Productivity Growth and Capital Flows:
The Dynamics of Reforms

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May 17, 2009 (Preliminary)

Abstract

Why does capital flow out of fast-growing countries? In this paper, we provide a quantitative framework incorporating heterogeneous production units and underdeveloped domestic financial markets to study the joint dynamics of total factor productivity (TFP) and capital flows. When an unexpected once-and-for-all reform eliminates idiosyncratic distortions and liberalizes capital accounts, the TFP of our model economy rises gradually and capital flows out of it. The rise in TFP reflects efficient reallocation of capital and talent, a gradual process drawn out by domestic financial market frictions. The concurrent capital outflows are driven by the positive response of domestic saving to higher returns and by the sluggish response of domestic investment to higher TFP—the latter being another ramification of domestic financial frictions. To highlight the interaction between international and domestic financial markets, we then consider a comprehensive reform that also reduces domestic financial frictions. In this exercise, the economy experiences TFP growth and capital inflows, consistent with the experiences of the few countries that implemented such comprehensive reforms.

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1 Introduction

The standard economic theory suggests that capital should flow from rich to poor countries, unless the poor countries have lower overall productivity (Lucas, 1990) or a higher relative cost of investment (Caselli and Feyrer, 2007). Another prediction of the standard theory, arguably less controversial, is that capital should flow into countries undergoing a sustained increase in total factor productivity (TFP). The experiences of developing countries during the last three decades contradict this prediction. If anything, capital tends to flow out of countries with fast-growing productivity, and into those with poorer performance (Prasad et al., 2007; Gourinchas and Jeanne, 2007).

From the time-series data of capital flows and TFP, we observe that many episodes of sustained

In our first exercise, starting from this initial condition, we implement a reform that eliminates the idiosyncratic distortions that interfere with efficient allocation of factors across entrepreneurs. At the same time, we liberalize the goods and capital flows in and out of this economy. We assume that domestic financial frictions remain as before. This sequencing of reforms—removing idiosyncratic distortions and opening up to international capital markets, while not reforming the domestic financial institutions—reflects the actual experiences during the 1980s of Chile, India, Israel, Korea, Mauritius, and Taiwan. For these countries, domestic financial markets remained relatively underdeveloped until the late 1990s. In fact, the reform of domestic financial institutions in emerging economies surfaced onto the center stage of international policy debate only after the East Asian and Russian financial crises of the late 1990s (Mishkin, 2003; Stulz, 2005; Kaminsky and Schmukler, 2008).

In our model, the elimination of idiosyncratic distortions leads to a sustained growth in productivity. TFP rises because the removal of idiosyncratic distortions leads to efficient reallocation of resources. The rise is gradual and persistent because the underdeveloped domestic financial markets can reallocate capital only slowly over time. Productive-but-poor individuals have to work for wage for a while before they can save up enough collateral and enter into entrepreneurship. In addition, even after they start their business, it takes time for them to overcome the credit constraints and operate at the maximal-profit scale.

More important, capital flows out of this economy. Intuitively, in a closed economy with financial frictions, the equilibrium interest rate is lower than in an economy with well-functioning financial markets: Credit frictions restrict the demand for credit by constrained entrepreneurs, and they also induce constrained entrepreneurs to accumulate more assets for self-financing purposes (more supply of capital). When capital flows are liberalized and this small, now-open economy takes as given the world interest rate, there is an excess supply of capital at the new higher rental rate of capital. The surplus capital gets employed overseas. The removal of idiosyncratic distortions brings in another force in the same direction. Immediately following the reform, the demand for capital from domestic production units falls further, as the previously-subsidized entrepreneurs either exit or curtail their production, while the now-productive individuals cannot enter and operate at an efficient scale right away because of the financial constraints. As the productive entrepreneurs enter and increase their scales of operation over time, domestic demand for capital goes up. This increased demand is matched by accumulation of assets (supply of capital) by these entrepreneurs for self-financing purposes, and hence capital does not flow into this economy.

In our second exercise, we reform the domestic financial institutions as a part of a broader reform package that also eliminates idiosyncratic distortions and liberalizes capital accounts. This is a reasonable description of an economy that implements an across-the-board reform. The drastic reforms of Estonia in the early 1990s are an representative example.

In this exercise, TFP increases for two reasons: the removal of idiosyncratic distortions, and the improved financial markets. Unlike in the first exercise, as we eliminate idiosyncratic distortions and open up the economy, capital flows into this economy. This outcome arises because the

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financial market in this reformed economy functions better than that in the first exercise. The reallocation of capital among heterogeneous producers are expedited, and the TFP grows much faster than in the first exercise. This TFP growth reflects the fact that productive individuals enter entrepreneurship more quickly, and that their scale of operation grows faster. Domestic capital demand rises immediately after the reform, capital flows in from overseas, bringing down the net foreign asset position to the negative territory.

It is informative to compare the second exercise with one using the standard neoclassical growth model. In our setup, an economy with perfect domestic credit markets is isomorphic to the neo-classical growth model. If the productivity of the aggregate production function goes up because of the removal of idiosyncratic distortions, capital will flow into this small open economy and equalize the return to capital with the world level instantaneously. Although our domestic financial market reform does not take our economy all the way to the perfect credit market benchmark, we obtain results that are qualitatively similar.

In both exercises, the reforms simultaneously implemented the removal of idiosyncratic distortions and the opening up of capital accounts. To understand why we model the reforms this way, consider the following. One possibility is for the country to open up the capital account without removing idiosyncratic distortions. As is discussed above, capital will still flow out of this country, because at the new interest rate there is excess supply of capital in the domestic rental market. However, TFP will remain largely unchanged, and we will not be able to address the observed co-movement of TFP and capital flows. Another possibility is to implement a reform to eliminate idiosyncratic distortions while remaining a closed economy. The TFP will increase over time as resources are reallocated, but by assumption we will not observe any capital flows.

Given the different results we obtain in the first and the second exercises, it is natural to ask which sequencing of reforms are more accurate descriptions of emerging economies' experiences. There is ample documentation showing the prevalence of the sequencing in our first experiment: Reduction of sector-specific or size-dependent taxes and subsidies, along with capital account liberalizations, preceded reforms of domestic financial institutions in the countries that are relevant for our analysis. In fact, the first two are often referred to as "first-generation" reforms, while domestic financial institutions belong to the domain of "second-generation" reforms (Camdessus, 1999).

We draw the following conclusions from our exercises. To assess the effects of the liberalizations of cross-border capital flows, it is important to first understand their interaction with various distortions that interfere with the allocation of production factors within an economy. It is also important to understand the scope and sequencing of reforms that will be undertaken with the capital account liberalization. Domestic financial frictions delay reallocation of resources following the elimination of distortions. This slow reallocation of resources is reflected on the persistent growth of TFP. At the same time, capital flows out of these economies as investment collapses in previously-subsidized producers and industries, and investment in productive producers and industries is slow to materialize because of domestic financial frictions. The rest of this paper is an attempt at a quantitative exploration of this mechanism.

