Capital Account Openness and the Losses from Financial Frictions

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Abstract

The goal of this paper is to isolate the role of openness to international financial markets (capital account openness) on the total factor productivity (TFP) effect of financial frictions. To do so, I formulate a model in which individual households are either workers or entrepreneurs, can only save in the form of capital, and entrepreneurs are subject to a collateral constraint. Using this structure, I compare two steady states of a calibrated model numerically: one in which the capital rental rate must clear a domestic capital rental market (closed economy), and one in which that rate is given by the world (small open economy). The model predicts that a small open economy is affected less by financial frictions than a closed economy: for the tightest collateral constraint, TFP in a small open economy is only about 1% lower than in the economy without a collateral constraint, while it is 15% lower in a closed economy. TFP losses in a small open economy reflect factor misallocation among incumbent entrepreneurs (intensive margin), not distortions along entry-exit margin, whereas for a tight financial frictions, there are distortions on both intensive and entry-exit margins in a closed economy. Using macro data, I find that a 1% rise in openness is associated with 0.196% decline in the effect of financial frictions on TFP. Running the same regression on subsamples, I also find that this empirical result mainly comes from a group of low income countries.

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1 Introduction

Recent papers by Buera and Shin (2010) (B&S), Buera, Kaboski, and Shin (2011) (BKS), and Midrigan and Xu (2010) (M&X) study the effect of financial market frictions on total factor productivity (TFP). Despite the similarities in their environments, B&S and BKS report that financial frictions could reduce TFP by almost 40%, while M&X report a reduction in the 5-7% range. Among other differences in their models is a difference regarding openness to international financial markets (capital account openness): B&S and BKS study a closed economy, while M&X assumes openness to a given world capital rental rate. The goal of this paper is to isolate the role of capital account openness on the TFP effects of financial frictions.

To do that, I formulate a single model that is similar to those in the above papers. Individual households either supply labor (are workers) or are entrepreneurs using a span-of-control-type production function. Households are homogeneous as workers, while the span-of-control productivity of a household (productivity as an entrepreneur) follows a two-state Markov process, the outcomes of which are independent across households. Households can only save in the form of capital and entrepreneurs are subject to a collateral constraint which limits the amount of capital they can employ to a multiple of their own capital. Using this structure, I compare two steady states of a calibrated model numerically: one in which the capital rental rate must clear a domestic capital rental market (closed economy), and one in which that rate is given by financially developed economies (small open economy).

I calibrate the closed economy model without a collateral constraint to represent the U.S. economy. I take parameters for risk aversion, the labor share in the production function, the depreciation rate, and the span of control from previous literature, while I match the model’s rate of return, the fraction of entrepreneurs, and the exit rate of entrepreneurs to the corresponding U.S. data statistics to pin down the discount rate and the transition matrix for entrepreneurial productivities. I choose the same parameters for the small open economy model without a collateral constraint and call the resulting common steady state the outcome for the benchmark economy. Taking as given the parameters in the benchmark economy, I vary the collateral constraint and compare steady state properties between the two.

\[^{1}\text{Developing a different environment, Moll (2012) claims that financial frictions matter either in the long run or in the short run: when idiosyncratic productivity shock is persistent, even if financial frictions have the small TFP effect, the speed of transitions are slow.}\]
alternative capital rental market specifications.

The main finding is that TFP in a small open economy is affected less by financial frictions than in a closed economy. For the tightest collateral constraint (an entrepreneur can only employ the capital he owns), TFP in a small open economy is only about 1% lower than in the benchmark economy, while it is 15% lower in a closed economy. The difference in TFP is accompanied by differences in both allocation of entrepreneurship among households with different productivity (entry-exit margin or extensive margin) and allocation of factors among incumbent entrepreneurs (intensive margin). In particular, in a small open economy, there is specialization in that all households with high productivity are entrepreneurs and all households with low productivity are workers. In this sense, our results in a small open economy resemble the results in M&X: TFP losses in a small open economy reflect factor misallocation among incumbent entrepreneurs, not distortions along entry-exit margin. In contrast, in a closed economy, there are distortions on both intensive and entry-exit margin: 15% of those with low productivity and 85% of those with high productivity are entrepreneurs in a closed economy and the dispersion in the marginal product of capital among producers in a closed economy is greater than in a small open economy.

