in order to match the prediction of the model regarding the differential effect of inequality across industries with the results obtained in the reduced form analysis. That is, for the country-level reforms I set $\frac{\partial(\widehat{\omega_1/\omega_2})}{\partial\widehat{\theta}} = \Omega(\cdot) = 3\%$ and for the state-level reforms $\frac{\partial(\widehat{\omega_1/\omega_2})}{\partial\widehat{\theta}} = \Omega(\cdot) = 1\%$.

3.4 Aggregate wage inequality

3.4.1 Lower bound

Before conducting the simulation, I use the results of the reduced form analysis of Chapter 2 to calculate a lower bound of the effect of financial liberalization on aggregate inequality. The percentage change in aggregate inequality is a weighted average of the change in inequality in both groups of industries:

$$\widehat{\omega} = \tau\widehat{\omega}_1 + (1 - \tau)\widehat{\omega}_2, \tag{3.7}$$

where τ is the share of total labor in industry 1, relative to total labor in both industries, i.e. $\tau = \frac{s_1 + u_1}{\sum_i s_i + u_i}$. If the level effect on the second subset of industries is labeled x_0, then the change in aggregate inequality is $\widehat{\omega} = \tau(x_0 + \delta) + (1 - \tau)x_0$, where δ denotes the differential effect. Setting $x_0 = 0$ yields a lower bound for the aggregate effect, $\underline{\widehat{\omega}} = \tau\delta$. From the country-level reduced form analysis, I know that $\delta_{country} = 3.0\%$ and I can compute $\tau_{country} = 0.33$. Likewise, for the state-level reforms, I have $\delta_{state} = 1.0\%$ and $\tau_{state} = 0.51$. Therefore, the lower bound for the aggregate increase in inequality for the average European country is $\underline{\widehat{\omega}}_{country} = 1.0\%$ and for the U.S. is $\underline{\widehat{\omega}}_{state} = 0.7\%$.

3.4.2 Simulation

After fitting the parameters to the model, I can simulate a financial reform and analyze the effect on aggregate inequality (see equation (3.7)). For the country-level reforms, I find that financial liberalization increases aggregate inequality for the average country by 1.6%. For the U.S. state-level reforms, financial deregulation increases aggregate inequality by 1.5%. These figures are 60% and 70% respectively higher than the lower bound calculations based on the reduced form analysis.

To gauge the size of importance effects, it is useful to compare them with the pattern of aggregate inequality observed in the data. Consider, for example, the U.K. case. The U.K. is a European country where inequality increased dramatically in the last decades. Labor markets in the U.K. are more flexible than the average European country. Between 1980 and 2000, aggregate British wage inequality, in the industries included in my sample, increased by 8%. With this analysis, I can attribute 20% of the total rise in inequality to financial liberalization. Consider now the U.S. case. Aggregate wage inequality in the U.S. increased by 10% in the 1980-2000 period. As a result, bank deregulation contributes 12% to the rise in inequality. Therefore, the contribution of financial liberalization on wage inequality in both the U.K. and the U.S. is sizable.

3.5 Level of wages

Finally, since the concept of capital-skill complementarity is by definition relative (capital increases the *relative* demand for skilled labor), the reduced form analysis can only inform about relative wages, not about absolute wages. Absolute wages can either increase or decrease as the capital stock increases.[6]

An additional benefit of the quantitative analysis is that it allows to analyze the effect on absolute wages, since I have not imposed any structure on the production function besides CSC and constant returns to scale. After simulating a financial reform in the model, I find that the absolute wages of both skilled and unskilled workers increase in absolute levels (in terms of the numeraire). For the country-level analysis, the wages of unskilled workers increase by 6.4%. For the state-level analysis, unskilled wages increase by 4.1%. Therefore, according to this analysis, financial liberalization is a policy that is Pareto improving for employees. That is, all workers benefit from the reform, but skilled workers benefit relatively more.

3.6 Labor market institutions

While an increase in labor market flexibility decreases the *differential* effect of financial liberalization on wage inequality across industries, it might increase or decrease the effect on *aggregate* inequality. More flexibility means that more relative labor can flow from industry 2 towards industry 1, which increases wage inequality in industry 2, but also

---

[6]Consider two production functions that exhibit capital-skill complementarity, $y = (k + u)^\alpha s^{1-\alpha}$ and $y = (\min\{k, s\})^\alpha u^{1-\alpha}$, with $\alpha \in (0, 1)$. In the first case, the absolute unskilled wage falls if capital increases. In the second case, the absolute skilled wage increases.

decreases wage inequality in industry 1. Given that the change in aggregate inequality is a weighted average of the change in inequality in both industries, the overall effect could go either way.

Figure 3.1 plots the model-derived relationship between labor flexibility and the change in aggregate inequality. As can be seen, for both the country-level (panel (a)) and the state-level (panel (b)) reforms, more flexibility increases the overall effect, although at a decreasing rate. For the country-level reforms, the effect converges to 3.5% for sufficiently flexible labor markets ($\psi > 10$). This effect is more than twice the effect calculated with the benchmark calibration (1.6%). On the other hand, the effect for the state-level reforms converges to 2% with sufficient labor flexibility, which is 30% larger than the benchmark effect (1.5%).

[Include figure 3.1 here]

3.7 Conclusions

In this essay, I have developed a two-sector general equilibrium model with sectors heterogeneous in financial constraints and capital-skill complementarity. Both the capital and the labor market of the economy exhibit frictions. I calibrate the model in order to match the prediction of the model with respect to the differential effect of inequality with the reduced form results obtained in the previous essay.

According to a back-of-the envelope calculation, the effect on aggregate wage inequality is sizable. Liberalization explains 20% of the increase in aggregate inequality in the U.K. during the 1980-2000 period and 15% of the rise in U.S. inequality during the same time period. In addition, I find that the absolute wages of both skilled and unskilled workers increase in absolute levels. Therefore, according to this analysis, financial liberalization is a policy that is Pareto improving for employees.

Finally, it is important to note that the time horizon of the model is short to medium-run. First, I have assumed that the aggregate supply of both types of labor is inelastic. In the long run, agents have incentives to acquire human capital in response to the higher returns to skill. Secondly, I have assumed that labor is imperfectly mobile across industries. Again, in the long-run the frictions that prevent labor from moving across industries should disappear. In future research, it might be interesting to develop a fully dynamic model to trace both the short/medium and long-run of effects of financial reform.

Table 3.1: Estimated and calibrated parameters

Parameter	Description	Country-level reforms	State-level reforms
ψ	Labor flexibility	0.8	2.5
$(\lambda_{s1}, \lambda_{u1})$	Allocative shares sect. 1	(0.25, 0.75)	(0.40, 0.60)
$(\lambda_{s2}, \lambda_{u2})$	Allocative shares sect. 2	(0.30, 0.70)	(0.35, 0.25)
$(\theta_{k1}, \theta_{s1}, \theta_{u1})$	Cost shares sect. 1	(0.82, 0.02, 0.16)	(0.70, 0.10, 0.20)
$(\theta_{k2}, \theta_{s2}, \theta_{u2})$	Cost shares sect. 2	(0.76, 0.10, 0.14)	(0.55, 0.25, 0.20)
$(\sigma_1^{ks}, \sigma_1^{ku}, \sigma_1^{su})$	Elast. substitution sect. 1	(1.10, 1.58, 1.33)	(1.10, 1.58, 1.33)
$(\sigma_2^{ks}, \sigma_2^{ku}, \sigma_2^{su})$	Elast. substitution sect. 2	(1.63, 1.49, 1.09)	(1.63, 1.49, 1.09)
δ	Differential effect on capital	3.3%	11%
$\widehat{\theta}$	Size of reform	11.0%	5.1%

Notes: the table depicts the full set of parameters used in the quantitative analysis of the paper, both for the country-level and the state-level analysis. The subset of parameters ψ, $(\lambda_{si}, \theta_{si}, \theta_{ui})_{i \in \{1,2\}}$, $(\theta_{ki}, \theta_{si}, \theta_{ui})_{i \in \{1,2\}}$, $(\sigma_i^{ks}, \sigma_i^{ku}, \sigma_i^{su})_{i \in \{1,2\}}$, δ were directly estimated. The parameter $\widehat{\theta}$ is calibrated in order the match the prediction of the model regarding differential inequality with the reduced form results.

Figure 3.1: Effect of reform on aggregate inequality under different labor market institutions
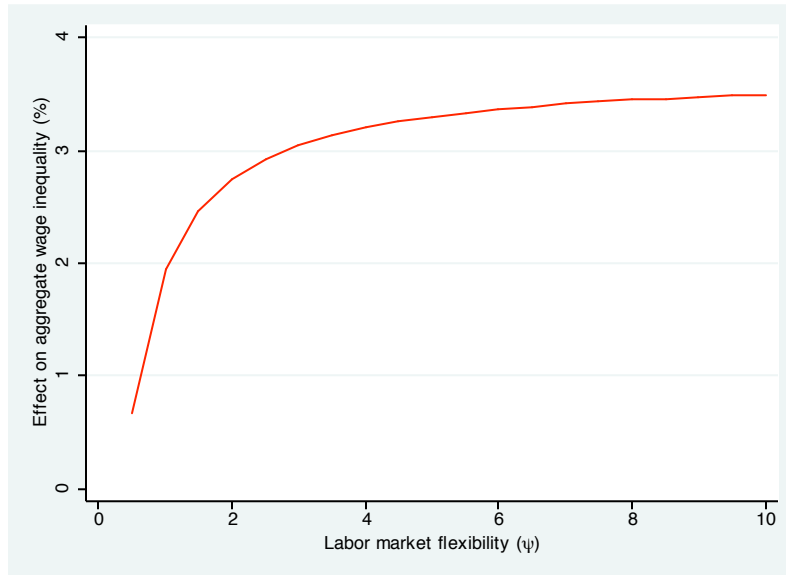
(a) Country-level reforms
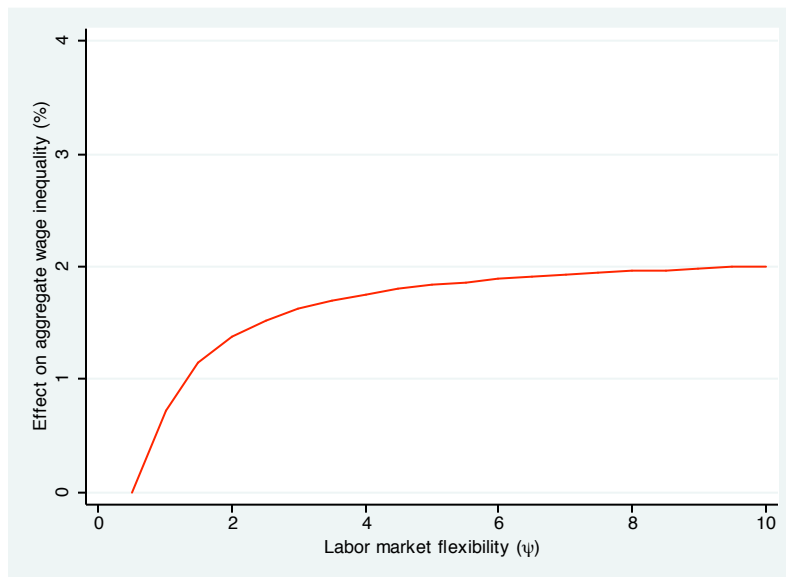
(b) State-level reforms

Notes: the figure plots the model-derived relationship between labor market flexibility and the effect of financial liberalization on aggregate wage inequality. Panel (a) and (b) depict the results for the country-level and state-level reforms, respectively. Source: own calculations.

Appendix A Log-linearization of model

The model described in section 3.2 can be solved using the dual approach to two-sector general equilibrium models. Since the production functions of each industry $i \in \{1, 2\}$ exhibit constant returns to scale, they may be described by their unit isoquant:

$$f_i(a_{ki}, a_{si}, a_{ui}) = 1,$$

where $a_{ki} = k_i/y_i$, $a_{si} = s_i/y_i$, and $a_{ui} = u_i/y_i$. The full-employment equations (3.3) and (3.5) can be therefore re-written as:

$$
\begin{aligned}
a_{k1}y_1 &= (\theta + \epsilon_1)A \\
a_{k2}y_2 &= (\theta + \epsilon_2)A \\
a_{s1}y_1 + a_{s2}y_2 &= S \\
a_{u1}y_1 + a_{u2}y_2 &= U
\end{aligned}
$$

These equations can be log-linearized as follows:

$$
\begin{aligned}
\widehat{a}_{k1} + \widehat{y}_1 &= \delta_1\widehat{\theta} + \widehat{A} \\
\widehat{a}_{k2} + \widehat{y}_2 &= \delta_2\widehat{\theta} + \widehat{A} \\
\lambda_{s1}\widehat{y}_1 + \lambda_{s2}\widehat{y}_2 &= \widehat{S} - (\lambda_{s1}\widehat{a}_{s1} + \lambda_{s2}\widehat{a}_{s2}) \\
\lambda_{u1}\widehat{y}_1 + \lambda_{u2}\widehat{y}_2 &= \widehat{U} - (\lambda_{u1}\widehat{a}_{u1} + \lambda_{u2}\widehat{a}_{u2}),
\end{aligned}
\tag{3.8}
$$

where a hat over a variable denotes a percentage change (i.e. $\widehat{x} = \frac{dx}{x}$), $\delta_i = \frac{\theta}{\theta + \epsilon_i}$, and λ_{ji} is the allocative share of factor j employed in industry i (e.g., $\lambda_{s1} = s_1/S$). It is immediate that $\lambda_{j1} + \lambda_{j2} = 1$ for $j \in \{s, u\}$. I normalize $\delta_1 = 1$ so that $\delta_2 = \delta < 1$ represents the differential increase in capital demand across industries.