2 Empirical Motivation: Allocation Puzzle

In this section we review the evidence on capital flows and productivity growth. First, we reproduce the findings of Gourinchas and Jeanne (2007) for the 1980–1995 period: countries that exhibit large TFP growth tend to increase their net foreign asset position.[1] We then explore in more detail the time series of TFP and net foreign asset positions of six countries that implemented large-scale economic reforms and liberalizations in this period: Chile, India, Israel, Korea, Mauritius, and Taiwan. As we show below, the large-scale economic reforms in these countries led to a sustained period of TFP growth accompanied by net accumulation of foreign assets.
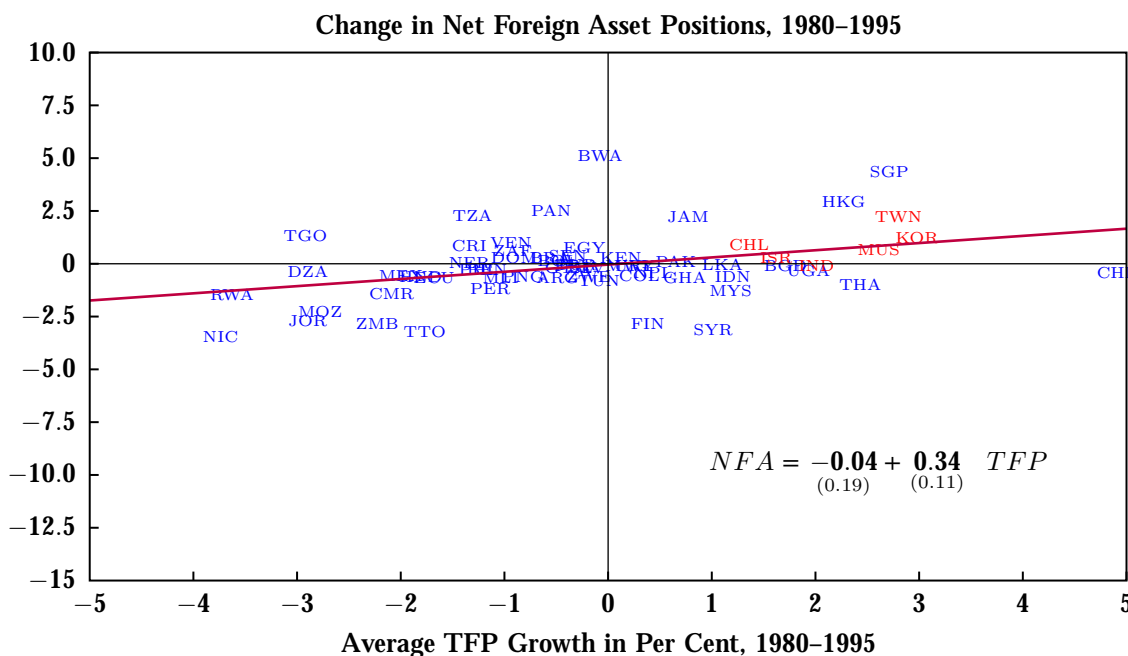

Fig. 1: Allocation Puzzle. The horizontal axis measures the average TFP growth rates over 1980–1995. The vertical axis measures the average rate of change in net foreign asset positions relative to PPP GDP over the same period: Negative (positive) number implies capital inflows (outflows). The net foreign asset position data is from Lane and Milesi-Ferretti (2007).

Figure 1 illustrates the relationship between the changes in net foreign asset positions and productivity growth. TFP growth is defined as per-capita growth net of the contribution of physical and human capital.[2] As is clear from the figure, there is a significant positive relationship between the net accumulation of foreign assets (capital outflows) and TFP growth. On average, one percentage point increase in TFP growth rate translates into 0.3 percentage point increase in the net foreign asset to GDP ratio.[3]

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[1] Related evidence is presented by Prasad et al. (2007).

[2] We use the series from Bernanke and Gürkaynak (2001) who assume a 7% return to schooling.

[3] Net foreign assets are measured in US dollars. We use international prices to construct GDP series. If we were to follow Gourinchas and Jeanne and use nominal exchange rates for GDP, the slope coefficient would be 1.02. We decided to use PPP GDP, as it better reflects actual patterns in capital flows.

We focus on the 1980–1995 period for two reasons. Firstly, 1980s saw the first wave of capital account liberalizations in emerging economies. Secondly, many emerging economies adopted an explicit policy of improving their net foreign asset positions in the aftermath of the East Asian and Russian financial crises of the late 1990s. We focus on the relationship between productivity and capital flows, and our framework is not designed for an analysis of crises or such post-crisis behavior.

We take a closer look at the countries in the northeast quadrant (productivity growth and capital outflows), and explore the time-series of their TFP and net foreign asset positions. For six of these countries, we can identify and date large-scale economic reforms that coincide with the onset of TFP growth. They are: Chile, India, Israel, Korea, Mauritius, and Taiwan. We do not consider Hong Kong and Singapore for two reasons. Firstly, unlike the six countries above, we could not clearly date a large-scale reform episodes for Hong Kong or Singapore. More important, Hong Kong and Singapore were developing into o -shore banking centers during this period, and hence interpreting their net foreign asset positions is tricky. See Lane and Milesi-Ferretti (2007) on this issue. Also note that our sample period precedes the massive acquisition of foreign assets by China (far right side in Figure 1).
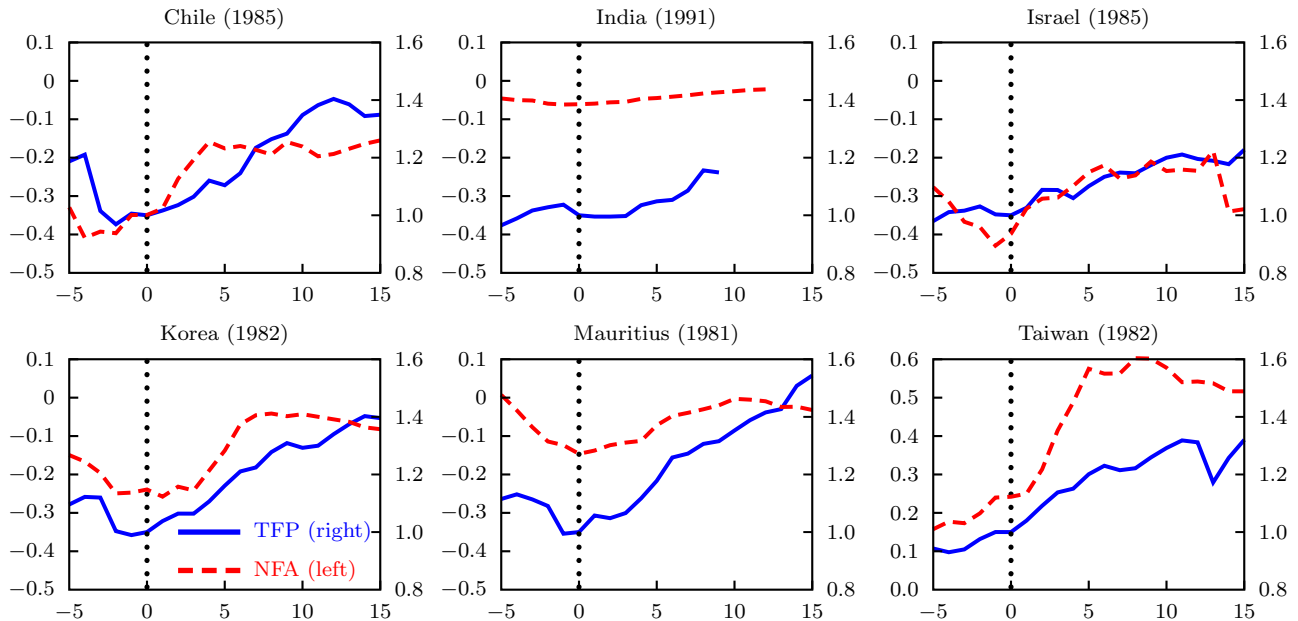

Fig. 2: TFP and Net Foreign Asset Position. Year 0 in the horizontal axis (unit in years) is the year of reform implementation, which is shown in parentheses next to the country name. Net foreign asset position as a fraction of GDP is measured on the left scale, and aggregate TFP can be read o the right scale. TFP is normalized by its value in year 0.