Finally, I use macro data and conduct reduced form estimation to check how capital account openness changes the TFP effect of financial frictions. As a measure of openness, I use Quinn (1997)'s indicator for a government policy stance toward capital account liberalization (de jure indicator). As a measure of the absence of financial frictions, I use the sum of private credit owed to bank and other financial intermediaries, private bond market capitalization, and stock market capitalization as a ratio of GDP - from Beck, Demirguc-Kunt, and Levine (2000) (external finance ratio). I regress log of TFP on log of external finance ratio, log of openness, an interaction term of log of external finance ratio and log of openness, and other country-level controls. Then the coefficient of the interaction term divided by the coefficient of log of openness measures how openness affects the elasticity of TFP with respect to the external finance ratio. The estimate is $-0.196$: that is, a 1% rise in openness is associated with 0.196% decline in the effect of financial frictions on TFP. To further investigate from which group of countries our empirical results come, I split the sample into two sub-samples of low income countries and the rest of the other countries by using World Bank income group categorization and run the same regression on both sub-samples separately. The results from sub-samples show that the estimate of the interaction between openness and the TFP effect of
financial frictions in low income countries is greater than the estimate in full sample
(in absolute terms), while the same estimate in the rest of the other countries is
not significant. Therefore, we conclude that our empirical result that a small open
economy is affected less by financial frictions mainly comes from a group of low
income countries.

2 Model and Equilibrium

This section introduces the model, defines an equilibrium, and describes how to
solve the equilibrium.

2.1 Model

Time is discrete and denoted by \( t \). There is one (produced) good per date. The econ-
omy consists of a continuum of infinitely lived households with total population \( 1 \).
The preferences of a household are given by

\[
E_0 \sum_{t=0}^{\infty} \beta^t \frac{c_t^{1-\gamma}}{1-\gamma}, \text{ where } 0 < \beta < 1, \gamma > 1.
\]

At each period, a household either becomes a worker who supplies one unit of
labor or becomes an entrepreneur. If a household chooses to be an entrepreneur, it
combines labor \( l \) and capital \( k \) with its entrepreneurial productivity \( e \) to produce

\[
y = e^{1-\eta} \left( l^\alpha k^{1-\alpha} \right)^\eta, \text{ where } \alpha, \eta \in (0, 1).
\]
A household’s entrepreneurial productivity \( e \in E \) follows two-state Markov process,
where \( E = \{e_l, e_h\} \) stands for the set of possible productivity realizations with \( e_l <
e_h \). The productivity realizations are independent across households.
A household enters each period with its productivity \( e \) and the capital (wealth) it
owns \( a \in A \) (\( A \) stands for the set of possible wealth) and chooses whether to become
a worker or an entrepreneur. Given its income, it ends a period by choosing its
consumption and its wealth in the next period. The state of the economy at period \( t \)
is joint distribution in the population \( M_t(a, e) \).
2.2 Equilibrium

I focus entirely on steady states and, therefore, only defines steady states. We assume that a law of large numbers holds so that idiosyncratic uncertainty must disappear on the aggregate. Labor and capital rental markets are the only markets in this economy and they are competitive. Denote by \( r \) and \( \delta \), the net rate of return from wealth and the depreciation rate. The rental rate of capital is the sum of the net rate of return and the depreciation, \( r + \delta \). Denote by \( w \) the wage rate. Then the entrepreneurial household’s profit maximization problem is given by

\[
\pi(a, e; w, r) = \max_{l \geq 0, k \geq 0} \left\{ e^{1 - \eta} (l^\alpha k^{1-\alpha})^\eta - wl - (r + \delta)k \right\},
\]

s.t. \( k \leq \lambda a \),

where \( 1 \leq \lambda < \infty \). Let \( l : A \times E \to \mathbb{R} \) and \( k : A \times E \to \mathbb{R} \) be the optimal labor and capital demand functions respectively. Due to the collateral constraint, the household’s capital rental is restricted by its wealth multiplied by the parameter \( \lambda \). In particular, \( \lambda = 1 \) implies no capital rental markets, so that a household should finance its entrepreneurial project with its own wealth. On the other extreme, \( \lambda = \infty \) corresponds to no frictions in capital rental markets.

We assume that a household cannot borrow intertemporally for consumption smoothing nor can they write contracts that depend on its productivity. Then, a household’s wealth should be greater than 0, e.g. \( A = [0, \infty) \), and its budget constraint is given by (a “′” denotes next period’s value)

\[
c + a' = (1 + r)a + \max_{i \in \{0, 1\}} \{ iw + (1 - i)\pi(a, e; w, r) \},
\]

where denote by \( i : A \times E \to \{0, 1\} \), an indicator function that takes a value 1 if a household works for wage and 0 otherwise.\(^2\)

To define the household’s problem in a recursive form and a recursive competitive equilibrium, I set down some notations. Denote respectively by \( \mathcal{B}(A \times E) \), the Borel \( \sigma \)-algebra of the product space \( A \times E \). We define an operator \( T : C(A \times E) \to C(A \times E) \) for any function \( v \in C(A \times E) \) (\( C(A \times E) \) is the set of bounded, continuous

\[^2\]If \( \lambda = 1 \), then \( r = -\delta \) and there is no cost of capital rental in the profit function (1). Therefore, any entrepreneur employs all his capital.
functions on \( A \times E \))
\[
\mathcal{I}v(a, e; w, r) = \max_{a' \in \Gamma(a, e; w, r)} u \left( (1+r)a + \max_{i \in \{0, 1\}} \{iw + (1-i)\pi(a, e; w, r)\} - a' \right)
+ \beta \int_{e'} v(a', e'; w, r) p(e, de'),
\]
(2)

where \( \Gamma(a, e; w, r) = [0, (1+r)a + \max_{i \in \{0, 1\}} \{iw + (1-i)\pi(a, e; w, r)\}] \). Let \( g : A \times E \to \mathbb{R} \) be the optimal policy function for wealth in the next period.