The zero-profit conditions (3.6) for each industry i can be re-written as:

$$a_{ki}r_i + a_{si}w_s + a_{ui}w_{ui} = p_i$$

Log-linearizing yields:

$$\theta_{ki}\widehat{a}_{ki} + \theta_{ki}\widehat{r}_i + \theta_{si}\widehat{a}_{si} + \theta_{si}\widehat{w}_s + \theta_{ui}\widehat{a}_{ui} + \theta_{ui}\widehat{w}_{ui} = \widehat{p}_i,$$

where θ_{ji} is the cost share of the factor j employed in industry i (e.g., $\theta_{k1} = r_1a_{k1}/p_1$). Note that since both production functions exhibit constant returns to scale, $\theta_{ki} + \theta_{si} + \theta_{ui} = 1$. The expression above can be simplified as follows. First, I define the unit cost function for each industry as:

$$c_i(r_i, w_s, w_{ui}) = \min_{a_{ki}, a_{si}, a_{ui}} \{a_{ki}r_i + a_{si}w_s + a_{ui}w_{ui} \quad \text{s.t.} \quad f_i(a_{ki}, a_{si}, a_{ui}) = 1\}$$

The first order conditions of the cost-minimization problem are $\eta \partial f_i/\partial a_{ki} = r_i/p_i$, $\eta \partial f_i/\partial a_{si} = w_s/p_i$, and $\eta \partial f_i/\partial a_{ui} = w_{ui}/p_i$, where η is the Lagrange multiplier of the unit production restriction. In the unit isoquant, $(\partial f_i/\partial a_{ki})da_{ki} + (\partial f_i/\partial a_{si})da_{si} + (\partial f_i/\partial a_{ui})da_{ui} = 0$. Log-linearizing

this expression and using the first order conditions yields $\theta_{ki}\widehat{a}_{ki}+\theta_{si}\widehat{a}_{si}+\theta_{ui}\widehat{a}_{ui} = 0$. As a result, the log-linearized zero-profit conditions reduce to:

$$\theta_{ki}\widehat{r}_i + \theta_{si}\widehat{w}_s + \theta_{ui}\widehat{w}_{ui} = \widehat{p}_i \tag{3.9}$$

Next, note that the imperfect labor mobility equation (3.2) can be re-written as:

$$\frac{a_{u1}y_1}{a_{u2}y_2} = \kappa \left(\frac{w_{u1}}{w_{u2}}\right)^{\psi}$$

Log-linearizing this equation yields:

$$(\widehat{a}_{u1} - \widehat{a}_{u2}) + (\widehat{y}_1 - \widehat{y}_2) = \psi(\widehat{w}_{u1} - \widehat{w}_{u2}) \tag{3.10}$$

Finally, I derive the optimal factor demands. By Shepard's Lemma, the optimal demands can be written as $a_{ki} = c_i^k(\cdot)$, $a_{si} = c_i^s(\cdot)$, and $a_{ui} = c_i^u(\cdot)$, where $c_i^j(\cdot) = \partial c_i/\partial p_j$ for $j \in \{k, s, u\}$ and p_j is the shorthand notation for the price of factor j. Log-linearizing the system above yields:

$$\widehat{a}_{ki} = \frac{r_i c_i^{kk}}{c_i^k}\widehat{r}_i + \frac{w_{si}c_i^{ks}}{c_i^k}\widehat{w}_s + \frac{w_u c_i^{ku}}{c_i^k}\widehat{w}_{ui}$$

$$\widehat{a}_{si} = \frac{r_i c_i^{sk}}{c_i^s}\widehat{r}_i + \frac{w_{si}c_i^{ss}}{c_i^s}\widehat{w}_s + \frac{w_u c_i^{su}}{c_i^s}\widehat{w}_{ui}$$

$$\widehat{a}_{ui} = \frac{r_i c_i^{uk}}{c_i^u}\widehat{r}_i + \frac{w_{si}c_i^{us}}{c_i^u}\widehat{w}_s + \frac{w_u c_i^{uu}}{c_i^u}\widehat{w}_{ui},$$

where $c_i^{jl}(\cdot) = \partial c_i^j/\partial p_l$ for $j, l \in \{k, s, u\}$. Given that the cost function $c_i(\cdot)$ is linear homogeneous, $c_i^j(\cdot)$ is homogeneous of degree zero in its arguments. Therefore:

$$r_i c_i^{kk}(\cdot) + w_s c_i^{ks}(\cdot) + w_{ui} c_i^{ku}(\cdot) = 0$$
$$r_i c_i^{sk}(\cdot) + w_s c_i^{ss}(\cdot) + w_{ui} c_i^{su}(\cdot) = 0$$
$$r_i c_i^{uk}(\cdot) + w_s c_i^{us}(\cdot) + w_{ui} c_i^{uu}(\cdot) = 0$$

The Allen-Uzawa partial elasticity of substitution measures the percentage change in the ratio of the inputs h and m in response to a change in the ratio of the two input prices, holding all other prices (but not all other inputs) and the output quantity constant. As shown by Uzawa (1962), the elasticity can be defined in terms of the cost function as follows:

$$\sigma_i^{hm} = \frac{c_i(\cdot)c_i^{hm}(\cdot)}{c_i^h(\cdot)c_i^m(\cdot)},$$

for $h, m \in \{k, s, u\}$. Using the homogenous-of-degree-zero conditions and the definition of elasticity of substitution, I can re-write the optimal factor demands as:

$$
\begin{aligned}
\widehat{a}_{ki} &= \theta_{si}\sigma_i^{ks}(\widehat{w}_s - \widehat{r}_i) + \theta_{ui}\sigma_i^{ku}(\widehat{w}_{ui} - \widehat{r}_i) \\
\widehat{a}_{si} &= \theta_{ki}\sigma_i^{ks}(\widehat{r}_i - \widehat{w}_s) + \theta_{ui}\sigma_i^{su}(\widehat{w}_{ui} - \widehat{w}_s) \\
\widehat{a}_{ui} &= \theta_{ki}\sigma_i^{ku}(\widehat{r}_i - \widehat{w}_{ui}) + \theta_{si}\sigma_i^{ku}(\widehat{w}_s - \widehat{w}_{ui})
\end{aligned}
\tag{3.11}
$$

The set of equations (3.8)-(3.9)-(3.10)-(3.11) conform a system of linear equations. I set to zero all changes of exogenous variables with exception of the policy change ($\widehat{A} = \widehat{S} = \widehat{U} = \widehat{p}_1 = \widehat{p}_2 = 0$).

The fact that industry 1 exhibits a stronger degree of CSC than industry 2 means that that $\sigma_1^{ku}/\sigma_1^{ks} > \sigma_2^{ku}/\sigma_2^{ks}$. To simplify the algebra, and without loss of generality, I set $\sigma_2^{ku} = \sigma_2^{ks} = \sigma_2$. In addition, I normalize $\sigma_1^{ks} = 0$ and define $\sigma_1 = \sigma_1^{ku}$. To further simplify the algebra, I also normalize $\sigma_1^{su} = \sigma_2^{su} = 0.$[7]

The percentage change in wage inequality across industries can be written as:

$$
\widehat{(\omega_1/\omega_2)} = (\widehat{w}_s - \widehat{w}_{u1}) - (\widehat{w}s - \widehat{w}_{u2}) = \widehat{w}_{u1} - \widehat{w}_{u2}
$$

After some fairly cumbersome algebra, I can solve the system of equations and obtain a closed-form expression for the change in wage inequality across industries

$$
\widehat{(\omega_1/\omega_2)} = \Omega(\cdot)\widehat{\theta},
\tag{3.12}
$$

where:

$$
\begin{aligned}
\Omega(\cdot) &= \left(\frac{\theta_{u2}}{\theta_{s2}} - \frac{\theta_{u1}}{\theta_{s1}}\right)\frac{\lambda_{s1} - \delta\lambda_{s2}}{\alpha_1} + \left[\left(\frac{\theta_{u2}}{\theta_{s2}} - \frac{\theta_{u1}}{\theta_{s1}}\right)\frac{\beta_1}{\alpha_1} - \frac{\theta_{k1}}{\theta_{s1}}\right]\xi \\
&+ \left[\left(\frac{\theta_{k2}}{\theta_{s2}} - \frac{\theta_{k1}}{\theta_{s1}}\zeta\right) + \left(\frac{\theta_{u2}}{\theta_{s2}} - \frac{\theta_{u1}}{\theta_{s1}}\right)\left(\frac{\beta_1}{\alpha_1}\zeta + \frac{\gamma_1}{\alpha_1}\right)\frac{\Theta}{\Lambda}\right] > 0
\end{aligned}
$$

and $\xi = \frac{[(\lambda_{u1}-\delta\lambda_{u2})\alpha_1 - (\lambda_{s1}-\delta\lambda_{s2})\alpha_2]}{\beta_1\alpha_2 - \beta_2\alpha_1}$, $\zeta = \frac{\gamma_2\alpha_1 - \gamma_1\alpha_2}{\beta_1\alpha_2 - \beta_2\alpha_1}$, $\alpha_1 = (\lambda_{s1}\theta_{u1}\sigma_1\theta_{s2} - \lambda_{s2}\theta_{k2}\sigma_2\theta_{u2})/\theta_{s2}$, $\beta_1 = \lambda_{s1}\theta_{u1}\sigma_1$, $\gamma_1 = (\lambda_{s2}\sigma_2\theta_{s2} + \lambda_{s2}\theta_{k2}\sigma_2[\theta_{s2} + \theta_{k2}])/\theta_{s2}$, $\alpha_2 = \lambda_{u1}\theta_{u1}\sigma_1 + \lambda_{u1}\theta_{k1}\sigma_1 + \lambda_{u2}\theta_{k2}\sigma_2$, $\beta_2 = \lambda_{u1}\theta_{u1}\sigma_1 + \lambda_{u1}\theta_{k1}\sigma_1$, $\gamma_2 = \lambda_{u2}\sigma_2 + \lambda_{u2}\theta_{k2}\sigma_2$, $\alpha_3 = (\psi[\theta_{u2}\theta_{s1} - \theta_{u1}\theta_{s2}] + \theta_{u1}\sigma_1\theta_{s2}\theta_{s1} + \theta_{k2}\sigma_2\theta_{u2}\theta_{s1})/\theta_{s2}\theta_{s1}$, $\beta_3 = (\psi\theta_{k1} + \theta_{u1}\sigma_1\theta_{s1})/\theta_{s1}$, and $\gamma_3 = (\psi\theta_{k2} + \sigma_2\theta_{s2} + \theta_{k2}\sigma_2[\theta_{s2} + \theta_{k2}])/\theta_{s2}$.

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[7]These normalizations are only made to simplify the algebra in the proofs of the propositions. The quantitative analysis of section 3.4 considers the full range of elasticities.

Chapter 4

Understanding Misallocation: The Importance of Financial Constraints

4.1 Introduction

It is well known that cross-country differences in income per capita are very large. Since the work of Klenow and Rodriguez-Clare (1997) and Hall and Jones (1999), there is a growing consensus that total factor productivity (TFP) is the most important factor in accounting for these differences. An emergent literature has developed in order to understand why TFP differs across countries. One particular strand, starting with Banerjee and Duflo (2005), has argued that differences in the allocation of resources across heterogeneous agents may be a significant factor in accounting for cross-country differences in TFP.

One potential source of misallocation relies on financial frictions. When an economy has an underdeveloped financial market, productive but poor firms lack the collateral required for taking out a loan. As a result, these firms may produce at a sub-optimal scale. Reallocating capital from rich and low-productivity firms towards poor and high-productivity ones would increase the economy's output. Failure to reallocate is referred to as resource misallocation. Such a misallocation shows up in aggregate data as low TFP.

This essay studies the relationship between financing frictions and misallocation by focusing on the episode of financial liberalization by a group of ten Eastern European countries. Starting in the mid 1990s, these countries drastically reduced the intervention of the government in financial activities. As a result, financial frictions were alleviated and financial depth increased. The main goal of our paper is to use microeconomic data to analyze whether these financial reforms led to higher TFP by allowing a better allocation of capital across firms. The main contribution of our essay is to provide the first reduced

form assessment, using a large firm-level dataset, on the effects of financial frictions on misallocation and TFP.

Looking at a cross-section of the ten transition economies under study in the year 2000, we observe a positive association between financial liberalization and aggregate productivity (see figure 4.1). However, since these countries were transitioning from a command to a market economy, other events that took place during the same period might be driving this relationship.

[Include figure 4.1 here]

To identify the *causal* impact of financial deregulation on productivity, we make use of the fact that this policy should have a stronger effect on those industries that are more financially constrained. In particular, the reform should affect particularly those industries that have high requirements of external finance (Rajan and Zingales, 1998) and high levels of asset tangibility (Braun, 2003; Claessens and Laeven, 2003).[1] We therefore exploit cross-industry differences in financial constraints to estimate the *differential* effect of financial liberalization on TFP across industries.

Exploiting differences in financial constraints across industries allows us to disentangle the effects of financial liberalization from other policies that could have taken place at the same time and that affect industries uniformly. To allow for a differential effect of other reforms across industries, we explicitly control for a large array of reform indicators constructed by Campos and Horvath (2009).

Another threat to identification is that financial liberalization is itself a political outcome, which might be endogenous to a specific pattern of industry-level TFP growth. We argue that this possibility is highly unlikely, since financial deregulation was largely induced by *external* pressures from outside governing bodies such as the European Union (EU), IMF, and OECD. Most of the sample countries were seeking EU membership, and accession imposed strict guidelines regarding financial repression. Also, many of the countries were asking for financial support from the IMF and expressed their commitment to undertake financial sector reforms in order to obtain such help. In addition, we document that financially constrained industries have relatively low political strength, which makes the possibility of reverse causality even more implausible.

We estimate firm-level productivity as the residual from an estimated production function. We then calculate industry TFP as the weighted average of productivity of all firms producing in that industry. Our first set of results indicates that financial liberalization

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[1]External financial dependence is defined as the fraction of capital expenditures not financed with cash flow from operations. Asset tangibility is the fraction of net plant, property, and equipment in total assets.

increases TFP particularly in industries that are heavily dependent on external finance and that have a high level of asset tangibility. The differential effect across industries is sizable. After a large financial reform, TFP in industries with high financial dependence increases by 16% more than in industries with low dependence. Likewise, TFP in industries with low asset tangibility increases by 29% more than in industries with high tangibility. However, these industry TFP gains could be the result of an improved allocation of capital across firms or of firms becoming individually more productive.