Figure 2 shows the evolution of net foreign asset positions (dashed lines) and productivity (solid lines) before and after major economic reforms. The year of the reform is set to zero, and the two variables are plotted for the surrounding 20 years. Net foreign asset positions are measured

relative to PPP GDP (left scale), and TFP is relative to the year zero level (right scale).[4] In all six cases, reforms ushered in a sustained period of productivity growth. At the same time, in all these episodes, capital flows out of these countries, and their net foreign asset positions increase. Figure 2 shows that the relationship in Figure 1 is not a result of time aggregation.

3 Model

The above empirical observations challenge us to construct a model of TFP dynamics and capital flows. We propose a model with individual-specific technologies and imperfect credit markets. Such a model has been used to study endogenous TFP dynamics (Buera and Shin, 2008).

In each period, individuals choose either to operate an individual-specific technology—i.e. become entrepreneurs, or to work for a wage. This entrepreneur-worker occupation choice allows for endogenous entry and exit in and out of the production sector, which are an important channel of resource reallocation. Imperfection in credit markets is modeled with a collateral constraint on capital rental that is proportional to an individual's wealth.

Individuals are heterogeneous with respect to their entrepreneurial ability and wealth. Our model generates endogenous dynamics for the joint distribution of ability and wealth. This ability-wealth dynamics will prove to be crucial for understanding macroeconomic transitions. In addition, heterogeneity in entrepreneurial ability is essential in modeling how resource misallocation leads to lower output and TFP.

We consider both an economy that is closed to capital flows and a small open economy facing a constant world interest rate. However, in this section, we do not consider idiosyncratic distortions. We show how to introduce idiosyncratic distortions into our model in Section 4.1.2.

Heterogeneity and Demographics   Individuals live indefinitely, and are heterogeneous with respect to their wealth a_t and their entrepreneurial ability e_t. An individual's ability follows a stochastic process. In particular, individuals retain their ability from one period to the next with probability ψ. It is assumed that this ability shock is i.i.d. across individuals. With probability $1 - \psi$, an individual draws a new entrepreneurial ability. We denote by $\mu(e)$ the measure of type-e individuals in the invariant distribution. We denote by $G_t(e, a)$ the cumulative density function for the joint distribution of ability and wealth at the beginning of period t.

The population size is normalized to one, and there is no population growth.

Preferences   Individuals discount their future utility using the same discount factor β. The preferences over contingent plans for the consumption sequence of a dynasty from the point of view

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[4]The dates of the reforms are 1981 for Mauritius, 1982 for Korea and Taiwan, 1985 for Chile and Israel, and 1991 for India. See the appendix for a description of these reform episodes. These dates are consistent with the documentation of Sachs and Warner (1995) and Wacziarg and Welch (2003).

of an individual in period t are represented by the following expected utility function:

$$\mathbb{E}_t \sum_{s=t}^{\infty} \beta^{s-t} u\left(c_s\right).$$

Technologies In any given period, individuals can choose either to work for wage or to operate an

no individual will renege on the rental contract, which implies a collateral constraint $k/\lambda \le a$ or $k \le \lambda a$.

It should be noted that we focus on within-period borrowing, or capital rental, for production purposes. We do not allow borrowing for intertemporal consumption smoothing in our model, which translates into $a \ge 0$.

Individuals' Problem The problem of an agent in period t can be written as:

$$\max_{\{c_s, a_{s+1}\}_{s=t}^{\infty}} \mathbb{E}_t \sum_{s=t}^{\infty} \beta^{s-t} u(c_s)$$

$$s.t. \ c_s + a_{s+1} \le \max\{w_s, \pi(a_s; e_s, w_s, r_s)\} + (1 + r_s)a_s, \ \forall s \ge t \tag{1}$$

where e_t, a_t, and the sequence of wages and interest rates $\{w_s, r_s\}_{s=t}^{\infty}$ are given, and $\pi(a; e, w, r)$ is the profit from operating an individual technology. This indirect profit function is defined as:

$$\pi(a; e, w, r) = \max_{l, k \le \lambda a} \{f(e, k, l) - wl - (\delta + r)k\}.$$

The input demand functions are denoted by $l(a; e, w, r)$ and $k(a; e, w, r)$.

A type-e individual with current wealth a will choose to be an entrepreneur if profits as an entrepreneur, $\pi(a; e, w, r)$, exceed income as a wage earner, w. This occupational choice can be represented by a simple policy function. Type-e individuals decide to be entrepreneurs if their current wealth a is higher than the threshold wealth $\underline{a}(e)$, where $\underline{a}(e)$ solves:

$$\pi(\underline{a}(e); e, w, r) = w.$$

For some e, there may not exist such an $\underline{a}$. In particular, if e is too low, then $\pi(a; e, w, r) < w$ for all a. In this case, this type of individuals will never become entrepreneurs. Intuitively, individuals of a given ability choose to become entrepreneurs if they are wealthy enough to run their businesses at a profitable scale. Similarly, agents of a given wealth choose to become entrepreneurs only if their ability is high enough.

Competitive Equilibrium (Closed Economy) Given $G_0(e, a)$, a competitive equilibrium in a closed economy consists of sequences of joint distribution of ability and wealth $\{G_t(e, a)\}_{t=1}^{\infty}$, allocations $\{c_s(e_t, a_t), a_{s+1}(e_t, a_t), l_s(e_t, a_t), k_s(e_t, a_t)\}_{s=t}^{\infty}$ for all $t \ge 0$, and prices $\{w_t, r_t\}_{t=0}^{\infty}$ such that:

1. Given $\{w_t, r_t\}_{t=0}^{\infty}$, e_t, and a_t, $\{c_s(e_t, a_t), a_{s+1}(e_t, a_t), l_s(e_t, a_t), k_s(e_t, a_t)\}_{s=t}^{\infty}$ solves the agent's problem in (1) for all $t \ge 0$;

2. The labor and capital markets clear at all $t \ge 0$, which by Walras' law implies goods market clearing as well:

$$\sum_{e \in \mathcal{E}} \left[\int_{\underline{a}(e, w_t, r_t)}^{\infty} l(a; e, w_t, r_t) G_t(e, da) - G_t(e, \underline{a}(e, w_t, r_t)) \right] = 0,$$

$$\sum_{e \in \mathcal{E}} \left[\int_{\underline{a}(e,w_t,r_t)}^{\infty} k\left(a; e, w_t, r_t\right) G_t\left(e, da\right) - \int_0^{\infty} a G_t\left(e, da\right) \right] = \mathbf{0},$$

3. **The joint distribution of ability and wealth $\{G_t\left(e, a\right)\}_{t=1}^{\infty}$ evolves according to the equilibrium mapping:**

$$G_{t+1}\left(e, a\right) = \psi \int_{u \leq a} \int_{a'(e,v)=u} G_t\left(e, dv\right) du$$

$$+ \left(1 - \psi\right) \sum_{e_-} \mu\left(e | e_-\right) \int_{u \leq a} \int_{a'(e_-, v)=u} G_t\left(e, dv\right) du.$$

A competitive equilibrium for a small open economy is defined in a similar fashion, given a world interest rate r^*. In this case, the domestic capital rental market and goods market do not need to clear, and the net foreign asset (NFA) equals:

$$NFA_t = \sum_{e \in \mathcal{E}} \mu\left(e\right) \left[\int_0^{\infty} a G_t\left(e, da\right) - \int_{\underline{a}(e,w_t,r^*)} k\left(a; e, w_t, r^*\right) G_t\left(e, da\right) \right].$$