Finally, the transition function \( Q : (A \times E) \times \mathcal{B}(A \times E) \to [0, 1] \) is given by
\[
Q((a, e), (A, E)) = \begin{cases} 
p(e, E) & \text{if } g(a, e) \in A \\
0 & \text{otherwise} \end{cases}
\]
(3)

for all \( a \in A, e \in E, A \times E \in \mathcal{B}(A \times E) \).

**Definition 2.1** (closed economy) A stationary recursive competitive equilibrium (RCE) consists of a value function, \( v : A \times E \to \mathbb{R} \), policy functions, \( g : A \times E \to \mathbb{R} \), \( i : A \times E \to \{0, 1\} \), \( l : A \times E \to \mathbb{R} \), and \( k : A \times E \to \mathbb{R} \), constant labor and capital rental rates, \( w \) and \( r \), and a probability measure \( M \in \mathcal{M} \) such that

1. Given \( w \) and \( r \), \( v \) is a fixed point of \( \mathcal{I} \) in the problem (2), \( g \) is the corresponding policy function, and \( i, l \) and \( k \) are occupation choice, profit maximizing labor and capital demand.
2. Labor and capital rental markets clear
\[
\int_{\{(a, e) : i(a, e) = 0\}} l(a, e) M(da, de) = \int_{\{(a, e) : i(a, e) = 1\}} M(da, de),
\]
\[
\int_{\{(a, e) : i(a, e) = 0\}} k(a, e) M(da, de) = \int aM(da, de).
\]
3. The aggregate law of motion \( \mathcal{P} \) generates the invariant probability measure \( M \)
\[
M(A, E) = \mathcal{P}(M(A, E)),
\]
for all \( A \times E \in \mathcal{B}(A \times E) \).
It is understood that the aggregate feasibility constraint should hold by Walras’ law. A stationary RCE in a small open economy is defined in a similar way except for that there is no capital rental market clearing condition.

**Definition 2.2 (small open economy)** A stationary recursive competitive equilibrium (RCE) consists of a value function, \( v : A \times E \rightarrow \mathbb{R} \), policy functions, \( g : A \times E \rightarrow \mathbb{R} \), \( i : A \times E \rightarrow \{0, 1\} \), \( l : A \times E \rightarrow \mathbb{R} \), and \( k : A \times E \rightarrow \mathbb{R} \), constant wage rate \( w \) and a probability measure \( M \in \mathcal{M} \) such that

1. Given wage rate \( w \), \( v \) is a fixed point of \( \mathcal{T} \) in the problem (2), \( g \) and \( f \) are the corresponding policy functions, and \( i, l \) and \( k \) are occupation choice, profit maximizing labor and capital demand.
2. Labor market clears
   \[
   \int_{\{(a,e):i(a,e)=0\}} l(a,e) M(da,de) = \int_{\{(a,e):i(a,e)=1\}} M(da,de).
   \]
3. The aggregate law of motion \( \mathcal{P} \) generates the invariant probability measure \( M \)
   \[
   M(A \times E) = \mathcal{P}(M(A \times E)),
   \]
   for all \( A \times E \in \mathcal{B}(A \times E) \).

### 2.3 Solving for an Approximate Equilibrium

Because we do not have a closed form for steady states in this model, I compute approximate steady states for various specifications of the model. I follow what is by now a fairly standard approach to compute steady states: I discretize the state space and employ Aiyagari (1994)’s nested fixed point method. In particular, in the most inner loop, I search for value function and stationary density of wealth, and, in the outside loop, I search for market clearing wage and rental rate by iterating each of them until convergence.

I use the value function iteration method to solve for an individual household problem. While our utility function and the density of wealth are continuous, a computer can only handle the discrete data. Therefore, the approximation of the functions and integrations should be done by a grid with discrete points. As the space for wealth, I choose finer spacing at the lower end of the grid and coarser
spacing at the higher end to capture the curvature of wealth density. To choose a sufficiently large number as the upper bound of the grid point for wealth, I verify with trial and error that once a household starts with wealth in our grid, its future wealth is bounded by the maximum value of the grid.