To identify the source driving the TFP gains, we use a standard industry decomposition method (Olley and Pakes, 1996). We express industry TFP as the sum of two components: an *average-productivity* term and an *allocation* term. The first component measures the individual efficiency of firms of the industry. The second component is the within-industry cross sectional size-productivity covariance. It measures the efficiency with which resources are allocated across firms within a sector.

We find that industry TFP gains are primarily driven by an increase in the covariance term, that is by a reduction of misallocation across firms. Reallocation explains 71% of the differential effect of the reform on TFP across industries with different levels of external financial needs. Similarly, reallocation explains 60% of the differential effect of the reform across industries with different levels of asset tangibility.

Our theoretical framework of financial frictions and misallocation implies that any improvement in the size-productivity covariance must be driven by a reduction of the within-industry covariance between productivity and the marginal product of capital. We find evidence for this mechanism in the data. We also provide evidence that the reform lowers the within-industry variance of the marginal product of capital across firms. In addition, we document that, consistent with our model, financial liberalization does not decrease neither the covariance between productivity and the marginal product of labor nor the variance of the marginal product of labor.

Finally, we analyze the effect of financial liberalization across firms that ex-ante face different levels of financial constraints. In particular, we compare *domestically*-owned firms with *foreign*-owned firms. Since foreign firms have access to an internal capital market, they should be less constrained than domestic firms. We find that financial deregulation increases the market share of domestically-owned firms relative to foreign-owned firms. The effect is particularly strong in highly financially constrained industries. In high external dependent industries, the market share of domestic firms increases by 7% more than the foreign firms' share. Likewise, in industries with low asset tangibility, domestic firms see their market share increase by 9% more than the share of foreign firms.

Overall, our paper provides evidence that financial liberalization can reduce the extent of resource misallocation and increase aggregate TFP. By reducing cross-country differ-

ences in TFP, this policy can contribute to close the gap of income per worker across countries.

This essay is organized as follows. In the next section we link our paper to the existing literature. In section 4.3 we present a stylized model and derive the testable implications. In section 4.4 we describe the reform process and the firm-level data used in the analysis. In section 4.5 we explain our identification strategy. In section we present 4.6 the main results. Additional results are presented in section 4.7. In section 4.8 we conclude.

4.2   Related literature

This paper is part of a rapidly expanding literature that views underdevelopment not just as a matter of lack of resources but also as a consequence of misallocation of such resources. Banerjee and Duflo (2005), Restuccia and Rogerson (2008), Guner et al. (2008), and Hsieh and Klenow (2009) were the first to argue that the extent of misallocation of resources in poor countries is large enough to explain a large part of the TFP gap between rich and poor economies.

One particular strand of this literature focuses on financial frictions as the underlying source of misallocation (Banerjee and Moll, 2010; Midrigan and Xu, 2010; Buera et al., 2011; Moll, 2012). All these papers conduct *structural* estimations. They develop general equilibrium models with imperfect financial markets, calibrate the structural parameters of the model using micro-level data, and quantify the magnitude of output loss due to misallocation. In contrast, our paper conducts a *reduced form* estimation of a concrete episode of a financial reform to measure empirically the effect of this policy on TFP and misallocation. A benefit of our approach is that our results do not depend on particular assumptions or parameter calibrations. A drawback is that in order to achieve identification we can only calculate the *differential* effect of the policy across industries, not the *aggregate* effect.

Our paper also relates to the work of Galindo et al. (2002) and Abiad et al. (2008). Both papers use micro-level data to provide evidence that financial liberalization is associated with an improvement in the allocation of investment. Unlike these papers, we have an identification strategy that allows us to estimate the *causal* effect of liberalization on allocation. Secondly, while these papers use data of only publicly traded firms, we include both *private* and *public* firms in our analysis. This is an important advantage since private firms are more financially constrained than public firms. An additional benefit is that the number of firms included in our paper is more than a 100 times larger than the number of firms used in these papers.

Finally, a group of papers has documented that financial liberalization increases eco-

nomic growth primarily by boosting TFP (Levine, 2005; Levchenko et al., 2009; Bekaert et al., 2011). Since these papers use aggregate data, they cannot analyze the factors leading to the TFP gains. We use a large micro-level database and contribute to this literature by providing evidence that these TFP gains arise mainly from a better allocation of resources across firms within an industry.

4.3   The model

4.3.1   Environment

Consider an economy that produces two goods (1 and 2) using two productive factors: capital (k) and labor (l). There are two types of agents in the economy: firms and workers. Firms are heterogeneous regarding their productivity ($z \geq 0$) and their wealth ($a \geq 0$). The joint distribution of productivity and wealth is denoted by $F(z, a)$. The mass of firms is normalized to one in each industry and entrepreneurs are not mobile across sectors. All workers supply inelastically one unit of labor. The aggregate supply of labor is L and the wage rate is denoted by w. The economy is small and open and takes the relative price of goods and the rental rate of capital (r) as given. For simplicity, we normalize the prices of both goods to one.

The production function of firms in each industry is:

$$y = z(k^\alpha l^{1-\alpha})^\nu,$$

where $\alpha \in (0, 1)$ and $v \in (0, 1)$ is a span of control parameter that induces decreasing returns to scale.

4.3.2   Factor markets

The capital rental market in the economy is imperfect. There is a financial friction that has an asymmetric effect across industries. Firms in each industry can borrow (b) only a multiple $\theta_s - 1$ of their wealth at the international rental rate:

$$b_s \leq (\theta_s - 1)a \qquad \text{for} \quad s \in \{1, 2\} \tag{4.1}$$

The multiple $\theta_s \geq 1$ is separated into two components, $\theta_s = \theta + \epsilon_s$. The parameter θ captures the degree of financial repression in the economy and the parameter ϵ_s measures the asymmetry of the financial friction across industries. One interpretation of constraint (4.1) is that the fraction of wealth that is tangible, and hence collateralizable, varies across industries.

Assumption 3. *The financial friction is more binding in industry 1 than in industry 2, i.e.:*

$$\epsilon_1 < \epsilon_2$$

This formulation of the capital market imperfection is analytically convenient. The parameter θ captures the degree of financial repression of the economy. By varying it, we can trace out all degrees of capital market efficiency. $\theta \to \infty$ corresponds to a perfect capital market while $\theta = 1 - \epsilon_s$ means that the capital market is completely shut down.

The labor market of the economy is perfectly competitive, so firms equate the marginal product of labor with the wage rate.

4.3.3 Factor demands

If the capital market were perfect, each firm would demand factors in order to solve the problem $\pi(z) = \max_{k,l}\{z(k^\alpha l^{1-\alpha})^v - rk - wl\}$. The optimal demands for capital and labor would be:

$$k^*(z) = \left[\nu z \left(\frac{\alpha}{r}\right)^{1-(1-\alpha)\nu} \left(\frac{1-\alpha}{w}\right)^{(1-\alpha)\nu}\right]^{\frac{1}{1-\nu}},$$

$$l^*(z) = \left[\nu z \left(\frac{\alpha}{r}\right)^{\alpha\nu} \left(\frac{1-\alpha}{w}\right)^{1-\alpha\nu}\right]^{\frac{1}{1-\nu}}$$

Consider now the economy with financial frictions. The maximum capital that a firm with wealth a can demand is $b_s + a = \theta_s a$. The level of wealth that allows the firm with productivity z to demand its optimal level of capital is $k^*(z)/\theta_s$. Then the set of constrained firms in sector s is given by:

$$\mathcal{C}_s = \{(a,z) : a < k^*(z)/\theta_s\}$$

For the constrained firms, the shadow price of capital they face will equal the constrained marginal product of capital:

$$m(a,z) = \alpha \left[\left(\frac{1-\alpha}{w}\right)^{(1-\alpha)\nu} z\nu\right]^{\frac{1}{1-(1-\alpha)\nu}} (\theta_s a)^{\frac{\nu-1}{1-(1-\alpha)\nu}}$$

For a given amount of wealth, a more productive firm will have a higher marginal product of capital, introducing a positive correlation between $m(a,z)$ and productivity, and distorting the optimal size-productivity relationship. Unconstrained firms just face

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the international rental rate. We can therefore write the marginal product of capital as follows:

$$f_k(a, z) = \max\{m(a, z), r\}$$

Note that since the labor market of the economy is frictionless, the marginal product of labor will always be equalized to the equilibrium wage rate, i.e. $f_l(a, z) = w$.

Profit maximization delivers the optimal scale of the firm, given factor prices:

$$y(a, z) = \left[\nu \left(\frac{\alpha}{f_k(a, z)} \right)^{\alpha} \left(\frac{1 - \alpha}{w} \right)^{1-\alpha} \right]^{\frac{\nu}{1-\nu}} z^{\frac{1}{1-\nu}}$$

4.3.4 Equilibrium and aggregation

Aggregate capital demand in each industry is equal to the sum of the capital demands of unconstrained and constrained firms. Given that the economy is small and open, aggregate capital supply is elastic and thus equilibrium capital equals capital demand. Likewise, aggregate labor demand is equal to the sum of labor demands of unconstrained and constrained firms. In equilibrium, the wage rate ensures that aggregate labor supply equals aggregate labor demand.

Denote by ω_k and ω_l the capital and labor share of a firm in each industry, i.e. $\omega_k = k/K$ and $\omega_l = l/L$ respectively. Then a firm's output can be re-expressed as:

$$y = z(k^{\alpha} l^{1-\alpha})^{\nu} = z[(\omega_k K)^{\alpha}(\omega_l L)^{1-\alpha}]^{\nu} = z\tilde{\omega}(K^{\alpha} L^{1-\alpha})^{\nu},$$

where $\tilde{\omega}(z, a) = (\omega_k^{\alpha} \omega_l^{1-\alpha})^{\nu}$ denotes the share of a firm in economy-wide capital and labor. As a result, aggregate output of sector s can be represented by the following aggregate production function:

$$Y_s = \int \int z\tilde{\omega}(z, a)(K^{\alpha} L^{1-\alpha})^{\nu} dF(z, a) = Z_s(K_s^{\alpha} L_s^{1-\alpha})^{\nu},$$

where industry TFP is given by a weighted-average of firm-level productivities:

$$Z_s = \int \int z\tilde{\omega}(z, a) dF(z, a) \tag{4.2}$$

To gain some intuition about the mechanisms behind the relationship of financial frictions and TFP, we can expand the expression in equation (4.2) as the sum of an average productivity term and the size-productivity covariance:

$$Z_s = \mathbb{E}[\tilde{z}] + \mathbb{C}ov[\tilde{\omega}(a, z), z] \tag{4.3}$$

The first term of the right hand side of equation (4.3) captures average firm productivity adjusted by an appropriate weight, i.e. $\mathbb{E}[\tilde{z}] \equiv \mathbb{E}[z] \cdot \mathbb{E}[\tilde{\omega}(a, z)]$. The second term captures how well existing resources are allocated across firms within sector s. The larger the covariance, the higher the share of production that goes to more productive firms and hence the better the allocation of resources. As can be seen from equation (4.3), all else equal an improvement in the allocation of resources will increase TFP through the size-productivity covariance.

4.3.5 Financial liberalization

Now, suppose that the government undertakes financial liberalization with the ultimate goal of fostering credit markets. A reform in the model consists of an increase in the parameter θ, which makes the financing constraint (4.1) less binding. The underlying logic is that financial liberalization alleviates asymmetric information problems in the capital market by improving the screening and monitoring ability of banks. The effects of financial liberalization are the following.

Proposition 1. *Total factor productivity and the size-productivity covariance increase.*

As explained above, an increase in the size-productivity covariance leads to an increase in TFP. To understand the intuition behind the increase in the covariance term, we can further decompose it as follows:[2]

$$\mathbb{C}ov[\log(\omega(a, z)), \log(z)] = \frac{\sigma_z^2}{1 - \nu} - \frac{\alpha\nu}{1 - \nu}\mathbb{C}ov[\log(f_k(a, z)), \log(z)], \qquad (4.4)$$

where $\sigma_z^2 \equiv \mathbb{V}ar(\log(z))$. Intuitively, with perfect financial markets, $f_k(a, z) = r$ so the marginal product of capital is equalized across firms. As a result, $\mathbb{C}ov[\log(f_k(a, z)), \log(z)] = 0$, so the size-productivity covariance is maximized and equals $\frac{\sigma_z^2}{1-\nu}$.[3] With imperfect capital markets, however, the marginal product of capital varies across firms. In particular, given a level of wealth, a more productive firm will be more constrained and face a higher shadow cost of capital. This positive covariance lowers the size-productivity covariance, as the second term in equation (4.4) becomes positive. Financial liberalization alleviates financial constraints and therefore reduces the covariance between productivity and the

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[2]Given that in our empirical implementation we work with logs, we decompose the covariance term in logs as well. We also replace $\tilde{\omega}$ by $\omega \equiv \frac{y}{Y}$, the market share of a firm. This has little relevance, since $\mathbb{C}ov[\log(\omega(a, z)), \log(z)] = \sigma_z^2 + \mathbb{C}ov[\log(\tilde{\omega}(a, z)), \log(z)]$.

[3]In the appendix we prove for the case of a joint lognormal distribution for wealth and productivity that $\mathbb{C}ov[\log(f_k(a, z)), \log(z)]$ is greater than zero and is declining in the reform parameter θ.

marginal product of capital. This increases the size-productivity covariance and hence industry-level TFP.

This decomposition therefore delivers another testable implication. If the increase in TFP is driven by an alleviation of financial frictions, then we should observe a reduction in the within-industry covariance of the marginal product of capital and productivity after reform. In contrast, given that firms equalize the marginal product of labor to the wage rate, we should observe no changes in the covariance between the marginal product of labor and productivity.

Proposition 2. *The increase in the size-productivity covariance is driven by a reduction in the covariance between the marginal product of capital and productivity.*

Another intuitive measure for misallocation arising from frictions in the capital market is the within-industry variance of the marginal product of capital. For instance, Hsieh and Klenow (2009) consider a model of monopolistic competition with idiosyncratic wedges. Using lognormality assumptions for productivity and wedges, they show that TFP can be expressed as a function of the variance of the marginal product of capital. Motivated by this expression, we also test the hypothesis that this variance should decline after a financial reform. For the same argument given above, we should observe no changes in the variance of the marginal product of labor.