4   Quantitative Exploration

The central objective of this paper is to construct a quantitative model of TFP dynamics and capital flows during the process of development—the transition of economies from a steady state with low per-capita income to a steady state with high per-capita income. Following a recent literature emphasizing the role of individual distortions (Restuccia and Rogerson, 2008; Guner et al., 2008; Hsieh and Klenow, 2007), we interpret development dynamics as arising from reforms that remove idiosyncratic distortions, while credit market frictions remain. In order to quantify our theory, we need to first choose a set of structural parameters (preferences, technologies, distribution of entrepreneurial ability) that are common across economies. Then we choose a set of structural parameters that are di erent across economies—parameters governing idiosyncratic distortions and financial frictions. Once all these parameters are chosen, we can use our model to obtain the initial condition for the transitions, $G_0\left(e, a\right)$. This initial condition is a stationary equilibrium of an economy that (i) has idiosyncratic distortions, (ii) is closed to goods and capital flows, and (iii) has a poorly-functioning domestic financial institutions.

We first calibrate the common parameters so that the stationary equilibrium of the benchmark economy with perfect credit markets matches the US data on standard macroeconomic aggregates, establishment-size distribution and dynamics, and income concentration. We then use data on idiosyncratic distortions to construct the initial steady state for our reform exercises.

4.1   Calibration

4.1.1   Parameters Common across Steady States

We first describe the parametrization of the benchmark model, and then discuss the calibration of the parameters that are common across economies. For the sake of clarity, we choose a parsimonious

	US Data	Model	Parameter
Top 10% Employment	0.63	0.63	$\eta = 4.6$, $\nu = 0.19$
Top 5% Earnings	0.30	0.31	
Exit rate	0.10	0.10	$\psi = 0.89$
Interest rate	0.04	0.04	$\beta = 0.92$

Table 1: Calibration

parametrization that follows as much as possible the standard practices in the literature.

We choose a period utility function of the isoelastic form:

$$u\left(c\right) = \frac{c^{1-\sigma} - 1}{1 - \sigma}.$$

We assume that an entrepreneur with talent e who hires k units of capital and l units of labor produces according to the following Cobb-Douglas production function:

$$f\left(e, k, l\right) = e\left(k^{\alpha} l^{1-\alpha}\right)^{1-\nu}, \tag{2}$$

where $1 - \nu$ is known as the span-of-control parameter. Accordingly, $1 - \nu$ represents the share of output going to the variable factors. Out of this, fraction α goes to capital, and $1 - \alpha$ goes to labor.

The entrepreneurial ability e is assumed to be a discretized version of a Pareto distribution whose probability density is $\eta e^{-(\eta+1)}$ for $e \geq 1$. Each period, an individual may retain her previous entrepreneurial ability with probability ψ. With probability $1 - \psi$, she draws a new ability realization from the Pareto distribution given above. Obviously, ψ controls the persistence of ability, while η determines the dispersion of ability in the population.

We now need to specify eight parameter values: two technological parameters α, ν, and the depreciation rate δ; two parameters describing the process for ability ψ and η; the subjective discount factor β and the reciprocal of the intertemporal elasticity of substitution σ.

We let $\sigma = 1.5$ following the standard practice. The one-year depreciation rate is set at $\delta = 0.06$. We choose $\alpha = 0.3$ to match the aggregate share of capital.

We are thus left with four parameters (ν, η, ψ, and β). We calibrate them to match four relevant moments in the US data: the employment share of the top decile of establishments; the share of earnings generated by the top five-percentile; the exit rate of establishments; and the real interest rate. We calibrate the perfect-credit benchmark of our model to match the target moments from the US data.

The first column of Table 1 shows the value of these moments in the US data. The largest—measured by employment—decile of establishments in the US account for 63 percent of total employment. We target the earnings share of the top five-percentile (0.3), and an annual job destruction rate of 10 percent. Finally, as the target interest rate, we pick 4 percent per year.

The second column of Table 1 shows the moments simulated from the calibrated model. Even though in the model economy all four moments are jointly determined by the four parameters, each moment is primarily a ected by one particular parameter.

We briefly discuss the identification and interpretation of some of the parameter values. Given the span-of-control parameter $1 - \nu$, the tail parameter of the ability distribution η can be inferred from the tail of the distribution of employment. We can then infer ν from the share of income of the top five per cent of earners. Top earners are mostly entrepreneurs (both in the data and in our model), and ν controls the share of income going to the entrepreneurial input. These two parameters are calibrated at $\nu = 0.19$ and $\eta = 4.6$. The parameter $\psi = 0.89$ leads to an annual exit rate of ten per cent in the model. Finally, the model requires a discount factor $\beta = 0.92$ to match the interest rate of four percent.

4.1.2 Output Distortions and Credit Frictions

We think of our initial condition as the joint ability-wealth distribution of a closed-economy stationary equilibrium under financial *and* non-financial frictions. These frictions can be modeled with idiosyncratic distortions, or individual-specific taxes and subsidies (τ_{yi}, τ_{ki}), that transform the static profit-maximization problem of an entrepreneur into:

$$(1 - \tau_{yi}) \, e_i \left(k_i^\alpha l_i^{1-\alpha} \right)^{1-\nu} - w l_i - (1 + \tau_{ki}) \left(\delta + r \right) k_i.$$

Note that τ_{ki} is a reduced-form representation of the financial frictions in our economy. This specification is identical to the framework that Hsieh and Klenow (2007) use to quantify idiosyncratic distortions in Chinese and Indian manufacturing sectors. In particular, they define and measure a geometric average of output and capital distortions for each production unit: $\tau_i \equiv (1 + \tau_{ki})^{(1-\nu)\alpha}/(1 - \tau_{yi})$.[5] They find that idiosyncratic distortions (τ_i) in Chinese and Indian manufacturing sectors are large, with a difference between the 90th and 10th percentiles of 1.73–1.87 log points (compared with 1.04 in the US), and are positively correlated with establishments' productivity, with a correlation coefficient of 0.66–0.70 (0.46 in the US). In Table 2 we reproduce these moments for China, India and the US. More dispersion of τ_i and a stronger positive correlation between τ_i and individual productivity translate into lower aggregate TFP and output. In the perfect-credit benchmark without non-financial distortions (i.e., $\tau_y \equiv 0$), measured τ_i is zero for all production units indexed by i. There are two reasons for omitting non-financial distortions (τ_y) in our perfect-credit benchmark economy and instead targeting the difference in the dispersion of distortions between the US and China/India. First, parts of the measured distortions may be measurement errors that affect the data from China, India and the US in a similar way. Second, the benchmark calibration (Section 4.1.1) is cleaner without τ_y's.

We impose a τ_y process and financial frictions ($\lambda = 1.5$, which results in an external finance to GDP ratio of a typical less developed economy, 0.6–0.8) onto our benchmark calibration (Table

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[5]Hsieh and Klenow assume monopolistically-competitive firms that use constant returns to scale technologies and face isoelastic demands. It can be shown that their measured distortions are isomorphic to those in our framework. An important caveat is that the span of control parameter, $1 - \nu$, corresponding to Hsieh and Klenow's calibration of the elasticity of substitution is on the low side (close to 0.5). In our economy, idiosyncratic distortions will have a substantially smaller effect on TFP, given our more conventional choice of $1 - \nu = 0.81$.