To solve the optimization problem in each iteration, I use Golden section search algorithm, which does not require the smoothness of the objective function (p.623 of Heer and Maußner (2005)). The household’s wealth choices are not restricted to lie on a grid point and the value of the value function between gridpoints are determined by linear interpolation. To get a stationary distribution, rather than applying the standard simulation method as in Aiyagari (1994) and B&S, I discretize the density function and iterate it until convergence (Algorithm 7.2.3 of Heer and Maußner (2005)).

In pinning down equilibrium wage and rental rate, I apply three alternative ways to an economy with different cases of \( \lambda \): \( \lambda = \infty \), \( \lambda > 1 \), and \( \lambda = 1 \). They are similar in that I follow Aiyagari (1994)’s nested fixed point method and pin down both or one of prices. The differences are as follows. First, for the case of the benchmark economy (\( \lambda = \infty \)), I impose specialization (all households with high productivity are entrepreneurs and all households with low productivity are workers) and find a steady state consistent with specialization. Under specialization, the wage rate can be written as the following function of the rental rate

\[
w = \alpha \left( \left( \eta \left( \frac{1 - \alpha}{r + \delta} \right)^{\eta(1-\alpha)} \right) \left( \frac{\mu_h}{\mu_l} e_h \right)^{1-\eta} \right)^{\frac{1}{1-\eta(1-\alpha)}}.
\]

Here, \( \mu_h \) and \( \mu_l \) denote the steady state masses of households with high productivity and with low productivity respectively. Therefore, in this case, we need only one outside loop. For the cases with \( \lambda \in (0, \infty) \), I confirm the capital rental market clearing condition in the outside loop and labor market clearing condition in the inside loop. Finally, when there is no capital rental market (\( \lambda = 1 \)), the rate of return from wealth is simply depreciation rate \( -\delta \). Therefore, I fix \( r = -\delta \) and solve for wage rate to clear labor market.

Although I numerically check the existence of equilibria, their existence in this model is not analytically guaranteed. One difficulty is to prove the existence of a stationary probability measure, which in turn requires the compactness of state...
space (Theorem 12.12 of Stockey, Lucas, and Prescott (1989)). Huggett (1993) proves the compactness of state space for wealth in an incomplete markets model with two-state Markov productivity process on endowment shock. Because of a collateral constraint and occupation choice, a household’s value function in our model is not differentiable. Therefore, in our model the compactness proof cannot be obtained in the way Hugget did.

3 Calibration

I calibrate the closed economy version of model with no frictions in capital rental market, \( \lambda = \infty \). I call this the benchmark economy. Table 1 summarizes the parameters, the moments I used for the calibration, and the resulting values for the initial calibration of the benchmark economy. The period in the model is one year. Risk aversion (\( \gamma \)), the labor share in production (\( \alpha \)), the depreciation rate (\( \delta \)), and the span of control (\( \eta \)) are chosen from the existing literature about the U.S. economy. Recent literature uses value for \( \eta \) that varies from 0.7153 (Blaum (2012)) to 0.90 (Khan and Thomas (2008)). I use \( \eta = 0.81 \) from Cooper and Haltiwanger (2006) who estimate the curvature of investment in profit function by using the U.S. manufacturing plant-level data.

The remaining parameters are the discount rate \( \beta \) and the parameters associated with the entrepreneurial productivity process. They are determined by requiring that the resulting steady states match the following features of the U.S. economy: the fraction of entrepreneurs in the population, the exit rate of entrepreneurs, and the interest rate. As a support for the productivity process, I use \( E = \{ e_l, 1.0 \} \) with \( e_l = 0.1, 0.05, \) or 0.2. We match the fraction of entrepreneurs and the exit rate for the benchmark economy to the corresponding U.S. data statistics, 12% and 20%.

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4 Even with slightly more general productivity process, e.g. three-state Markov process, the existence proof in an incomplete markets model seems to be hard. The main difficulty is to prove that the policy for wealth in the next period is increasing in labor productivity. Miao (2002) proves it in the model of Aiyagari (1994) but with additional stronger assumptions on utility function and productivity process.

5 Using FOC for labor demand, the entrepreneurial profit is given by

\[
(1 - \alpha \eta) e^{1-\eta} \left( \frac{\alpha \eta}{w} \right)^{\frac{1-\alpha \eta}{1-\alpha \eta}} k^{\frac{1-\alpha \eta}{1-\alpha \eta}} - (r + \delta)k.
\]

The estimate for \( \frac{(1-\alpha \eta)}{1-\alpha \eta} \) in Cooper and Haltiwanger (2006) is 0.59. Given our labor share \( \alpha = 0.67 \), the span of control parameter is 0.81.
Table 1: Parameter values for the benchmark equilibrium