Comparing industries with different levels of financial constraints, a reform will have the following effects.

Proposition 3. *The increase in total factor productivity and size-productivity covariance is larger in industry 1 than in industry 2.*

Given that the financing constraint is more binding in industry 1 than in industry 2, industry 1 will benefit disproportionately from the reform. As a result, the size-productivity covariance and therefore TFP will increase by more than in industry 2.

Proposition 4. *Wages increase. If labor is not perfectly mobile across sectors, the increase is larger in industry 1 than in industry 2.*

Holding factor prices constant, only previously constrained firms will increase their factor demand after reform. This will lead to an increase in the demand for labor, and, with a fixed supply of labor, an increase in the wage rate. If there is some degree of segmentation of labor markets, the wage rate will increase more in industry 1, since this industry benefits relatively more by the reform.

Proposition 5. *The market share of constrained firms increases by more than the share of unconstrained firms. The increase is larger in industry 1 than in industry 2.*

As explained in the previous proposition, the wage rate increases after financial liberalization. This general equilibrium effect will force previously unconstrained firms to lower their factor holdings, and they will lose in market share. Again, the effect will be stronger in industry 1, which is financially more constrained.

4.4 Financial reforms and data

4.4.1 Reform process

Starting in the beginning of the 1990s, Eastern European countries undertook dramatic reforms in their transition from a centrally planned economy to a free market economy. Financial liberalization reforms were a key component of the second phase of transition, which was designed to be market deepening.[4] Financial deregulation was largely induced by *external* pressures from outside governing bodies such as the EU, the IMF, and the OECD. The pressure from the EU and the OECD was a result of the countries' prospective accession to these institutions. The pressure from the IMF derived from the request for financial support.

The countries chosen for our study arise from the intersection of countries that experienced significant financial reforms since the 1990s and countries whose firms are well represented in our firm-level dataset. Since most Western European countries experienced financial reforms in the 1970s and 80s, and coverage is poor for some Eastern European countries, this intersection restricts our study to 10 transition economies: Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Russia, and Ukraine.

Czech Republic, Estonia, Hungary, Latvia, Lithuania, and Poland joined the EU in 2004. Part of the same wave of enlargement was the accession of Bulgaria and Romania in 2007, which were unable to join in 2004 but constitute part of the same enlargement. To join the EU, a state needs to fulfill economic and political conditions summarized in the Copenhagen criteria. The economic criteria, broadly speaking, require that candidate countries have a functioning market economy. This required a substantial reduction of the government intervention in the financial sector. These criteria had a substantial influence on policies in Eastern European countries. Schimmelfennig and Sedelmaier (2004) (p. 671) note that "The credibility that the EU will reward rule adoption with membership, which increased significantly once accession negotiations started, emerges as the most important factor influencing the cost-benefit calculations of CEEC governments. The

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[4]The first phase of transition consisted of market-enabling reforms (e.g. liberalization of prices) while the third phase consisted of market-sustaining economic reforms (e.g. enterprise restructuring and modernization). See EBRD (2007) for details.

massive benefits of EU membership being within close reach, the fulfillment of EU acquis conditions became the highest priority in CEEC policy-making, crowding out alternative pathways and domestic obstacles."

For example, in 1997 the European Commission, in its report on the progress of the Czech Republic in the accession process, recommended that bank privatization and improvement of the regulatory framework and standards of governance would bring the country closer towards fulfillment of the Copenhagen criteria. It then consistently pushed for bank privatization in successive annual assessments (Vliegenthart and Horn, 2007).

In their request for financial support from the IMF, many countries expressed their commitment to undertake financial sector reforms. For example, the letter of intent (LOI) of the government of Bulgaria in 1998 stated that "Our priorities in the structural areas are to complete privatization of the state banks and enterprises and to develop and deepen financial markets." The LOI of Ukraine in 1998 stated that "Financial sector reform and an acceleration of privatization will also be important elements of our medium-term program." According to Romania's 1999 LOI, "In the key area of banking supervision, we envisage measures to strengthen the National Bank of Romania's supervisory and enforcement capacities and to ensure banks' compliance with prudential regulations."[5]

Finally, three of the countries under study (Czech Republic, Hungary, and Poland) are members of the OECD. The OECD also imposed pressure to its prospective members. For example, following the division of the country into two republics in 1993, the Czech Republic authorities began to map the steps toward capital account liberalization. According to a number of former officials interviewed, the process of eliminating capital controls was largely driven by the country's prospective accession to the OECD (IMF, 2005).

4.4.2   Reform data

The data on financial liberalization used in this paper comes from Abiad et al. (2010). The authors create a liberalization index, which runs from 1975 to 2005 and measures the removal of government control of the financial sector. Recognizing the multifaceted nature of financial liberalization, the index is an aggregation along seven dimensions: (1) directed credit, (2) interest rate controls, (3) entry barriers, (4) restrictive operational regulations, (5) privatization in the financial sector, (6) controls on international financial transactions, and (7) securities market policy.

Along each dimension, a country is given a final score on a graded scale from 0 to 3, with 0 corresponding to the highest degree of repression and 3 indicating full liberalization.

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[5]The letters of intent are available from the IMF's website, http://www.imf.org.

The index therefore ranges from 0 to 21. Table 4.1 reports the evolution of the financial reform index for our sample of countries during the 1994-2005 period.[6]

[Include table 4.1 here]

Among all countries, Ukraine presents the highest level of financial repression during this period. In 2005, Ukraine's index of financial liberalization was less than 70% of the maximum achievable level. Estonia, on the other hand, is the country with the least government intervention in the financial sector. Hungary is the economy that most rapidly deregulated its financial markets during these years. Its financial liberalization index almost doubled between 1994 and 2005.

There are several papers documenting that financial liberalization alleviates financial constraints faced by firms (Laeven, 2003) and leads to deeper financial markets (Tressel and Detragiache, 2008). If we look at our cross-section of countries (figure 4.2), we can observe that countries with more deregulated financial markets do in fact exhibit higher financial depth.[7]

[Include figure 4.2 here]

4.4.3 AMADEUS data

The firm-level data comes from AMADEUS. AMADEUS is a commercial database provided by Bureau van Dijk (BvD). It contains financial information on over five million public and privately held firms across many Western and Eastern European countries. BvD collects the data from local information providers, which in most cases are the local company registers. The database comes in yearly versions and each vintage includes up to ten years of information per firm.

Table 4.2 reports the coverage of firms for the ten countries in our sample. The differences in the number of firms across countries can mainly be attributed to different filing requirements for companies. In most cases, these filing requirements are related to size criteria, or to the mode of incorporation.[8] The large number of Romanian firms is particularly striking in the table. This can be attributed to the exceptional coverage of

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[6]Our sample spans between 1994 and 2005 since our firm-level data starts from 1994 and the financial liberalization data ends in 2005.

[7]Financial depth is measured as the ratio of private credit to GDP.

[8]For instance, in Bulgaria all companies that match at least two out of the following three criteria have to file: at least 50 persons staff, total assets at least EUR 500.000, or turnover at least EUR 1.000.000. In Hungary, all companies except private entrepreneurs have to file records.

small firms: 77% of Romanian firms have less than 10 employees in the first year they appear in the data, which is by far the highest percentage across all countries.[9]

[Include table 4.2 here]

Our sample period is also characterized by a significant increase in the number of observed firms over time. According to BvD representatives, the inclusion of small-and medium-sized enterprises has contributed significantly to this increase. Moreover, BvD has made an effort to source additional data, working together with country authorities. In our empirical analysis, our coefficient of interest will be identified by within-country variation across industries. A potential concern might be that this increase in coverage was biased across industries. Although this would not directly affect our main variables of interest, such as the size-productivity covariance, it would directly affect sector-level totals (e.g. total output, total number of employees). We therefore check whether this increase in the number of firms is biased across industries with different degrees of financial constraints (external financial dependence and asset tangibility). We do not find evidence of any such bias.[10]

Due to data restrictions, we do not attempt to provide a detailed analysis of the intensive versus extensive margin in the process of reallocation. Depending on the filing requirements, we are unable to capture entry or exit if entrants are either too small to meet the filing requirements or if they start their business in a mode of incorporation that excludes them from the requirement to file accounts. 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.

Another threat for the representativeness of our data is the well-known survivorship bias that is inherent in the construction of the AMADEUS data. If a firm has stopped filing, it is kept in the database for four subsequent years and is then deleted. This biases the coverage towards surviving firms and has limited the time coverage of several previous studies using AMADEUS. For our study, it is essential to follow firms within a country for consecutive years. We overcome this bias by appending two versions (2006 and 2002) of the database. Firms that exited prior to 2002 and got deleted in the 2006 version of the database are present in the 2002 vintage and will therefore be included in our appended dataset.

AMADEUS includes a large number of small and medium-sized enterprises (SMEs). This is a distinct advantage over datasets that only contain listed companies (e.g. COM-PUSTAT Global), especially in the context of studying financial frictions. Table 4.3

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[9]The average for other countries is 40%.

[10]This evidence is not reported here to conserve space, but is available from the authors upon request.

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 manufacturing firms from EUROSTAT.

[Include table 4.3 here]

Although AMADEUS contains many SMEs, we can see from the table that they are under-represented in our data. However, since SMEs should suffer more than large firms from financial frictions, we think of this bias in coverage as going against us finding an effect of financial liberalization on TFP.

4.5 Empirical strategy

4.5.1 Identification strategy

To identify the causal effect of financial liberalization on TFP and misallocation, we exploit variation in financial constraints across industries. For technological reasons, some industries are more constrained than others. First, some industries inherently need more external financing than others (Rajan and Zingales, 1998). As an industry's dependence on external finance increases, the availability of outside capital becomes more important. Second, some industries operate naturally with a higher proportion of tangible assets than others (Braun, 2003; Claessens and Laeven, 2003). As an industry's asset tangibility decreases, the amount of collateral that can be pledged for loans becomes scarcer. As a result, financial deregulation should increase TFP particularly in industries with high needs of external finance and low levels of asset tangibility.

If there are other reforms taking place at the same time than financial liberalization that affect all industries equally, their effect will be cancelled by the cross-industry comparison. However, there might be other reforms that affect industries differentially depending on their degree of financial constraints. We address this issue by controlling explicitly for the interaction of a large set of observable reforms and industry financial constraints. In particular, we use the internal, external, and privatization reform indicators constructed by Campos and Horvath (2009). Our identification assumption is that after controlling for these additional reforms, there are no other policies that affect particularly industries with strong financial constraints.

While identification does not require that industries have exactly the same level of financial constraints in every country, it does rely on the *ranking* of sectors remaining relatively stable across countries. Given that we are working with a fairly homogenous group of transition economies, we consider this a reasonable assumption.

A final concern is that a country might have deregulated its financial market in order to accommodate the needs of a high-productivity growth industry. If this industry is highly financially constrained, this would impose a threat to identification through reverse causality. However, as discussed in the previous section, the decision to deregulate was triggered mainly by pressures from external organizations, which are unrelated to industry-specific characteristics.

Furthermore, we provide evidence that financially constrained industries exhibit relatively low political strength, which makes the possibility of reverse causality even more unlikely. We use two proxies of industry-level political strength at the beginning of the sample. The first is relative size, which we measure as the share of assets of an industry relative to the economy wide assets. Panels (a) and (b) of figure 4.3 shows that industries with high financial dependence and low asset tangibility are actually associated with low relative sizes. The second proxy used is the degree of industry fragmentation, which we compute using the Herfindahl index.[11] From panels (c) and (d), we can observe that relationship between concentration and financial constraints is weak, but if anything more financially constrained industries exhibit less concentration.

[Include table 4.3 here]

4.5.2 Sectoral indices

The first measure of industry-level financial constraints we use is external financial dependence (Rajan and Zingales, 1998). The index of dependence is measured as the median ratio across firms belonging to the corresponding U.S. industry of capital expenditures minus cash flow from operations to capital expenditures. Second, we use asset tangibility (Braun, 2003; Claessens and Laeven, 2003). The tangibility index is measured as the median ratio across firms of the value of net property, plant, and equipment to total assets.

Table 4.4 reports the two sectoral indices for the 22 manufacturing industries analyzed in our paper.

[Include table 4.4 here]

As can be seen from the table, electrical machinery is an example of an industry with very high financial needs, while one of the industries with lowest needs is food products. Likewise, basic metals exhibits one of the highest degree of asset tangibility, while medical

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[11]The Herfindahl index is calculated by squaring the market share of each firm and then summing the resulting numbers, i.e. $H_s = \sum_i \omega_{si}^2$.

instruments is an example of a very low tangibility industry. The two sectoral indices are negatively correlated.

4.5.3 Productivity decomposition

We start by measuring firm-level TFP. For each country, we compute firm-level productivity residually from the production function:

$$\log(z)_{ist} = \log(y)_{ist} - \alpha_s^k \log(k)_{ist} - \alpha_s^l \log(l)_{ist}, \tag{4.5}$$

where i denotes a firm, s a sector, and t a year. y corresponds to revenues, k to fixed assets, and l to number of employees.

In principal, we could estimate directly the parameters of equation (4.5). The two threats for identification would be endogeneity of some of the inputs (which depend on productivity) and sample selection (exit of inefficient firms). Olley and Pakes (1996) and Levinsohn and Petrin (2003) propose methods to deal with these two threats. However, we are unable to replicate these methods since we lack data on intermediate inputs and our data has insufficient details on firm exit.