	90 − 10	$corr[\log(e), \log(\tau)]$	TFP	Wealth Share of Top 5% e
US	1.04	0.46	$\cdots$	$\cdots$
China/India	1.73–1.87	0.66–0.70	$\cdots$	$\cdots$
$\lambda = 1.5, \tau_y \equiv 0$	0.82	0.53	0.81	0.47
$\lambda = 1.5, \tau_y \neq 0$	0.86	0.40	0.66	0.37

Table 2: Measured Distortions. The column '90–10' reports the log di erence between the 90th and 10th percentile production units in terms of τ. The upper panel data on the US and China/India are from Hsieh and Klenow (2007). The lower panel reports corresponding moments from our model. The first row in the lower panel is the case with financial frictions only. The last row is the case with both financial and non-financial frictions. TFP is normalized by its level in the perfect credit benchmark with no distortions ($\tau_y \equiv 0, \tau_k \equiv 0$ for all production units). The last column reports the share of wealth held by the top five percentile of the ability distribution.

1), and use our model to compute the stationary equilibrium.[6] We discipline our choice of τ_y so that, among the active entrepreneurs in the stationary equilibrium, the log di erence between the 90th and 10th percentiles (in terms of τ) is around 0.8 (the di erence between China/India and the US).[7] Note that, to be conservative, we choose a low value (0.4) for the correlation between distortions and productivity: A higher correlation between distortions and productivity implies more misallocation in the steady state and hence a bigger e ect on transition dynamics.[8] Last but not least, we also impose that the subsidies and taxes through τ_y cancel out across all active establishments.

The second-to-last row of Table 2 corresponds to an economy with financial frictions but no τ_y. The di erence between the 90th and 10th percentiles (τ) is around 0.82 log points and the correlation coe cient between log ability and log distortions is 0.53. In this economy, TFP is only a ected by capital distortions, and TFP is 24 per cent below that of the benchmark economy. The bottom row ($\lambda = 1.5, \tau_y \neq 0$) of Table 2 is the stationary equilibrium that closely matches our targets. In particular, the TFP of the economy subject to both output and capital distortions is 34 per cent lower than the benchmark economy (third column). Both output and capital distortions have a similar role in lowering TFP: Financial frictions alone reduce the perfect-credit TFP by 19 per cent, and the output distortions further reduce TFP by additional 15 per cent (again relative to the perfect-credit level).

In computing the stationary equilibrium, we also obtain the corresponding distribution of ability and wealth. The wealth share of the top five percentile individuals in terms of ability (e) is 0.37

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[6] We specify a process for distorted entrepreneurial abilities $\tilde{e} = (1 - \tau_y) e$. The process for distorted abilities $\tilde{e}$ is described by a probability distribution $\varphi(\tilde{e}|e)$, summarizing the probability with which an individual with ability $e \in \mathcal{E}$ is assigned a distorted ability $\tilde{e} \in \tilde{\mathcal{E}}$. The support of the distorted abilities is a transformation of that of true abilities, $\tilde{\mathcal{E}} = \mathcal{T}(\mathcal{E})$. We assume that the distorted ability and the true ability are equally persistent, and have the same support.

[7] It turns out that the effects on TFP of the underlying distribution of distortions are not necessarily well captured by a limited set of moments. We choose to complement the information provided by the moments reported in Hsieh and Klenow (2007) with a conservative lower bound for the effect on TFP, but still be guided as much as possible by the available data.

[8] This is generally true, with the exception of the case with log-normal shocks. See Hsieh and Klenow (2007).

in the economy with financial and non-financial frictions. This is lower than in the economy with $\tau_y \equiv 0$ (0.47). With financial frictions, individual wealth determines via the collateral constraint how much capital an entrepreneur can use for production. The lower concentration of wealth (and hence resources) in the hands of the most productive entrepreneurs is a measure of resource misallocation attributable to non-financial distortions (τ_y).

The joint distribution of wealth and ability summarized in the bottom row of Table 2 is the initial condition for our transition exercise in Section 4.3.

4.2 Steady State Results: Financial Frictions and the Return to Savings

We first study the long-run effects of financial frictions. In Figure 3, we consider how allocations and prices of the stationary equilibria respond to changes in the collateral constraint parameter λ. Note that a lower λ means more financial frictions, with $\lambda = 1$ corresponding to zero external financing and $\lambda = +\infty$ to perfect credit markets. For this analysis, the economy is closed, and there is no output distortion ($\tau_y \equiv 0$). There is a monotonic relationship between λ and the equilibrium ratio of external finance to GDP: The higher λ, the higher the external finance to GDP ratio. We plot equilibrium output and interest rate against external finance to GDP ratio, instead of λ itself. In the figure, we are considering the range of external finance to GDP that is relevant to developing countries (0.1 to 1.58). Our perfect credit benchmark, for example, has an external finance to GDP ratio exceeding 2.0, which corresponds to the US level.
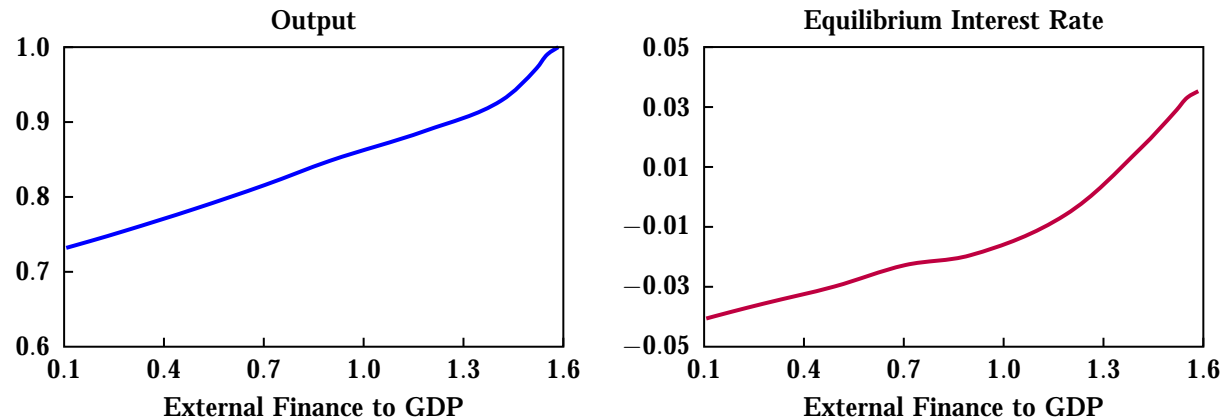

Fig. 3: The Effect of Financial Frictions on Closed-Economy Stationary Equilibria. We generate stationary equilibria corresponding to different degrees of financial frictions (λ). These economies are closed, and there are no non-financial frictions/distortions. The external finance to GDP ratio (horizontal axis) has a monotonic (positive) relationship with λ. Here λ ranges from 1.1 (external finance to GDP of 0.1) to 7.5 (external finance to GDP of 1.58). Output (left panel) is normalized by its level with $\lambda = 7.5$.

The left panel shows the effect of the collateral constraint on aggregate output, which is measured relative to its value in the case with $\lambda = 7.5$ (external finance to GDP ratio of 1.58). Note that financial frictions have sizable effects on output: As we reduce financial intermediation, output drops by 27 per cent. Nevertheless, this exercise shows that financial frictions alone are not enough to account for the output gap between developed and less developed economies.