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>risk aversion</td>
<td>$\gamma$</td>
<td>1.5</td>
</tr>
<tr>
<td>labor share</td>
<td>$\alpha$</td>
<td>0.67</td>
</tr>
<tr>
<td>depreciation rate</td>
<td>$\delta$</td>
<td>0.06</td>
</tr>
<tr>
<td>span of control</td>
<td>$\eta$</td>
<td>0.81</td>
</tr>
<tr>
<td>discount rate</td>
<td>$\beta$</td>
<td>0.95</td>
</tr>
</tbody>
</table>

**Discretization of $e$**

- number of grid points: 2
- productivity states: $E = \{e_l, 1\}$ with $e_l = 0.1, 0.05, \text{ or } 0.2$
- transition matrix:
  \[
  \pi_{ee'} = \begin{pmatrix}
  0.97 & 0.03 \\
  0.20 & 0.80 \end{pmatrix}
  \]

**Discretization of $a$**

- number of grid points: 1000
- wealth states: $A = \{0, \ldots, 80\}$

**Targets and results**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Target</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>rate of return</td>
<td>4%</td>
<td>4%</td>
</tr>
<tr>
<td>fraction of entrepreneurs</td>
<td>12%</td>
<td>12%</td>
</tr>
<tr>
<td>exit rate of entrepreneurs</td>
<td>20%</td>
<td>20%</td>
</tr>
</tbody>
</table>
respectively (Quadrini (2000)). The target net rate of return from capital $r$ for the benchmark economy is 4%.

Table 2: Comparing benchmark with U.S. data

<table>
<thead>
<tr>
<th></th>
<th>benchmark model (λ = ∞)</th>
<th>data (U.S. 1990-1994)</th>
</tr>
</thead>
<tbody>
<tr>
<td>capital to GDP ratio</td>
<td>2.67</td>
<td>2.16</td>
</tr>
<tr>
<td>external finance ratio</td>
<td>2.11</td>
<td>2.15</td>
</tr>
</tbody>
</table>

Next, in the table 2 we evaluate the calibration results for the benchmark economy ($λ = ∞$) by comparing two steady state statistics to the corresponding data statistics: capital to GDP ratio and external finance ratio. The particular reason I choose two statistics is that external finance ratio is widely used as a proxy for financial development and financial frictions could affect capital accumulation. Note that neither of them is the target for our calibration. The predicted capital to GDP ratio and external finance to GDP ratio are respectively 19% greater and 2% smaller than their data statistics. Because there are a number of frictions in a real economy, we may view our calibration results as the equilibrium outcomes in the absence of these other frictions.

For the small open economy, I impose the same parameters and the world rental rate is determined by an economy with $λ = ∞$. Then, when there is no collateral constraint, the steady state properties in a small open economy is the same to the steady state properties in a closed economy.

4 Results

The goal of this section is to compare the steady state properties in a closed economy to the steady state properties in a small open economy, when varying the degree

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6Quadrini (2000) defines entrepreneurs as households that own a business or have a financial interest in some business enterprise. The percent is similar to active business owners in Table 1 of Cagetti and Nardi (2008) who also report that the statistics are similar for 1989, 1992, and 1995 waves of the Survey of Consumer Finances.

7I will describe how to construct external finance ratio and capital to GDP ratio in Section 3.

8The previous studies also look at one or both of these statistics to evaluate their calibration results, e.g. B&S, BKS, and M&X.
of financial frictions ($\lambda = 1, 1.25, 1.5, 2, 3, 4, 5, 6, 7, \infty$). In most of our analysis, I focus on the results from economies with support of productivities $E = \{0.1, 1\}$. In Figure 5, I compare the results between the alternative supports of productivities.

Figure 1: TFP Losses from Financial Frictions

Figure 1 shows our main numerical results: TFP in both a small open economy and a closed economy for each $\lambda$. We normalize TFP in the benchmark economy at 1 and TFP in an economy with a finite collateral constraint is the value relative to TFP in the benchmark economy. The figure shows that TFP loses in a closed economy are larger than TFP losses in a small open economy for each finite $\lambda$. For instance, for the tightest collateral constraint (an entrepreneur only employ capital he owns), TFP in a small open economy is only about 1% lower than in the benchmark economy, while it is 15% lower in a closed economy.

To further analyze the difference in TFP between the two capital rental market specifications, I show in Figure 2 how the mass of entrepreneurs with each productivity level varies with $\lambda$. I normalize the overall mass of households with each productivity level at 1. The figure shows that the difference in TFP between the two rental market specifications (Figure 1) is accompanied by the allocation of entrepreneurship among households (entry-exit margin or extensive margin). While entrepreneurs in a closed economy consist of households with both low and high
productivity levels when a collateral constraint is tight, in a small open economy there is specialization in that all households with high productivity are entrepreneurs and all households with low productivity are workers. The results in a small open economy resemble the results in M&X, who take as given a small open economy and study the model with and without entry-exit: financial frictions do not tend to prevent productive households from becoming entrepreneurs in a small open economy.