Instead of estimating the parameters, we set input elasticities equal to factor shares. We impose constant returns to scale and measure the labor elasticity for each sector as the average labor share across all of countries and years, i.e. $\alpha_s^l = (wl/y)_s$. The data on labor shares comes from the UNIDO dataset. In section 4.7 we show that our results are robust to using labor productivity as an alternative measure of firm-level efficiency.[12]

Next, we define industry-level productivity as a weighted average of firm-level productivities:

$$\log(Z)_{st} = \sum_i^n \omega_{ist} \log(z)_{ist},$$

where ω_{ist} is the share of revenues of firm i in total revenues of sector s. We use the method of Olley and Pakes (1996) to decompose industry-level productivity into two components:

$$\log(Z)_{st} = \underbrace{\log(\overline{z})_{st}}_{\text{average-productivity term}} + \underbrace{\sum_i^n \Delta \omega_{ist} \Delta \log(z)_{ist}}_{\text{allocation term}}, \tag{4.6}$$

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[12]Note that since we lack information on firm-level prices, we are using a *revenue*-based measure of TFP. See Foster et al. (2008) for the differences between revenue and physical-based TFP measures.

where $\Delta\omega_{ist} \equiv \omega_{ist} - \overline{\omega}_{st}$, $\Delta\log(z)_{sit} \equiv \log(z)_{sit} - \log(\overline{z})_{st}$, and $\overline{\omega}_{st}$ and $\log(\overline{z})_{st}$ denote the unweighted mean share and unweighted mean (log) productivity, respectively.[13]

The component $\log(\overline{z})$ of equation (4.6) represents the *average-productivity* term and the component $\sum \Delta\omega \Delta\log(z)$ the *allocation* term. The productivity term measures the contribution of individual firm productivity to industry productivity. The allocation term corresponds to the sample size-productivity covariance. The larger this covariance, the higher the share of production that goes to more productive firms. This results in a better allocation of resources and therefore higher industry productivity.

4.6 Results

4.6.1 Industry effects

We start by analyzing the effect of financial liberalization on industry output and its different components. For this, we estimate the following generalized difference-in-differences specification:

$$\log(Q)_{cst} = \alpha Ref_{ct} \cdot Fin_s + \beta x_{ct} \cdot Fin_s + \eta_{ct} + \eta_{cs} + \epsilon_{cst} \quad \text{for} \quad Q \in \{Y, K, L, Z\},$$

where Q_{cst} denotes either output, capital, employment or TFP of country c in sector s in year t. Ref_{ct} represents the financial reform index for each country in each moment of time. Fin_s measures sector s's level of financial constraints, which in alternative regressions we proxy with external financial dependence and asset tangibility. x_{ct} is a vector including internal, external, and privatization reform indicators. The specification includes country×year and country×industry fixed effects.[14] The standard errors of this and all regressions are clustered at the country level.[15]

The coefficient of interest is α, which measures the *differential* effect of financial liberalization across industries with different levels of financial constraints. The coefficient is identified purely from the cross-industry variation *within* a country over time. The results are presented in table 4.5.

[Include table 4.5 here]

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[13]Note that $\sum \omega \log(z) = \sum(\overline{\omega} + \Delta\omega)[\log(\overline{z}) + \Delta\log(z)] = n\overline{\omega}\log(\overline{z}) + \sum \Delta\omega \Delta\log(z) = \log(\overline{z}) + \sum \Delta\omega \Delta\log(z)$.

[14]Country ×year fixed effects absorb time-varying country characteristics, such as the overall level of development, growth, and country-wide reforms. Country×industry fixed effects capture the peculiar characteristics of each industry within each country.

[15]This allows for any intraclass correlation across industries within a country and any serial correlation within a country across time.

Panel A of the table reports the results using external financial needs as the measure of financial constraints, while panel B uses asset tangibility. From the table, we can observe that financial liberalization increases output disproportionately in industries with high requirements for external finance and low tangibility. The effect is statistically significant at the 5% level.

To interpret the magnitude of the effect, consider a country undertaking a large reform, which according to Abiad et al. (2010) corresponds to an increase of the financial liberalization index by three units. The differential effect of the reform on two industries with different levels of financial constraints is $\alpha \cdot 3 \cdot (Fin_h - Fin_l)$. The point estimate implies that liberalizing financial markets increases output in the 75th-percentile industry by financial dependence by 16% more than in the 25th-percentile industry. Likewise, it increases output in the 25th-percentile industry by asset tangibility by 24% more than in the 75th-percentile industry.[16]

Turning to the determinants of industry output, we find no significant effect on either capital or labor, but the effect on TFP is highly significant at the 1% level. The magnitude of the effect is also large: the differential effect across industries with different levels of financial dependence is 16% and across industries with different asset tangibility is 21%. This finding is consistent with previous evidence documenting that financial liberalization increases economic growth primarily through higher TFP (Levine, 2005; Levchenko et al., 2009; Bekaert et al., 2011).

4.6.2 Productivity decomposition

The TFP gains documented in the previous section could be the result of higher firm-level productivity or a better allocation of resources across firms. To disentangle these two effects, we use the Olley and Pakes (1996) methodology and decompose TFP in an average-productivity and an allocation term. We then analyze the effect of financial liberalization on each of these components:

$$\log(Z)_{cst}^j = \alpha Ref_{ct} \cdot Fin_s + \beta x_{ct} \cdot Fin_s + \eta_{cs} + \eta_{ct} + \epsilon_{cst} \quad \text{for} \quad j \in \{total, average, allocation\} \tag{4.7}$$

Table 4.6 reports the results. The results show that financial liberalization increases both the average-productivity and the allocation term particularly in the high-constrained industries (panels A and B). However, the effect on the productivity term is both less significant and smaller in magnitude than the allocation term effect.

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[16]The 75th and 25th-percentile industries by financial dependence (asset tangibility) are motor vehicles and tanning & dressing of leather (non-metallic mineral products and tobacco products).

[Include table 4.6 here]

According to the results, financial liberalization increases the allocation (average-productivity) term in industries with high financial dependence by 12% (5%) more than in industries with low dependence. In other words, the increase in the allocation term explains 71% of the differential increase in TFP across industries, while the remaining 29% is explained by the increase in within-firm productivity. Similar results arise when we use asset tangibility. In this case, the allocation and average-productivity term explain 60% and 40% of the differential effect on TFP, respectively.[17]

4.6.3   Firm-level productivity

Given that the Olley and Pakes (1996) methodology is a *cross-sectional* productivity decomposition, we have to be careful in interpreting the *change* in its components across time. In particular, if the set of firms changes from one period to the other, an increase in the average-productivity term can be the result of *existing* firms increasing their productivity or of more productive firms entering and less productive firms exiting.

We can address this concern by estimating directly the effect of financial liberalization on firm-level productivity:

$$\log(z)_{csit} = \alpha Ref_{ct} \cdot Fin_s + \beta x_{ct} \cdot Fin_s + \eta_{ct} + \eta_i + \epsilon_{cst}$$

The specification includes fixed effects for each firm i, which allows us to estimate within-firm changes in productivity. The effect is identified using only the variation of *existing* firms, since these have information both prior and after the reform.[18] Results are shown in table 4.7.

[Include table 4.7 here]

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[17]If after reform large firms yield higher productivity growth than small firms, this could be captured by an increase in our allocation term. To check whether this is a potential concern, we estimate the following firm-level productivity regression:

$$\log(z)_{csit} = \alpha_1 Ref_{ct} \cdot Fin_s + \alpha_2 Ref_{ct} \cdot Large_i + \alpha_3 Ref_{ct} \cdot Fin_s \cdot Large_i + \eta_{ct} + \eta_i + \epsilon_{cst}$$

In this specification, $Large_i$ is a dummy variable that is one for firms above the median of lagged employment size in their country-sector-year cell. Since α_3 is is not statistically significant, we do not find evidence for this potential concern. The results, which are not presented here for space reasons, are available upon request.

[18]To make these results comparable to the industry-level estimations, we weigh each firm observation by the inverse of the number of firms in the corresponding country-year-industry cell.

The table shows that for both financial constraints measures financial deregulation increases firm-level productivity disproportionately in high-constrained industries. The effect is statistically different from zero. More importantly, the coefficients are almost identical to the ones obtained in the average-productivity estimations (column (2) of table 4.6). The differential effect using external financial dependence is 4.7% for both the average-productivity and the firm-level regressions. Similarly, the differential effect using asset tangibility is 11.5% for the average-productivity regression and 10.5% for the firm-level regression.

We can therefore conclude that the increase in the within term documented in the previous section is the result of higher productivity of existing firms and not the result of differences in productivity of firms that are entering and exiting the market.

Although understanding the link between financial frictions and firm-level productivity goes beyond the scope of this paper, we briefly point out two reasons by which financial liberalization could increase firm productivity. First, financial deregulation can lead to a within-firm reallocation of resources across products, which could increase the productivity of multi-product firms (Bernard et al., 2011). Secondly, since financial constraints restrain the ability of firms to innovate (Gorodnichenko and Schnitzer, 2012), deregulation could lead to more innovation and therefore firm-productivity gains.

4.6.4 Marginal product of factors

To further understand the mechanisms by which financial liberalization improves the allocation of resources across firms, we analyze empirically two testable implications derived from the model of section 4.3. First, we estimate the effect of the reform on the covariance between the marginal product of factors and TFP and next we estimate the effect on the variance of the marginal product across firms.

Given that we have assumed Cobb-Douglas production functions, the marginal product of factors are proportional to the average products, i.e. $f_k(z, k, l) = \alpha_s y/k$ and $f_l(z, k, l) = (1 - \alpha_s)y/l$. We start by analyzing the effects of the reform on the within-industry covariance between the marginal products of factors and TFP:

$$\mathbb{C}ov[\log(f_m), \log(z)]_{cst} = \alpha Ref_{ct} \cdot Fin_s + \beta x_{ct} \cdot Fin_s + \eta_{ct} + \eta_{cs} + \epsilon_{cst} \quad \text{for} \quad m \in \{k, l\}$$

The estimation results are reported in table 4.8. As can be seen, financial liberalization decreases (increases) the covariance between the marginal product of capital and TFP disproportionately in industries with high external financial needs (asset tangibility). The effects are significant at the 5% level and large in magnitude. The differential effect across industries with different levels of financial needs (asset tangibility) is 10% (17%). We can

also observe that the effect on the covariance of the marginal product of labor and TFP is both statistically not significant and very small in magnitude, as predicted by theory.

[Include table 4.8 here]

Next, we measure the effects of financial deregulation on the within-industry variance of marginal products of factors:

$$\mathbb{V}ar[\log(f_m)]_{cst} = \alpha Ref_{ct} \cdot Fin_s + \beta x_{ct} \cdot Fin_s + \eta_{ct} + \eta_{cs} + \epsilon_{cst} \quad \text{for} \quad m \in \{k, l\}$$

According to the results, which are depicted in table 4.9, the deregulation of financial markets decreases the variance of the marginal product of capital particularly in financially constrained industries. The effect is highly significant and of large economic magnitude: the cross-industry differential effect is 22% and 35% when using the financial dependence and asset tangibility index, respectively. Again, there is no significant effect on the variance of the marginal product of labor, which further supports our results.

[Include table 4.9 here]

4.6.5 Firm-level market shares

In the previous section we have documented that financial liberalization increases TFP primarily through a better within-industry allocation of resources. If this is the case, we should expect the market share of firms that are ex-ante more financial constrained to increase after deregulation.

In this section, we analyze the effect of financial deregulation on the market share of *domestically*-owned firms relative to *foreign*-owned firms.[19] Foreign-owned affiliates should be less financially constrained because they can access additional funding from their parent company.[20] Manova et al. (2011) show in fact that foreign-owned affiliates have better export performance than domestic firms and that this advantage is systematically greater in financially-constrained sectors. We estimate the following firm-level equation:

$$\log(\omega)_{cist} = \alpha Ref_{ct} \cdot Dom_i + \beta x_{ct} \cdot Dom_i + \eta_{ct} + \eta_i + \epsilon_{csit} \quad \text{for} \quad s \in \{all, Fin_h, Fin_l\},$$

where ω denotes the market share of firm i in industry j (in terms of capital) and Dom is a dummy indicating whether a firm is domestically-owned or not. The coefficient of interest,

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[19]In our sample, 15% of the firms are affiliates of a multinational company.

[20]See Desai et al. (2004) for evidence that multinationals employ internal capital markets opportunistically to overcome imperfections in external financial markets.

α, measures the differential effect of deregulation on firms with different ownership types. According to theory, this differential effect should be increasing with an industry's level of financial constraints. So in addition, we estimate the regression for the subset of industries with high and low levels of constraints.[21] This extra layer of difference allows for a stronger identification of the causal effect of the reform. Table 4.10 reports the results.

[Include table 4.10 here]

We can see from column (1) that the differential effect of financial liberalization on the market share of domestic firms is positive and highly significant. Deregulation increases the share of domestic firms by 4% more than foreign firms. Moreover, the differential effect is particularly large in industries with high financial needs (7%) and low asset tangibility (9%). The effect is very small in magnitude and statistically not different from zero in unconstrained industries.

4.7 Additional results

In this section we present a series of additional exercises that further support the main results found in the paper.

Creditor rights. We start by studying how the effect of financial liberalization varies according to a country's contracting institutions. Since financial liberalization increases financial depth particularly in countries with solid contracting institutions (Galindo et al., 2002), the effect on TFP should be increasing in the strength of creditor rights. We use the creditor rights index developed by Haselmann et al. (2010).

We divide our set of countries into two groups, depending on whether the creditor rights index at the beginning of the sample is above or below the median across all countries. We then re-estimate equation (4.7) for each of the two groups. The results are reported in table 4.11. For both measures of financial constraints, the effect of the reform is highly significant and large in magnitude for the group of strong-creditor rights countries (column (1)-(3)), in contrast to the group of countries with weak creditor rights (column (4)-(6)). The coefficients of both sub-samples are statistically different from each other.

[Include table 4.11 here]

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[21]We classify an industry as highly financially constrained if its financial constraint index is larger than the median of the index across all industries.

Wages. A financial reform alleviates financial frictions allowing constrained firms to demand more capital. Since labor complements with capital, the reform also increases labor demand and in equilibrium wages. This increase in wages is important since it is the market force that makes large unproductive firms reduce their size (see model in section 4.3). In this section we test whether financial liberalization in fact boosts wages.[22] Results are reported in table 4.12.