More important, economies with worse credit markets have lower equilibrium interest rates. The lower interest rate in the general equilibrium follows from entrepreneurs' restricted demand for capital because of tighter collateral constraints, and also from their higher savings rate because of the need for self-financing (a higher supply of capital, all else equal). This prediction of our model is consistent with empirical findings. Figure 4 plots the time-averaged returns to saving of a country against its income level. The regression line has a positive slope, validating our model prediction that returns to saving in less developed countries with poorly-functioning financial markets are lower than those in developed countries.[9] This is not surprising given the prevalence of "financial repression" in less developed countries.

Average Annual Ex-Post Real Returns to Saving in Per Cent

$$r = \underset{(2.75)}{-\mathbf{8.61}} + \underset{(0.32)}{\mathbf{1.07}} \log y$$

Log Per-Capita GDP
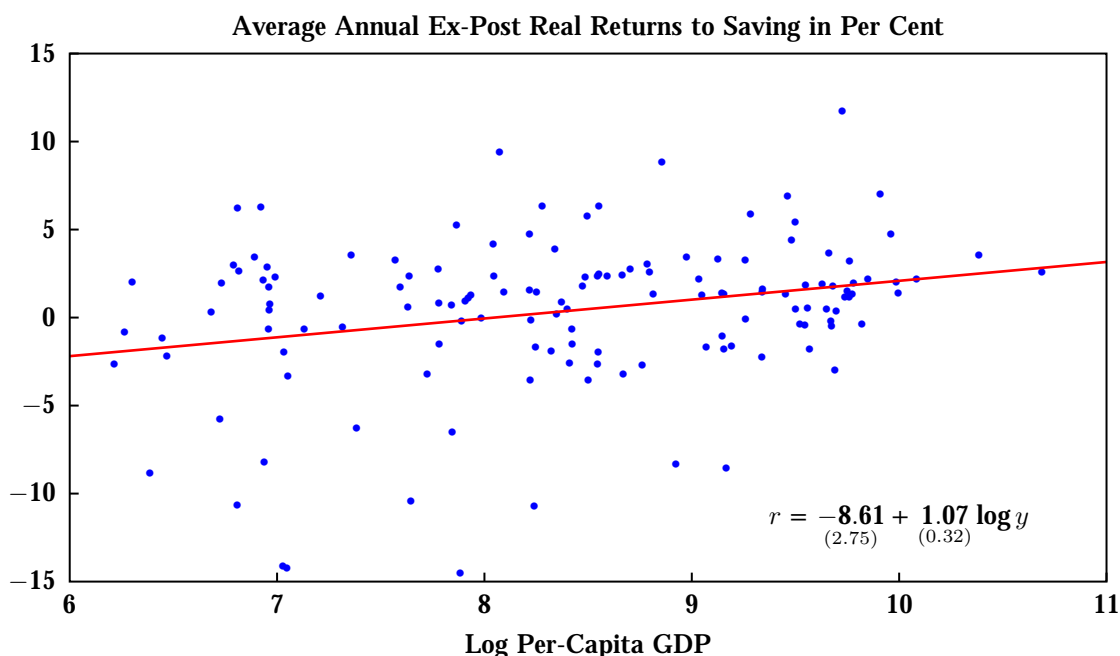
Fig. 4: Returns to Saving across Countries. The data are from the International Financial Statistics (IFS) database. We subtract ex-post inflation rates from nominal deposit rates. When deposit rates are not available, we use returns on government-issued securities.

From this, we can foresee what will happen if capital is allowed to flow across countries. When a less developed country opens up to international capital market, the domestic interest rate will rise and be equalized with the world interest rate, which is pinned down by a large, rich country with well-functioning financial markets. At this new interest rate, there is excess supply of domestic capital in the rental market, and this surplus capital will be rented out to overseas production units. This is the main mechanism explored in the literature to explain why capital may flow from less developed to more developed economies. The examples include Gertler and Rogo (1990), Boyd and Smith (1997), Matsuyama (2005), and Mendoza et al. (2007), among many others. Our

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[9]The average return is not adjusted for risk. Given the volatility of the real returns to saving in less developed economies, the regression line will tilt steeper, if we look at risk-adjusted returns. Independently of our work, Ohanian and Wright (private communication) obtained similar results.

contribution is to go beyond this result and explore the joint dynamics of aggregate productivity and capital flows. To the best of our knowledge, we are the first to do so.

4.3 Post-Reform Transition Dynamics

In this section, we study the joint behavior of TFP and capital flows following large-scale economic reforms and liberalizations. We consider two main exercises. Both will start with a closed economy that are burdened with idiosyncratic distortions, in addition to financial frictions, and hence resource misallocation. In particular, this closed economy has idiosyncratic distortions, whose magnitude is consistent with the magnitude reported by Hsieh and Klenow (Table 2). The domestic financial market is not functioning well, with $\lambda = 1.5$ to be consistent with data on external finance (Beck et al., 2000).

Before we begin, we consider two simple exercises to illustrate the effect of different reforms. In our main exercises, we open the economy to goods and capital flows, precisely when we implement a reform to eliminate idiosyncratic distortions. In the simple exercises, starting from the same initial condition, we consider first opening up the economy while leaving idiosyncratic distortions intact. We then look at a different example of eliminating idiosyncratic distortions while leaving the economy closed to goods and capital flows.
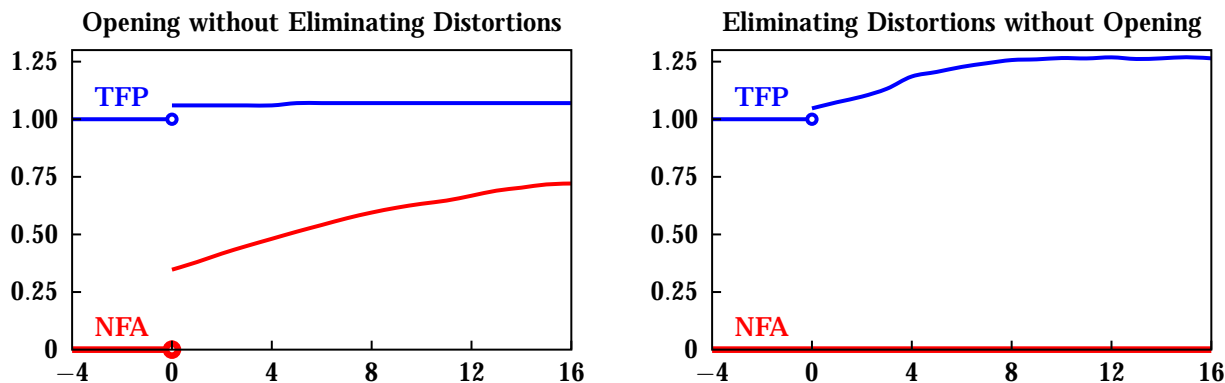

Fig. 5: One Reform at a Time. In the left panel, the economy opens up to the international capital market in year 0, but no reform is implemented to address either idiosyncratic distortions or domestic financial markets. NFA is relative to the pre-reform aggregate capital stock K_{0-}. TFP is relative to its pre-reform level. In the right panel, a reform is implemented to remove all idiosyncratic distortions. It is assumed that the economy remains closed, and that the domestic financial frictions remain intact. The unit of the horizontal axis is years.

In the left panel of Figure 5, we open up the economy to goods and capital flows in year zero, without doing anything about the idiosyncratic distortions. The domestic financial market is left as it was. Capital flows out of the economy, and the net foreign asset position (NFA) jumps up and increases smoothly over time. This result should have been expected based on our discussion in Section 4.2. However, without any reform on idiosyncratic distortions, the aggregate productivity (TFP) of the economy barely moves. It actually goes up by 6 per cent, as the higher rental rate of capital (world level) shuts down marginal production units, who tends to be incompetent

entrepreneurs supported by subsidies. In addition, the higher TFP also reflects the fact that productive entrepreneurs can enter and grow faster than before, as they now get higher returns to their saving.