For financial frictions $\lambda \geq 4$, all households with high productivity are entrepreneurs and all households with low productivity are workers: that is, misallocation along the entry-exit margin disappears even in a closed economy (Figure 2). However, TFP in a closed economy is still lower than TFP in a small open economy: for the case of $\lambda = 4$, the difference is 3% (Figure 1). To see the difference in the factor allocation among incumbent entrepreneurs (intensive margin), we compare the density of marginal product of capital between the two rental market specifications. Each graph in Figure 3 shows the density of marginal product of capital for either $\lambda = 1$ (no capital rental market) or $\lambda = 4$ and either a small open economy.

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9Because a collateral constraint is involved only with capital demand and there is a single wage rate in our model, there is no gap in marginal product of labor among entrepreneurs. However, the allocation of labor among producers is not efficient in that it differs from the allocation of labor in the benchmark economy.
Figure 3: Density of marginal product of capital

The first graph in Figure 4 shows that households in a small open economy accumulate more wealth on average than in a closed economy and are less likely...
to be collateral-constrained. The difference in average wealth between the two rental market specifications is accompanied by the difference in the rental rate of capital. The second graph in Figure 4 shows the rental rate in the two rental market specifications: the rental rate in a small open economy is fixed at the world rate of return 4%, while the rental rate in a closed economy declines with the tightness of a collateral constraint and is lower than the rental rate in a small open economy, which is determined from financially developed economies.\footnote{There is one possible channel through which the rental rate in a closed economy declines with the tightness of a collateral constraint: the collateral constraint suppresses the demand of capital and the rental rate in a closed economy should decrease to clear the capital rental market.}

In addition, the first graph in Figure 4 also shows that average wealth decreases with $\lambda$ in a small open economy. The results imply that a small open economy with a tight collateral constraint accumulates more wealth than the rest of the world (benchmark economy). Therefore, their capital flows out of their domestic capital rental market and their consumption is strictly greater than their net production (domestic output net of depreciation).

Figure 5 compares TFP between the alternative supports of productivities: we maintain high productivity level at 1 and only change low productivity level 0.1 to either 0.05 or 0.2. The results in the other cases are similar to Figure 1: TFP in a small open economy is affected less by financial frictions. Quantitatively, the effect
of financial frictions on TFP in a closed economy varies with low productivity level $e_l$. For the tightest collateral constraint, TFP in a closed economy is 91% of benchmark economy when low productivity $e_l = 0.2$, while it is 80% when $e_l = 0.05$. In contrast, because the resulting steady state in a small economy is an equilibrium with specialization, TFP in a small open economy does not vary with our choice of low productivity $e_l$. The accurate quantification of TFP losses from financial frictions requires the data about productivity of individuals who choose not to be producers. However, such data are not available for both the U.S. and developing countries.\footnote{For instance, B&S, BKS, and M\&X assume functional form of productivity process and use evidence of incumbent producers to construct the parameters of the process.} However, while our quantitative results depend on the support of productivities, considering the other support for productivities does not seem to change our qualitative results: TFP in a small open economy is affected less by its financial frictions than in a closed economy. In the next section, we are going to test such qualitative prediction of the model.
5 Evidence

The goal of this section is to estimate the interaction between capital account openness and the effect of financial frictions on TFP. The empirical test in this section is more general than our numerical analysis: while we only consider the absence or presence of capital account control in our numerical analysis, the indicator of capital account openness here captures the severity and magnitude of openness. This allows us to estimate the elasticity of TFP effect of financial frictions with respect to openness. In the following I will describe data, the regression specifications, and results.

5.1 Data

The data necessary for our empirical analysis are capital, GDP per worker, external finance to GDP ratio (external finance ratio or capitalization ratio), the measure of capital account openness, and the other country-level controls. All data span from 1990 to 1994 except for the openness measure.

Capital is constructed by using data from Penn World Table 7.1 (PWT71). Because PWT71 only provides investment series, I construct capital by calculating the growth rate of investment series between 1970 and the first available year of investment (1950) and then apply perpetual inventory method (p.685 of Caselli (2005)). I drop the countries whose first available investment data is later than 1970. GDP per worker is rgdpwok in PWT71. Given capital and GDP per worker, TFP is constructed from Cobb-Douglas function of physical capital and worker.

Following the tradition in the literature, I use the external finance to GDP ratio as a proxy for the absence of financial frictions (financial development). Our external finance to GDP ratio (total capitalization ratio) is constructed as the sum of (i) private credit owed to bank and other financial intermediaries, (ii) private bond market capitalization, and (iii) stock market capitalization as a ratio of GDP - from Beck, Demirguc-Kunt, and Levine (2000). Following BKS, I multiply the stock market capitalization by the book value-market value ratio, 0.33. Because stock market capitalization does not reflect the amount of funds actually obtained by issuers (Rajan and Zingales (1998)), I check that our results are robust to redefining the capitalization ratio as either the ratio of (i) to GDP or the ratio of (i)+(ii) to GDP.