[Include table 4.12 here]

From the table, we can see that financial liberalization increases wages particularly in industries with high financial constraints. Deregulation increases wages in industries with high financial dependence (low asset tangibility) by 6% more than in industries with low dependence (high tangibility).

Alternative productivity measure. Throughout the paper, we have used TFP as a measure of efficiency. An alternative measure of efficiency is labor productivity.[23] The main advantage of this measure is its simplicity, since it is calculated simply as the ratio between output and employment. In table 4.13 we show that the productive decomposition produces the same results (both qualitatively and quantitatively) independent of the efficiency measure used.

[Include table 4.13 here]

4.8   Conclusions

If an economy exhibits perfect financial markets, productivity is the only determinant of the size of firms. If, on the other hand, the financial market is underdeveloped, wealth also plays an important role for determining a firm's size. As a result, resources are not allocated towards their most efficient use, resulting in low aggregate productivity.

An improvement in the functioning of the financial market should weaken the link between entrepreneurial wealth and firm size. Resources should become allocated more efficiently and aggregate TFP should increase. In this essay, we focus on a specific reform which reduces financial frictions, financial liberalization. We use a large cross-country

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[22]We construct wages at the firm level as the ratio between the wage bill and the number of employees. We then aggregate wages to the industry level.

[23]Several papers, including (Bartelsman et al., 2012), use labor productivity for industry productivity decompositions.

firm-level database to analyze whether the reform increases TFP and whether the efficiency with which resources are allocated improves. To identify the causal effect of the reform on productivity and misallocation, we exploit differences in financial constraints across industries.

We find that financial liberalization indeed increases TFP particularly in financially constrained industries, i.e. sectors with high external financial needs and low asset tangibility. To understand the factors that are driving the productivity gains, we decompose industry productivity into an average-productivity term (measuring firm efficiency) and an allocation term (measuring resource allocation quality). We find that a better allocation of resources is the main driver of the TFP gains. This result is confirmed by our finding that the reform reduces the covariance between TFP and marginal product of capital, and reduces the variance of the marginal product of capital. The finding that the market share of ex-ante financially constrained firms (domestically-owned firms) increases after financial deregulation further supports our results.

Our findings contribute to the discussion about the importance of financial frictions for aggregate TFP losses. While Buera et al. (2011) document that misallocation arising from financial frictions leads to large productivity losses, Midrigan and Xu (2010) document only a minor effect. However, both papers study the effect of financial frictions across *steady states*, where firms are able to accumulate internal funds and grow out of their financing constraints. In our essay, we focus on the *transition* to the steady state. We show that during this transition, financial frictions are an important source of misallocation and a reform that alleviates these frictions leads to large TFP gains. As such, our results show that the liberalization of financial markets can contribute to closing the gap of cross-country differences in income per worker.

Figure 4.1: Financial liberalization and aggregate productivity in a cross-section of Eastern European countries
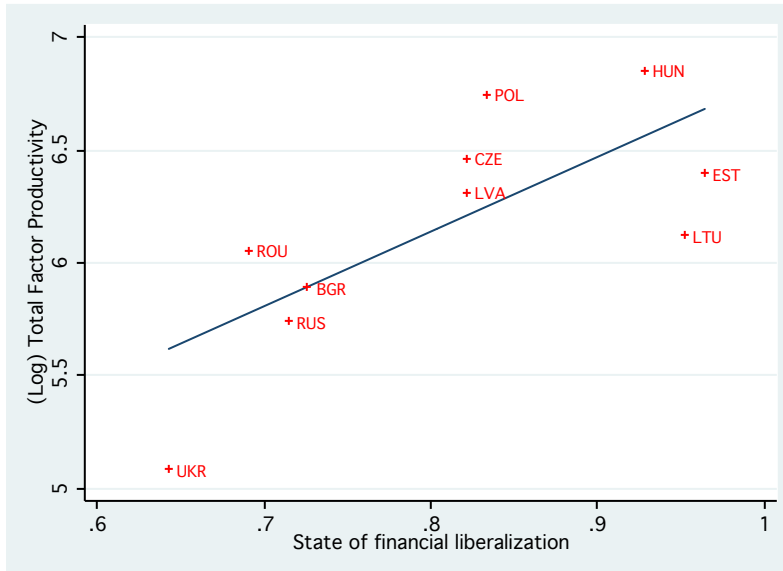
Notes: the figure plots the relationship between the state of financial liberalization (normalized to be between 0 and 1) and the (log) of aggregate TFP in a cross-section of ten transition economies in 2000. Sources: own calculations based on data from Abiad et al. (2010) and AMADEUS (see main text for details).

Figure 4.2: Financial liberalization and financial depth in a cross-section of Eastern European countries
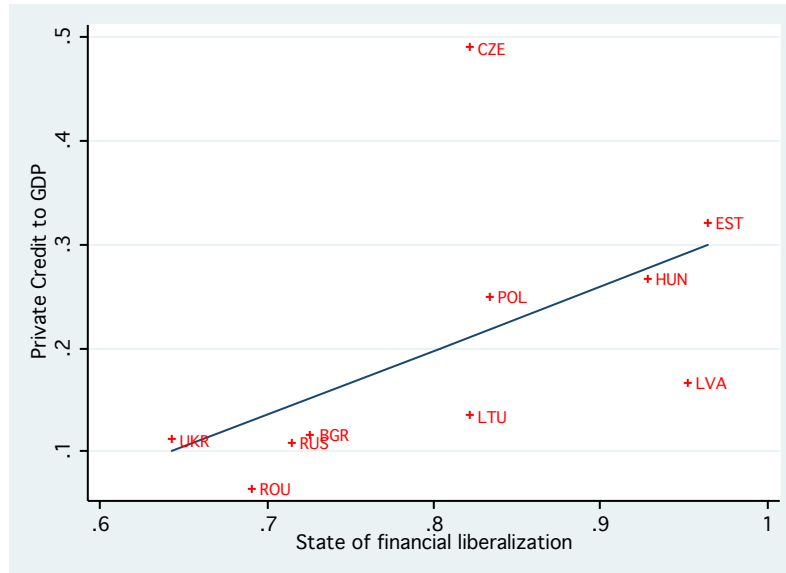
Notes: the figure plots the relationship between the state of financial liberalization (normalized to be between 0 and 1) and the ratio of private credit to GDP in a cross-section of ten transition economies in 2000. Sources: own calculations based on data from Abiad et al. (2010) and Beck and Demirguc-Kunt (2009).

Figure 4.3: Industry political strength and financial constraints
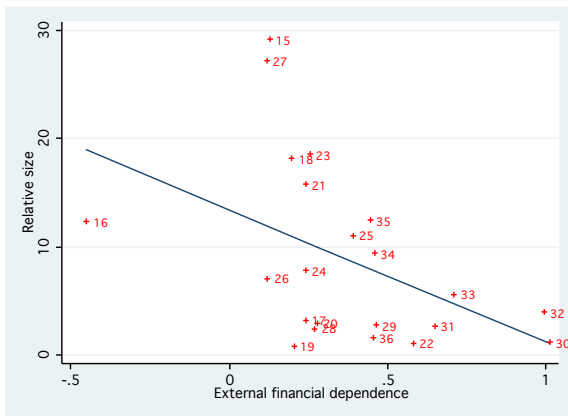
(a) Relative size and financial dependence
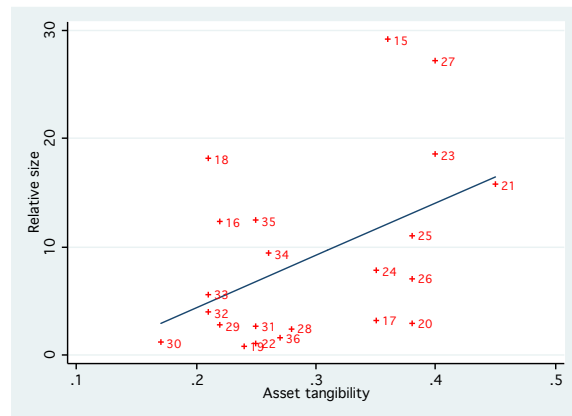
(b) Relative size and asset tangibility
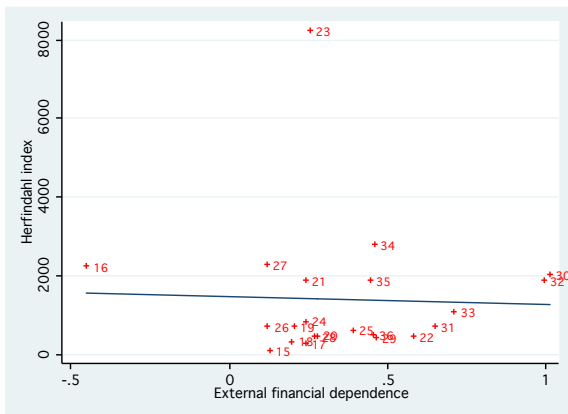
(c) Herfindahl index and financial dependence
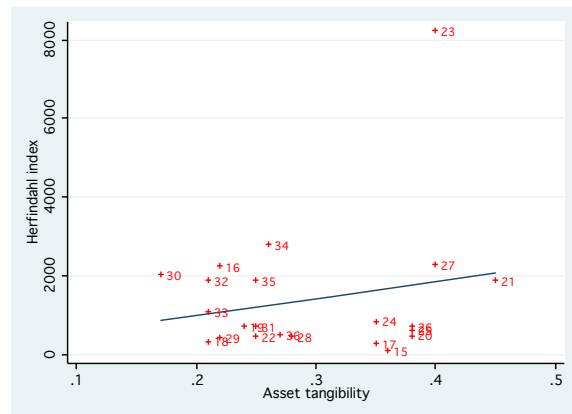
(d) Herfindahl index and asset tangibility

Notes: the figure plots the relationship between industry political strength and financial constraints. Panels (a) and (b) [(c) and (d)] proxy political strength with an industry's size relative to the economy [industry concentration, measured as the Herfindahl index, $H_s = \sum_i \omega_{si}^2$.] Panels (a) and (c) [(b) and (d)] measures industry financial constraints using the external financial dependence [asset tangibility] index. Source: own calculations.

Table 4.1: Evolution of financial liberalization for Eastern European countries

Country	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Bulgaria	10	9.25	8	8.25	10.25	11.25	15.25	16	17	18	18	17.25
Czech Republic	12.5	12.5	15.5	15.5	15.5	17.25	17.25	19.25	19.25	19.25	19.25	19.25
Estonia	14.25	17.25	18.25	18.25	19.25	20.25	20.25	21	21	21	21	21
Hungary	10.5	11.5	15.5	18.5	19.5	19.5	19.5	20.25	20.25	20.25	20.25	20.25
Latvia	16	17	18	18	18	20	20	21	21	21	21	21
Lithuania	11.5	12.5	12.5	14.5	15.25	17.25	17.25	18.25	19.25	19.25	19.25	19.25
Poland	10.5	11.5	14.5	16.5	17.5	17.5	17.5	17.5	17.5	17.5	18.5	18.5
Romania	10.5	11.5	11.5	13.25	12.5	13.5	14.5	15.5	15.5	16.5	18.5	18.5
Russia	11.5	13.25	14.25	15.25	16	15	15	16	16	17	17	17
Ukraine	9.5	9.5	9.5	11.5	11.5	13.5	13.5	13.5	14.5	14.5	14.5	14.5

Notes: the table reports the evolution of the Abiad et al. (2010) financial liberalization index for the ten transition economies in our sample during the 1994-2005 period. The index aggregates seven financial sector dimensions: (1) directed credit, (2) interest rate controls, (3) entry barriers, (4) restrictive regulations, (5) privatization in financial sector, (6) controls on international financial transactions, and (7) securities market policy.

Table 4.2: Coverage of firms in AMADEUS dataset

Country	Number of Firms
Bulgaria	12,385
Czech Republic	9,179
Estonia	6,031
Hungary	1,567
Latvia	1,011
Lithuania	1,967
Poland	7,870
Romania	74,191
Russia	59,594
Ukraine	5,693
Total	179,488

Notes: the table reports the coverage of firms for the ten countries in our sample. Source: own calculations based on AMADEUS.

Table 4.3: Employment distribution across different size bins

Country	$1< L <9$	$10< L <49$	$50< L <249$	$L >250$
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%

Notes: the table reports the employment distribution across different size bins for the ten countries in our sample. It also compares the AMADEUS average employment distribution with the EUROSTAT distribution, which includes the universe of firms. Source: own calculations based on AMADEUS and EUROSTAT.

Table 4.4: External financial dependence and asset tangibility indices

Industry name	(1) ISIC rev 3.	(2) Ext. financial dependence	(3) Asset tangibility
Manufacture of food products and beverages	15	0.13	0.36
Manufacture of tobacco products	16	-0.45	0.22
Manufacture of textiles	17	0.24	0.35
Manufacture of wearing apparel	18	0.20	0.21
Tanning and dressing of leather	19	0.21	0.24
Manufacture of wood	20	0.28	0.38
Manufacture of paper and paper products	21	0.24	0.45
Publishing, printing and rep. of media	22	0.58	0.25
Manufacture of coke, refined petroleum products	23	0.26	0.40
Manufacture of chemicals and chemical products	24	0.24	0.35
Manufacture of rubber and plastics products	25	0.39	0.38
Manufacture of other non-metallic mineral products	26	0.12	0.38
Manufacture of basic metals	27	0.12	0.40
Manufacture of fabricated metal products	28	0.27	0.28
Manufacture of machinery and equipment	29	0.46	0.22
Manufacture of office, acc. and comp. machinery	30	1.01	0.17
Manufacture of electrical machinery and apparatus	31	0.65	0.25
Manufacture of radio, television and comm. equipment	32	1.00	0.21
Manufacture of medical, precision and optical inst.	33	0.71	0.21
Manufacture of motor vehicles, trailers and semi-trailers	34	0.46	0.26
Manufacture of other transport equipment	35	0.45	0.25
Manufacture of furniture; manufacturing n.e.c.	36	0.45	0.27

Notes: the table reports the external financial dependence index (column (2)) and the asset tangibility index (column (3)) for the 22 industries in the sample. Financial dependence is defined as the fraction of capital expenditures not financed by cash flow from operations. Asset tangibility is defined as the ratio of tangible assets to total assets. Source: own calculations based on Rajan and Zingales (1998) and Braun (2003).