In the right panel of Figure 5, we consider the opposite: implementing a reform to remove all idiosyncratic distortions, while leaving the economy closed.[10] Again, the domestic financial market is left as it was. Following the reform, TFP jumps up by 14 per cent, and gradually increases over time: over the first ten years following the reform, TFP increases by about 2.5 per cent per year. This reflects more efficient reallocation of resources over time, as productive entrepreneurs save up and enter, while incompetent ones who lose their subsidy exit. However, obviously by assumption, there is no flow of capital in and out of the economy, and the net foreign asset position stays at zero.

The above examples show that we need to consider an exercise where we eliminate distortions and open up the economy, as our goal is to study the joint dynamics of TFP and capital flows.

Exercise 1: Removal of Distortions and Opening Up   The economic liberalization occurs in year zero. It is unexpected. Once it happens, everyone understands that it is a once-and-for-all change. In this episode, the liberalization consists of two components. One is the opening up of the economy's capital accounts, and the other is the removal of the idiosyncratic distortions. However, we assume that domestic financial frictions remain unchanged. We are thinking of the financial frictions as arising from enforcement problem, which is a component of broader institutions, and hence more sluggish. The reform experiences of the countries we study in Section 2 are consistent with this sequencing of reforms. Measured in both de jure and de facto sense, domestic financial market reforms lag behind the removal of size-dependent or industry-specific taxes and subsidies, as well as capital account liberalizations.

The result of this liberalization episode is shown in Figure 6. From year 0, as the reform is implemented, resources now get reallocated more efficiently. The increasing TFP reflects this reallocation (solid line, center panel). More efficient reallocation of resources occur along two margins. First, capital and labor are reallocated among existing entrepreneurs (intensive margin). In addition, more productive entrepreneurs will enter, while previously-subsidized incompetent entrepreneurs will exit (extensive margin). The dashed line in the middle panel shows the average ability/talent of active entrepreneurs. Note that the efficient reallocation along these two margins occur gradually over time (the unit for the horizontal axis is years), as the reallocation is slowed down by domestic financial frictions. Both TFP and the average entrepreneurial talent are measured relative to their pre-reform levels. The GDP per capita (right panel) also increases following the reform, largely reflecting the increase in TFP early on (first eight years) and accumulation of capital later (10 to 20 years after the reform). GDP is also measured relative to its pre-reform level.

In the left panel, the net foreign asset position jumps up and then goes further up gradually. The increase in the NFA in the beginning is driven by the fall in demand in the domestic capital rental

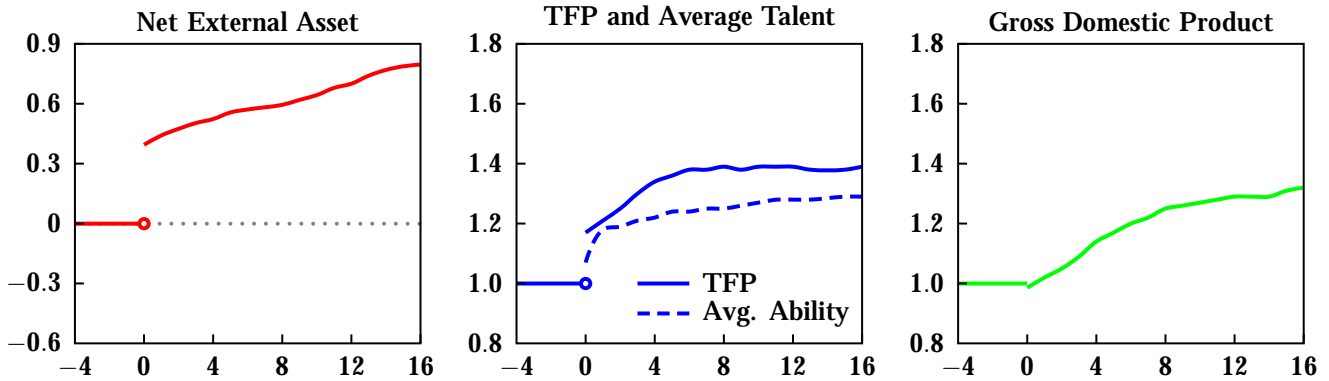[10]See Buera and Shin (2008) for a detailed analysis of this case.

Fig. 6: Transition Dynamics without Domestic Financial Market Reform. In year 0, a reform is implemented to remove all idiosyncratic distortions in the economy. At the same time, the economy opens up to the world capital market. Domestic financial frictions remain intact. In the left panel, net foreign asset positions are measured relative to the pre-reform aggregate capital stock (K_{0-}). An increase in net foreign asset position implies capital outflows. In the center panel, TFP (solid line) and the average ability of active entrepreneurs (dashed line) are shown. Both quantities are relative to their respective pre-reform level. The right panel plots the GDP series, also relative to its pre-reform level. The unit of the horizontal axis is years.

market. Opening up capital accounts implies that the domestic rental rate of capital is equalized to the world level. As the rental rate increases to the world level, less capital is demanded. At the same time, entrepreneurs who lose their subsidy during the reforms will begin to exit, further reducing the demand in the capital rental market. However, they are not immediately replaced by truly productive individuals who were previously taxed highly and kept out of entrepreneurial activities. These individuals are not rich enough to overcome the collateral constraints and start production immediately. All these factors explain a fall in domestic capital demand, and the surplus capital flows out of the country, increasing the NFA. As the productive entrepreneurs enter and increase their scales of operation over time, domestic demand for capital goes up. This increased demand is matched by accumulation of assets (supply of capital) by these entrepreneurs for self-financing purposes (domestic financial frictions still remain). In addition, the higher interest rate induces individuals to save more, further driving up the net foreign asset position over time. The NFA is measured relative to the pre-reform capital stock (K_{0-}).

Exercise 2: Removal of Distortions, Opening Up, Domestic Financial Sector Reform
The diﬀerence here is that the large-scale reform at year 0 has one additional component. On top of the capital account liberalization and the removal of idiosyncratic distortions, this economy will also reform its domestic financial markets, increasing its λ from 1.5 to 7.5. The choice of $\lambda = 7.5$ corresponds to the equilibrium external finance to GDP ratio of 1.58, which is a level few, if any, developing countries reached before 2000. In this sense, $\lambda = 7.5$ represents a very well-functioning financial market by the developing country standard.