I take the measure of capital account openness (CAP100), from Quinn (1997). He construct the indicator on a government’s policy stance toward capital account
liberalization (*de jure* indicator), using IMF’s annual publication, Annual Report on Exchange Arrangements and Exchange Restrictions.\(^{12}\) Quinn’s indicator is provided as 5-year average values and is 0-100 scale. Therefore, the indicator offers not only of the existence or absence of restrictions but the severity or magnitude of the restrictions. Following Quinn and Toyoda (2008), I use 5-year lags on the openness measure (the average from 1985 to 1989).\(^{13}\) Using the average of the openness measure from 1990 to 1994 does not change our results significantly and the results are available upon request.

The other country-level controls consist of GDP as a proxy for the scale of an economy, import plus export as a ratio of GDP (openk from PWT71) as a proxy for an economy’s access to larger markets, and institutional quality proxied by government antidiversion policies (GADP from Hall and Jones (1999)).

### 5.2 Evidence from Interaction Effects

This section establishes the main empirical results of this paper.\(^{14}\) I check in which direction and how much openness to international financial market changes TFP effect of financial frictions. How openness affects the elasticity of TFP with respect to external finance ratio, \(\xi\), is given as follows

\[
\xi = \frac{\partial \log \left( \frac{\partial \log (TFP)}{\partial \log (ExFinance)} \right)}{\partial \log (CapOpen)} = \partial \left( \frac{\partial \log (TFP)}{\partial \log (ExFinance)} \right) \frac{\text{CapOpen}}{\text{CapOpen}} \,, \tag{A}
\]

\[
\times \left( \frac{\partial \log (TFP)}{\partial \log (ExFinance)} \right)^{-1} \,, \tag{B}
\]

\(^{12}\)Quinn and Toyoda (2008) and Quinn, Schindler, and Toyoda (2011) compare his indicator to the other *de jure* and *de facto* indicators.

\(^{13}\)A government is more likely to liberalize its capital account when it expects brightest future. Quinn and Toyoda (2008) claim that a focus on a 5-year lags in openness measure should attenuate such endogeneity bias.

\(^{14}\)To take a first glance at the interaction between openness and TFP effect of financial frictions, I also conduct split-sample estimation. In particular, I split the sample into two groups: relatively open economies and closed economies and regress log of TFP on log of external finance ratio. The slope of the open economies’ group is flatter than that of the closed economies’ group: a open economy’s TFP is affected less by financial frictions. Therefore the results comply with the results which we will see in this section. The split sample results are available upon request.
where $CapOpen$ and $ExFinance$ respectively denote capital account openness measure and external finance ratio.

Table 3: Estimation Results: Full Sample

<table>
<thead>
<tr>
<th></th>
<th>financial development measured as</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>total bank bank + bond</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>log(ExFin)</td>
<td>0.342** (0.146)</td>
<td>0.355** (0.149)</td>
<td>0.380*** (0.144)</td>
<td></td>
</tr>
<tr>
<td>log(CapOpen)</td>
<td>0.165*** (0.062)</td>
<td>0.147** (0.066)</td>
<td>0.143** (0.064)</td>
<td></td>
</tr>
<tr>
<td>log(ExFin) * log(CapOpen)</td>
<td>-0.067* (0.038)</td>
<td>-0.068* (0.039)</td>
<td>-0.072* (0.037)</td>
<td></td>
</tr>
<tr>
<td>controls</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>observations</td>
<td>399</td>
<td>399</td>
<td>399</td>
<td></td>
</tr>
<tr>
<td>R2</td>
<td>0.647</td>
<td>0.648</td>
<td>0.650</td>
<td></td>
</tr>
</tbody>
</table>

Note: Heteroskedasticity robust standard errors are reported in parentheses with ***, **, and * respectively denoting significance at 1%, 5%, and 10%. Controls consist of log of GDP, log of openness to trade, log of institutional quality, and year dummies.

To derive the estimate in (4), we estimate the following regression with an interaction term

$$
\log(TFP_{it}) = c + \beta_{1}^{TFP} \log(CapOpen_{it}) \times \log(ExFinance_{it}) + \beta_{2}^{TFP} \log(ExFinance_{it}) + \beta_{3}^{TFP} \log(CapOpen_{it}) + \beta_{4}^{TFP} X_{it} + \epsilon_{it}
$$

(5)

where $X_{it}$ contains country-level controls such as log of GDP, log of openness to trade, and log of a proxy for institutional quality and year dummies. Two estimates in (5), $\hat{\beta}_{1}^{TFP}$ and $\hat{\beta}_{2}^{TFP}$, respectively provide the estimates of (A) and (B) in equation (4). Then the estimate of $\xi$ in equation (4), $\hat{\xi}$, is obtained as the ratio between $\hat{\beta}_{1}^{TFP}$ and $\hat{\beta}_{2}^{TFP}$, e.g. $\frac{\hat{\beta}_{1}^{TFP}}{\hat{\beta}_{2}^{TFP}}$.