Table 4.5: Effects of financial liberalization on industry output, capital, labor, and TFP

	(1) Output	(2) Capital	(3) Labor	(4) TFP
A. External financial dependence				
Fin Lib · EFD	0.203**	0.035	0.040	0.214***
	(0.063)	(0.053)	(0.031)	(0.035)
Internal · EFD	0.021	0.029	0.013	0.001
	(0.018)	(0.022)	(0.013)	(0.024)
External · EFD	0.000	-0.010	0.014	-0.010
	(0.011)	(0.023)	(0.011)	(0.015)
Privat · EFD	-0.003	0.052*	0.002	-0.055
	(0.051)	(0.024)	(0.016)	(0.041)
Differential effect	16.0%	3.0%	3.4%	16.3%
C-Y fixed effects	yes	yes	yes	yes
C-I fixed effects	yes	yes	yes	yes
Observations	1717	1717	1717	1717
R-squared	0.968	0.955	0.980	0.916
B. Asset tangibility				
Fin Lib · Tang	-0.503**	-0.099	-0.101*	-0.612***
	(0.212)	(0.212)	(0.050)	(0.139)
Internal · Tang	-0.006	-0.061	0.008	-0.047
	(0.071)	(0.072)	(0.031)	(0.064)
External · Tang	-0.075*	-0.008	-0.043	-0.015
	(0.038)	(0.044)	(0.035)	(0.055)
Privat · Tang	0.199	0.048	-0.015	0.339**
	(0.196)	(0.150)	(0.026)	(0.146)
Differential effect	-24.1%	-4.3%	-5.0%	-29.0%
C-Y fixed effects	yes	yes	yes	yes
C-I fixed effects	yes	yes	yes	yes
Observations	1717	1717	1717	1717
R-squared	0.965	0.954	0.980	0.912

Notes: the table presents the estimates of the effect of financial liberalization on industry output, capital, labor and TFP. EFD stands for external financial dependence and Tang for asset tangibility. Panel A (B) measures industry financial constraints using the EFD (Tang) index. The differential effect measures the relative impact of the reform on industries at the 75th and 25th-percentile of the each index. Standard errors in parentheses are clustered at the country level using block-bootstrapping. ***, **, * denote statistical significance at 1%, 5%, and 10%.

Table 4.6: Financial liberalization and industry TFP decomposition

	(1) Industry TFP	(2) Average-productivity Term	(3) Allocation Term
	A. External financial dependence		
Fin Lib · EFD	0.214***	0.060*	0.154***
	(0.035)	(0.029)	(0.026)
Internal · EFD	0.001	0.001	0.001
	(0.024)	(0.014)	(0.018)
External · EFD	-0.010	0.015	-0.025***
	(0.015)	(0.012)	(0.006)
Privat · EFD	-0.055	-0.014	-0.042*
	(0.041)	(0.027)	(0.019)
Differential effect	16.3%	4.7%	11.6%
C-Y fixed effects	yes	yes	yes
C-I fixed effects	yes	yes	yes
Observations	1717	1717	1717
R-squared	0.916	0.974	0.676
	B. Asset tangibility		
Fin Lib · Tang	-0.612***	-0.243***	-0.369***
	(0.139)	(0.070)	(0.099)
Internal · Tang	-0.047	-0.108***	0.062
	(0.064)	(0.027)	(0.080)
External · Tang	-0.015	-0.002	-0.013
	(0.055)	(0.033)	(0.031)
Privat · Tang	0.339**	0.170***	0.169
	(0.146)	(0.049)	(0.109)
Differential effect	-29.0%	-11.6%	-17.4%
C-Y fixed effects	yes	yes	yes
C-I fixed effects	yes	yes	yes
Observations	1717	1717	1717
R-squared	0.912	0.973	0.672

Notes: the table presents the estimates of the effect of financial liberalization on industry TFP and its average-productivity and allocation components. EFD stands for external financial dependence and Tang for asset tangibility. Panel A (B) measures industry financial constraints using the EFD (Tang) index. The differential effect measures the relative impact of the reform on industries at the 75th and 25th-percentile of the each index. Standard errors in parentheses are clustered at the country level using block-bootstrapping. ***, **, * denote statistical significance at 1%, 5%, and 10%.

Table 4.7: Financial liberalization and firm-level productivity

	(1) Using EFD	(2) Using Tang
Fin Lib · EFD	0.061** (0.025)	
External · EFD	-0.001 (0.009)	
Internal · EFD	0.005 (0.008)	
Privat · EFD	-0.018 (0.010)	
Fin Lib · Tang		-0.219* (0.104)
External · Tang		0.023 (0.037)
Internal · Tang		-0.105 (0.059)
Privat · Tang		0.086**
Differential effect	4.7%	-10.5%
C-Y fixed effects	yes	yes
Firm fixed effects	yes	yes
Observations	700,189	700,189
R-squared	0.893	0.893

Notes: the table presents the estimates of the effect of financial liberalization on firm-level productivity. EFD stands for external financial dependence and Tang for asset tangibility. Column (1) [(2)] measures industry financial constraints using the EFD [Tang] index. The differential effect measures the relative impact of the reform on industries at the 75th and 25th-percentile of the each index. Standard errors in parentheses are clustered at the country level using block-bootstrapping. ***, **, * denote statistical significance at 1%, 5%, and 10%.

Table 4.8: Financial liberalization and the covariance between marginal products of factors and TFP

	(1) Cov(MPK,TFP)	(2) Cov(MPL,TFP)
A. External financial dependence		
Fin Lib · EFD	-0.137**	-0.005
	(0.055)	(0.034)
Internal · EFD	-0.003	-0.013
	(0.016)	(0.012)
External · EFD	-0.005	-0.015
	(0.018)	(0.011)
Privat · EFD	0.105*	0.010
	(0.049)	(0.024)
Differential effect	-10.5%	-0.4%
C-Y fixed effects	yes	yes
C-I fixed effects	yes	yes
Observations	1,717	1,717
R-squared	0.807	0.776
B. Asset tangibility		
Fin Lib · Tang	0.355**	-0.055
	(0.141)	(0.090)
Internal · Tang	-0.049	0.003
	(0.057)	(0.023)
External · Tang	0.009	0.013
	(0.051)	(0.020)
Privat · Tang	-0.179	0.078**
	(0.124)	(0.031)
Differential effect	17.0%	2.6%
C-Y fixed effects	yes	yes
C-I fixed effects	yes	yes
Observations	1,717	1,717
R-squared	0.801	0.774

Notes: the table presents the estimates of the effect of financial liberalization on the covariance between TFP and the marginal product of capital (column (1)) and labor (column (2)). EFD stands for external financial dependence and Tang for asset tangibility. Panel A (B) measures industry financial constraints using the EFD (Tang) index. The differential effect measures the relative impact of the reform on industries at the 75th and 25th-percentile of the each index. Standard errors in parentheses are clustered at the country level using block-bootstrapping. ***, **, * denote statistical significance at 1%, 5%, and 10%.

Table 4.9: Financial liberalization and the variance of marginal products of factors

	(1) Var(MPK)	(2) Var(MPL)
A. External financial dependence		
Fin Lib · EFD	-0.293***	0.001
	(0.086)	(0.049)
Internal · EFD	-0.001	-0.025
	(0.033)	(0.022)
External · EFD	0.007	-0.021
	(0.024)	(0.013)
Privat · EFD	0.200**	0.016
	(0.074)	(0.033)
Differential effect	-22.5%	0.1%
C-Y fixed effects	yes	yes
C-I fixed effects	yes	yes
Observations	1,717	1,717
R-squared	0.762	0.739
B. Asset tangibility		
Fin Lib · Tang	0.742**	-0.142
	(0.240)	(0.109)
Internal · Tang	-0.093	0.044
	(0.107)	(0.031)
External · Tang	-0.045	-0.003
	(0.085)	(0.019)
Privat · Tang	-0.460*	0.146***
	(0.233)	(0.039)
Differential effect	35.6%	-6.8%
C-Y fixed effects	yes	yes
C-I fixed effects	yes	yes
Observations	1,717	1,717
R-squared	0.753	0.738

Notes: the table presents the estimates of the effect of financial liberalization on the variance of the marginal product of capital (column (1)) and labor (column (2)). EFD stands for external financial dependence and Tang for asset tangibility. Panel A (B) measures industry financial constraints using the EFD (Tang) index. The differential effect measures the relative impact of the reform on industries at the 75th and 25th-percentile of the each index. Standard errors in parentheses are clustered at the country level using block-bootstrapping. ***, **, * denote statistical significance at 1%, 5%, and 10%.

Table 4.10: Financial liberalization, firm-level market shares, and ownership

	(1) All industries	(2) High EFD	(3) Low EFD	(4) Low Tang	(5) High Tang
Fin Lib · Dom	0.013***	0.022**	0.004	0.029***	0.002
	(0.003)	(0.008)	(0.004)	(0.004)	(0.002)
Internal · Dom	-0.003	-0.008**	0.000	-0.004	-0.003
	(0.003)	(0.003)	(0.005)	(0.003)	(0.004)
External · Dom	0.003	0.005	0.001	-0.003	0.006
	(0.004)	(0.004)	(0.005)	(0.004)	(0.005)
Privat · Dom	-0.022***	-0.032***	-0.012	-0.031***	-0.015*
	(0.006)	(0.005)	(0.010)	(0.006)	(0.008)
Differential effect	3.9%	6.6%	1.2%	8.7%	0.6%
C-Y fixed effects	yes	yes	yes	yes	yes
Firm fixed effects	yes	yes	yes	yes	yes
Observations	326,810	160,069	166,741	125,718	201,092
R-squared	0.963	0.957	0.967	0.961	0.963

Notes: the table presents the estimates of the effect of financial liberalization on firm-level market shares for firms with different ownership types. EFD stands for external financial dependence and Tang for asset tangibility. Columns (2) and (3) [(4) and (5)] consider the subset of industries with high and low EFD [Tang]. The differential effect measures the relative impact of the reform on domestic firms with respect to foreign firms. Standard errors in parentheses are clustered at the country level using block-bootstrapping. ***, **, * denote statistical significance at 1%, 5%, and 10%.

Table 4.11: Financial liberalization, TFP industry decomposition, and creditor rights

	Strong creditor rights			Weak creditor rights		
	(1) Industry TFP	(2) Average-productivity Term	(3) Allocation Term	(4) Industry TFP	(5) Average-productivity Term	(6) Allocation Term
A. External financial dependence						
Fin Lib · EFD	0.204***	0.043	0.161***	0.149	0.046	0.103*
	(0.020)	(0.034)	(0.018)	(0.064)	(0.026)	(0.040)
Internal · EFD	-0.007	0.011	-0.017**	0.031	0.005	0.026
	(0.009)	(0.010)	(0.006)	(0.019)	(0.010)	(0.014)
External · EFD	-0.025*	-0.008	-0.016*	0.008	0.025*	-0.017**
	(0.010)	(0.007)	(0.007)	(0.005)	(0.009)	(0.005)
Privat · EFD	-0.007	0.034	-0.040	-0.076	-0.033*	-0.043
	(0.015)	(0.028)	(0.026)	(0.042)	(0.012)	(0.031)
C-Y fixed effects	yes	yes	yes	yes	yes	yes
C-I fixed effects	yes	yes	yes	yes	yes	yes
Observations	945	945	945	772	772	772
R-squared	0.928	0.975	0.706	0.901	0.974	0.638
B. Asset tangibility						
	Strong creditor rights			Weak creditor rights		
Fin Lib · Tang	-0.596***	-0.300***	-0.296**	-0.365	-0.139	-0.225
	(0.088)	(0.071)	(0.074)	(0.208)	(0.093)	(0.128)
Internal · Tang	0.013	-0.159**	0.173***	-0.149	-0.081**	-0.068
	(0.063)	(0.059)	(0.018)	(0.065)	(0.016)	(0.054)
External · Tang	0.010	0.046	-0.035	-0.085	-0.041	-0.044*
	(0.068)	(0.067)	(0.021)	(0.038)	(0.030)	(0.014)
Privat · Tang	0.187*	0.154**	0.034	0.402	0.161**	0.240
	(0.085)	(0.046)	(0.042)	(0.181)	(0.051)	(0.134)
C-Y fixed effects	yes	yes	yes	yes	yes	yes
C-I fixed effects	yes	yes	yes	yes	yes	yes
Observations	945	945	945	772	772	772
R-squared	0.920	0.973	0.699	0.902	0.973	0.644

Notes: the table presents the estimates of the effect of financial liberalization on industry TFP and its average-productivity and allocation components for different levels of creditor rights. Columns (1)-(3) [(4)-(6)] consider the subset of countries with strong [weak] creditor rights. EFD stands for external financial dependence and Tang for asset tangibility. Panel A (B) measures industry financial constraints using the EFD (Tang) index. The differential effect measures the relative impact of the reform on industries at the 75th and 25th-percentile of the each index. Standard errors in parentheses are clustered at the country level using block-bootstrapping. ***, **, * denote statistical significance at 1%, 5%, and 10%.

Table 4.12: Financial liberalization and industry wages

	(1) Using EFD index	(2) Using Tang index
Fin Lib · EFD	0.084* (0.037)	
Internal · EFD	-0.003 (0.026)	
External · EFD	0.002 (0.029)	
Privat · EFD	0.105** (0.037)	
Fin Lib · Tang		-0.137 (0.098)
Internal · Tang		0.040 (0.095)
External · Tang		-0.027 (0.075)
Privat · Tang		-0.168 (0.112)
Differential effect	6.5%	-6.6%
C-Y fixed effects	yes	yes
C-I fixed effects	yes	yes
Observations	1350	1350
R-squared	0.969	0.965

Notes: the table presents the estimates of the effect of financial liberalization on industry wages. EFD stands for external financial dependence and Tang for asset tangibility. Column (1) [(2)] measure industry financial constraints using the EFD [Tang] index. The differential effect measures the relative impact of the reform on industries at the 75th and 25th-percentile of the each index. Standard errors in parentheses are clustered at the country level using block-bootstrapping. ***, **, * denote statistical significance at 1%, 5%, and 10%.