Table 3 shows our main empirical results. When we use total capitalization ratio (total in column (1)), the estimate of coefficient for $\xi$ is $\hat{\xi} = \frac{\hat{\beta}_{1}^{TFP}}{\hat{\beta}_{2}^{TFP}} = \frac{-0.067}{0.342} = -0.196$: that is, a 1% rise in openness is associated with 0.196% decline in the
effect of financial development on TFP. Column (2) and (3) show the results from two alternative measures of financial development: the private credit owed to bank and financial intermediaries as a ratio of GDP (bank in column (2)) and the sum of the private credit and bond market capitalization as a ratio of GDP (bank+bond in column (3)). The estimate for $\xi$ is $-0.192 \left( = -\frac{0.068}{0.355} \right)$ or $-0.189 \left( = -\frac{0.072}{0.380} \right)$ depending on the measure of financial development.

Table 4: Estimation Results: low income country and the rest of world

<table>
<thead>
<tr>
<th></th>
<th>low income</th>
<th>rest of world</th>
<th>bank +bond</th>
<th>bank +bond</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>total (1)</td>
<td>bank (2)</td>
<td>+bond (3)</td>
<td>total (4)</td>
</tr>
<tr>
<td>$\log(ExFin)$</td>
<td>1.351***</td>
<td>1.125***</td>
<td>1.128***</td>
<td>0.195*</td>
</tr>
<tr>
<td></td>
<td>(0.390)</td>
<td>(0.421)</td>
<td>(0.418)</td>
<td>(0.110)</td>
</tr>
<tr>
<td>$\log(CapOpen)$</td>
<td>-0.273</td>
<td>-0.209</td>
<td>-0.210</td>
<td>0.037</td>
</tr>
<tr>
<td></td>
<td>(0.194)</td>
<td>(0.226)</td>
<td>(0.225)</td>
<td>(0.051)</td>
</tr>
<tr>
<td>$\log(ExFin)$</td>
<td>-0.364***</td>
<td>-0.301***</td>
<td>-0.302***</td>
<td>-0.042</td>
</tr>
<tr>
<td></td>
<td>(0.106)</td>
<td>(0.115)</td>
<td>(0.114)</td>
<td>(0.029)</td>
</tr>
<tr>
<td>controls</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>observations</td>
<td>143</td>
<td>143</td>
<td>143</td>
<td>256</td>
</tr>
<tr>
<td>R2</td>
<td>0.413</td>
<td>0.402</td>
<td>0.402</td>
<td>0.662</td>
</tr>
</tbody>
</table>

Note: Heteroskedasticity robust standard errors are reported in parentheses with *** *, **, and * respectively denoting significance at 1%, 5%, and 10%. Controls consist of log of GDP, log of openness to trade, log of institutional quality, and year dummies.

To further investigate from which group of countries our results come, I split the sample into two subgroups of low income countries and the rest of the other countries by using World Bank income group categorization and run the regression (5) on both sub-samples separately. Table 4 shows the results. The results from split-samples show that the estimate of the interaction between openness and the TFP effect of financial frictions in low income countries is greater than the estimate in full sample in absolute terms ($\hat{\xi} = -0.269$, $-0.268$, and $-0.268$ from column (1), (2) and (3)), while the same estimate in the rest of the other countries is not significant (column (4), (5), and (6)). To summarize the results from table 3 and 4, there is evidence that TFP in an open economy is affected less by financial frictions.
and this empirical result mainly comes from a group of low income countries.

6 Final Remarks

There are at least three limitations in this paper, which also could be possible future works. First, like the recent studies on financial integration (e.g. Mendoza, Quadrini, and Rios-Rull (2009) and Angeletos and Panousi (2011)) in our model we only consider the presence or absence of a government control on capital account. Therefore, even though data on magnitude or severity of the restrictions on capital account are available, we can only check whether the model’s predictions are consistent with data qualitatively. It would be interesting to formulate a model with severity of the restrictions on capital account and empirically assess the model’s quantitative prediction. Second, the sectors differ in their dependence on the external financing. The recent papers by BKS and Blaum (2012) explicitly study this sector level difference. But, to the best of my knowledge, the interaction between capital account openness and TFP effect of financial frictions in the model with the sector level difference has not been studied. Finally, we could conduct normative analysis. Unlike some of existing literature (Aoki, Benigno, and Kiyotaki (2009)), our results seem to suggest that opening up to international financial markets is good for an economy even when the economy is financially underdeveloped. Studying which factor leads to the gain (or loss) from capital account liberalization in terms of both steady states and transitions would be another interesting direction.

References