Table 4.13: Financial liberalization and industry labor productivity decomposition

	(1) Industry TFP	(2) Average-productivity Term	(3) Allocation Term
	A. External financial dependence		
Fin Lib · EFD	0.241***	0.060	0.181***
	(0.066)	(0.046)	(0.038)
Internal · EFD	0.003	-0.000	0.003
	(0.037)	(0.012)	(0.030)
External · EFD	-0.040**	0.005	-0.045***
	(0.014)	(0.010)	(0.013)
Privat · EFD	-0.028	-0.014	-0.015
Differential effect	18.6%	4.7%	14.0%
C-Y fixed effects	yes	yes	yes
C-I fixed effects	yes	yes	yes
Observations	1717	1717	1717
R-squared	0.861	0.984	0.549
	B. Asset tangibility		
Fin Lib · Tang	-0.630*	-0.203	-0.427*
	(0.284)	(0.132)	(0.208)
Internal · Tang	0.012	-0.053	0.065
	(0.165)	(0.037)	(0.135)
External · Tang	-0.019	0.010	-0.029
	(0.065)	(0.044)	(0.028)
Privat · Tang	0.385	0.134	0.251
	(0.335)	(0.103)	(0.236)
Differential effect	-29.8%	-9.5%	-20.2%
C-Y fixed effects	yes	yes	yes
C-I fixed effects	yes	yes	yes
Observations	1717	1717	1717
R-squared	0.858	0.983	0.545

Notes: the table presents the estimates of the effect of financial liberalization on industry labor productivity and its average-productivity and allocation components. EFD stands for external financial dependence and Tang for asset tangibility. Panel A (B) measures industry financial constraints using the EFD (Tang) index. The differential effect measures the relative impact of the reform on industries at the 75th and 25th-percentile of the each index. Standard errors in parentheses are clustered at the country level using block-bootstrapping. ***, **, * denote statistical significance at 1%, 5%, and 10%.

A Appendix

Proof of proposition 1

Assume that productivity and wealth follow a joint lognormal distribution:

$$\begin{bmatrix} \log(z) \\ \log(a) \end{bmatrix} \sim \mathcal{N}\left(\mu, \Sigma\right)$$

with variance-covariance matrix

$$\Sigma = \begin{bmatrix} \sigma_z^2 & \sigma_{za} \\ \sigma_{za} & \sigma_a^2 \end{bmatrix}$$

We can then express the shadow cost of capital for constrained entrepreneurs, $m(a, z)$, as follows:

$$\log(m(a, z)) = g(\theta) + \frac{1}{1 - (1 - \alpha)\nu}\left(\log(z) - (1 - \nu)\log(a)\right),$$

where $g(\theta)$ is defined as $g(\theta) = \log(\alpha) + \frac{1}{1-(1-\alpha)\nu}\left(\log(\nu) + (1 - \alpha)\nu \log\left(\frac{1-\alpha}{w}\right) - (1 - \nu)\log(\theta)\right)$, so that $g'(\theta) < 0$. The log shadow cost of capital and log productivity then follow a joint normal distribution. In particular, the mean of the shadow cost of capital for constrained firms depends on the reform parameter θ:

$$\mu_m = g(\theta) + \frac{1}{1 - (1 - \alpha)\nu}\left(\mu_z - (1 - \nu)\mu_a\right)$$

so that $\frac{\partial \mu_m}{\partial \theta} = g'(\theta) < 0$. Intuitively, a loosening of financial frictions allows constrained entrepreneurs to expand their capital holdings and reduce their marginal product of capital. The covariance between $\log(m)$ and $\log(z)$ can be written as follows:

$$\rho \equiv \mathbb{C}ov(\log(m), \log(z)) = \frac{1}{1 - (1 - \alpha)\nu}\left(\sigma_z^2 - (1 - \nu)\sigma_{za}\right)$$

We assume that this covariance is bigger than zero. Intuitively, as long as wealth and productivity do not yield a very high positive correlation, more productive firms will on average be more constrained than less productive firms. As we will show next, this generates an implicit tax for more productive firms, making the size-productivity covariance smaller than in the optimal allocation.

Denote $b \equiv \log(r)$, so that $\log(\tilde{r}(a, z)) = \max(\log(m(a, z)), b)$. Recall the equation describing the size-productivity covariance:

$$\mathbb{C}ov[\log(\omega(a, z)), \log(z)] = \frac{\sigma_z^2}{1 - \nu} - \frac{\alpha\nu}{1 - \nu}\mathbb{C}ov[\log(\tilde{r}(a, z)), \log(z)]$$

To show that the size-productivity covariance is smaller than in the optimal allocation, we must first show that $\mathbb{C}ov[\log(\tilde{r}(a, z)), \log(z)] > 0$. Next, we show that the size-productivity covariance is increasing after a reform, i.e. we show that $\frac{\partial \mathbb{C}ov[\log(\tilde{r}(a,z)), \log(z)]}{\partial \theta} < 0$.

Part I: Positive covariance.

$$
\begin{aligned}
\mathbb{C}ov(\max(m,b),z) &= \mathbb{E}[\max(m,b)z] - \mathbb{E}[\max(m,b)]\mathbb{E}[z] \\
&= \mathbb{E}[\max(m,b)\mathbb{E}[z|m]] - \mathbb{E}[\max(m,b)]\mathbb{E}[z] \\
&= \mathbb{E}[\max(m,b)\left(\mu_z + \frac{\rho}{\sigma_m^2}(m - \mu_m)\right)] - \mathbb{E}[\max(m,b)]\mu_z \\
&= \frac{\rho}{\sigma_m^2}\mathbb{E}[(\max n, b - \mu_m + \mu_m)n] \\
&= \frac{\rho}{\sigma_m^2}\mathbb{E}[(\max n, b' + \mu_m)n] \\
&= \frac{\rho}{\sigma_m^2}\left(\int_{-\infty}^{-b'} u\max(u,b')f(u)du + \int_{-b'}^{b'} u\max(u,b')f(u)du + \int_{b'}^{\infty} u\max(u,b')f(u)du\right) \\
&= \frac{\rho}{\sigma_m^2}\left(-\int_{b'}^{\infty} bvf(v)dv + 0 + \int_{b'}^{\infty} u^2 f(u)du\right) \\
&= \frac{\rho}{\sigma_m^2}\left(\int_{b'}^{\infty} u(u - b')f(u)du\right) > 0
\end{aligned}
$$

Part II: Covariance is declining in θ.

To show that the reform increases the size-productivity covariance, we now need to show that $\frac{\partial \mathbb{C}ov(\max m,b,z)}{\partial \theta} < 0$. Without loss of generality, we normalize the variance of m to one: $\sigma_m^2 = 1$.

$$
\mathbb{C}ov(\max(m,b),z) = \int \max(m,b)(m - \mu_m(\theta))f(m,\mu_m(\theta))dm
$$

$$
\begin{aligned}
\frac{\partial \mathbb{C}ov(\max(m,b),z)}{\partial \theta} &= \int \max(m,b)\mu'(\theta)f(m,\mu_m(\theta))dm + \int \max(m,b)(m - \mu(\theta))f_2(m,\mu_m(\theta))\mu'dm \\
&= \mu'\left[\int \max(m,b)\left((m - \mu)^2 - 1\right)f(m,\mu)dm\right] \\
&= \mu'\left[\int (\max(m - \mu, b - \mu) + \mu)\left((m - \mu)^2 - 1\right)f(m,\mu)dm\right] \\
&= \mu'\left[\int \max(n,b')\left(n^2 - 1\right)f(n)dn\right]
\end{aligned}
$$

where b' is defined as $b' = b - \mu_m$. The last equality follows from $\int \mu((m - \mu)^2 - 1)f(m)dm = 0$, because the variance of m was normalized to one. The variable n is standard normally distributed.

Since we know that $\mu'_m(\theta) < 0$, the rest of the proof focuses on showing that the term in brackets is larger than zero. To proceed, we consider different intervals for the parameter b'

Case 1: $b' < 1$

$$\int_{-\infty}^{b'} (n^2 - 1)f(n)dn + \int_{b'}^{-b'} (n^3 - n)f(n)dn + \int_{-b'}^{\infty} n(n^2 - 1)f(n)dn$$
$$= \int_{-b'}^{\infty} b'(p^2 - 1)f(p)dp + \int_{-b'}^{\infty} p(p^2 - 1)f(p)dp$$
$$= \int_{-b'}^{\infty} (p + b')(p^2 - 1)f(p)dp > 0$$

where the last inequality comes from the fact that $p + b' \geq 0$ and $(p^2 - 1) > 0$ because $p^2 \geq (-b')^2 \geq 1$.

Case 2: $b' \in (-1, 0)$

Using the result from the previous case, we want to show that $\int_{-b'}^{\infty} (p + b')(p^2 - 1)f(p)dp > 0$ for $b' \in (-1, 0)$.

$$\int_{-b'}^{\infty} (p + b')(p^2 - 1)f(p)dp$$
$$= \int_{-b'}^{1} (p + b')(p^2 - 1)f(p)dp + \int_{1}^{\infty} (p + b')(p^2 - 1)f(p)dp$$

For the first integral, notice that $(p^2 - 1) < 0$ and $(p + b') > 0$. So we can make the integral smaller by replacing p with the its highest value, 1. For the second integral, $(p + b')(p^2 - 1) > 0$ for any p. We can therefore make that integral smaller by replacing p with its lowest value, again 1.

$$\int_{-b'}^{\infty} (p + b')(p^2 - 1)f(p)dp$$
$$> \int_{-b'}^{1} (1 + b')(p^2 - 1)f(p)dp + \int_{1}^{\infty} (1 + b')(p^2 - 1)f(p)dp$$
$$= (1 + b') \int_{-b'}^{\infty} (p^2 - 1)f(p)dp > 0$$

We know that $1 + b' > 0$. About the integral, we know that $\int_{-\infty}^{\infty} (p^2 - 1)f(p)dp = 0 = \int_{-\infty}^{b'} (p^2 - 1)f(p)dp + \int_{b'}^{-b'} (p^2 - 1)f(p)dp + \int_{-b'}^{\infty} (p^2 - 1)f(p)dp$. Due to symmetry of $p^2 - 1$ and $f(p)$ around zero, $\int_{-b'}^{\infty} (p^2 - 1)f(p)dp = \int_{-\infty}^{b'} (p^2 - 1)f(p)dp$. We also know that $\int_{b'}^{-b'} (p^2 - 1)f(p)dp < 0$. Therefore it follows that $\int_{-b'}^{\infty} (p^2 - 1)f(p)dp > 0$.

Case 3: $b' > 1$

$$\int \max(n, b') \left(n^2 - 1\right) f(n) dn$$

$$= \int_{-\infty}^{b'} b' \left(n^2 - 1\right) f(n) dn + \int_{b'}^{\infty} n \left(n^2 - 1\right) f(n) dn > b' \int_{-\infty}^{b'} \left(n^2 - 1\right) f(n) dn = 0$$

Case 4: $b' \in [0, 1)$

$$\int \max(n, b') \left(n^2 - 1\right) f(n) dn$$

$$= \int_{-\infty}^{b'} b' \left(n^2 - 1\right) f(n) dn + \int_{b'}^{\infty} n \left(n^2 - 1\right) f(n) dn$$

The last integral can be written as follows:

$$\int_{b'}^{\infty} n \left(n^2 - 1\right) f(n) dn$$

$$= \int_{b'}^{1} n \left(n^2 - 1\right) f(n) dn + \int_{1}^{\infty} n \left(n^2 - 1\right) f(n) dn$$

For the first part, notice that $n^2 - 1 < 0$. We can therefore write $\int_{b'}^{1} n \left(n^2 - 1\right) f(n) dn > \int_{b'}^{1} 1 \left(n^2 - 1\right) f(n) dn$. For the second integral, since $n^2 - 1 > 0$, we can write $\int_{1}^{\infty} n \left(n^2 - 1\right) f(n) dn > \int_{1}^{\infty} 1 \left(n^2 - 1\right) f(n) dn$ Therefore:

$$\int_{b'}^{1} n \left(n^2 - 1\right) f(n) dn + \int_{1}^{\infty} n \left(n^2 - 1\right) f(n) dn > \int_{b'}^{\infty} \left(n^2 - 1\right) f(n) dn$$

Finally, getting back to the initial integral, we can write:

$$\int \max(n, b') \left(n^2 - 1\right) f(n) dn$$

$$= \int_{-\infty}^{b'} b' \left(n^2 - 1\right) f(n) dn + \int_{b'}^{\infty} n \left(n^2 - 1\right) f(n) dn$$

$$> \int_{-\infty}^{b'} b' \left(n^2 - 1\right) f(n) dn + \int_{b'}^{\infty} \left(n^2 - 1\right) f(n) dn$$

$$> \int_{-\infty}^{\infty} b' \left(n^2 - 1\right) f(n) dn + \int_{b'}^{\infty} \left(1 - b'\right) \left(n^2 - 1\right) f(n) dn > 0$$

The whole integral is greater zero, because the first term equals zero, and the second term is greater zero, with the same argument used before in case 2: Since we know that $\int_{-\infty}^{\infty} (1 -$

$b') \left(n^2 - 1\right) f(n) dn = 0$ and $\int_{-b'}^{b'} (1 - b') \left(n^2 - 1\right) f(n) dn < 0$ and $\int_{-\infty}^{-b'} (1 - b') \left(n^2 - 1\right) f(n) dn = \int_{b'}^{\infty} (1 - b') \left(n^2 - 1\right) f(n) dn$, it follows that $\int_{b'}^{\infty} (1 - b') \left(n^2 - 1\right) f(n) dn > 0$.

This proves that $\int \max(n, b')(n^2 - 1) f(n) dn > 0$. Together with $\frac{\partial \mu_m}{\partial \theta} < 0$, this implies that the covariance between the shadow cost of capital and productivity is decreasing in θ. $\square$

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