The result is shown in Figure 7. The TFP figure is qualitatively similar to the previous picture. Removal of the idiosyncratic distortions leads to more eﬃcient reallocation of resources, as is
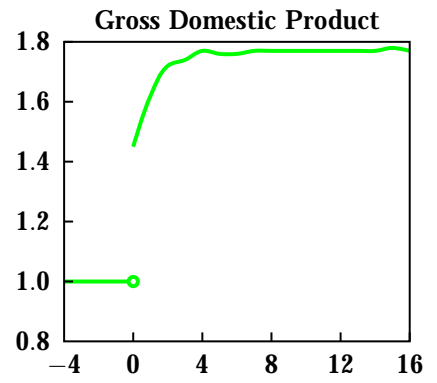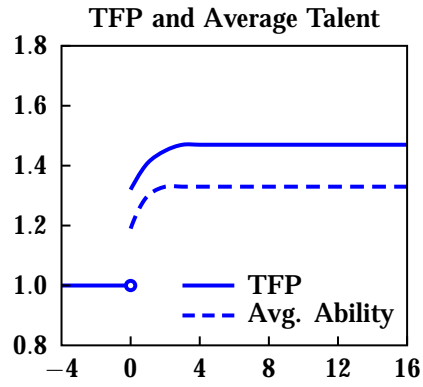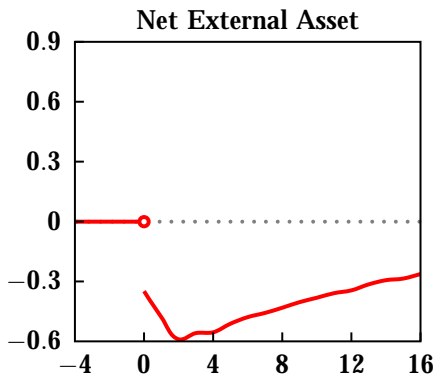
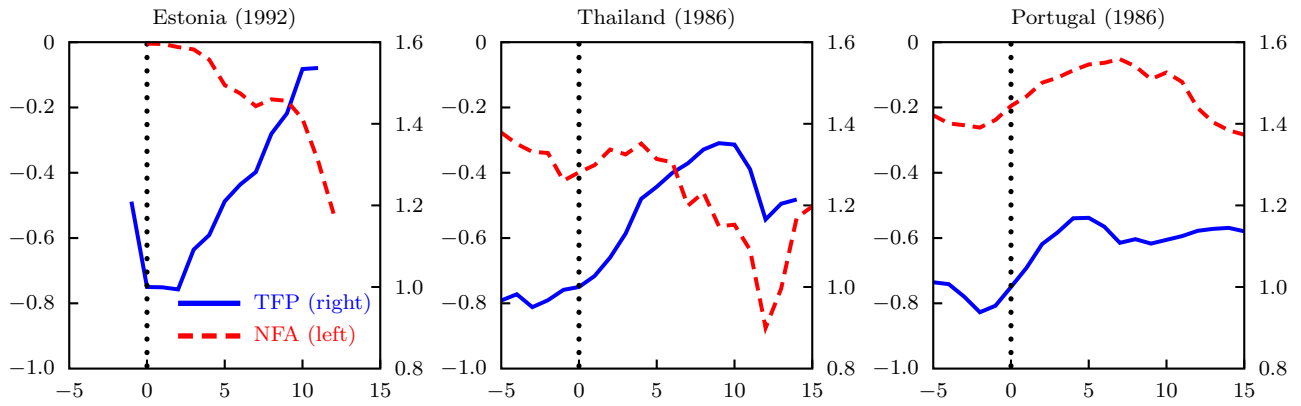Fig. 4: Transition Dynamics of Domestic Financial Market Reform (18 years)

Fig. 8: TFP and Net Foreign Asset Position. Year 0 in the horizontal axis is the year of reform implementation, which is shown in parentheses next to the country name. Net foreign asset position as a fraction of GDP is measured on the left scale, and aggregate TFP can be read o the right scale. TFP is normalized by its value in year 0. The unit of the horizontal axis is years.
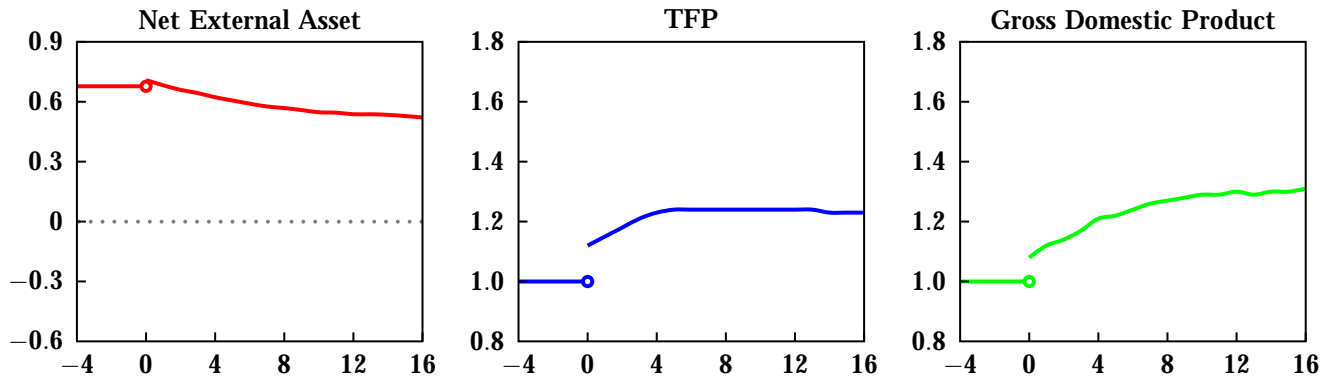
Fig. 9: Transition Dynamics with Financial Repression. The economy is already open to the flows of goods and capital prior to the reform. Note that the initial condition of this exercise is different from that of Exercises 1 and 2. In year 0, a reform is implemented to remove all idiosyncratic distortions in the economy. As in Exercise 1, domestic financial frictions remain intact. In the left panel, net foreign asset positions are measured relative to the pre-reform aggregate wealth of domestic residents. In the center panel, TFP (solid line) and the average ability of active entrepreneurs (dashed line) are shown. Both quantities are relative to their respective pre-reform level. The right panel plots the GDP series, also relative to its pre-reform level. The unit of the horizontal axis is years.

privatization allowed the formation of business conglomerates through the sale of state-owned assets, which were purchased with soft financing provided by the state with funds obtained by abusing the implicit bank deposit insurance. This second wave of reforms proved to be more persistent.

Controls on capital outflows imposed in 1982 were removed in 1985, while restriction on short-term capital inflows remained. At the time of the reform, the domestic financial markets were recovering from the financial crisis of 1982. While the financial system developed significantly in the following decades, in the initial periods financial intermediation was relatively limited.

India, 1991   Following an external payment crisis, in 1991 India embarked on a broad set of reforms. These reforms included (i) the abolition of industrial licensing and the narrowing of the scope of public sector monopolies to a much smaller number of industries; (ii) the liberalization of inward foreign direct and portfolio investment; (iii) the sweeping liberalization of trade which included the elimination of import licensing and the progressive reduction of non-tari barriers; (iv) financial sector liberalization, including the removal of controls on capital issues, freer entry for domestic, and foreign, private banks and the opening up of the insurance sector; (v) the liberalization of investment in important services, such as telecommunications (Kochhar et al., 2006).

Deregulation of capital flows began in 1991. Exchange rates were unified in 1993, and current account convertibility was achieved by 1994. Gradual banking sector reform started in mid 1990s, but credit control remains throughout the 1990s.

Israel, 1985   In 1985 a successful stabilization plan was put into place, which fundamentally changed the structure and performance of the Israeli economy. As a consequence of budget adjustments and subsequent reforms, the principal markets (capital, foreign exchange, and labor) underwent important changes. Government intervention in the markets of production factors and in finances was significantly reduced. The share of government expenditure in the GDP decline by 20 percentage points in the first 10 years of the reform. Furthermore, the composition of the budget went from an emphasis on subsidies toward factors of "priority" industries and regions, into broader investment in infrastructure. Earlier protectionist tendencies were slowly reverted. In 1985 a free-trade agreement with the US was signed, and by 1990 all non-tari barriers on imports from "third countries" were abolished and replaced with relatively high tari s (20–75 percent), and in 1992 a process of lowering these tari s started (Ben-Bassat, 2002).

Capital controls imposed in 1970 were reversed in 1987. Distortions to domestic financial markets were significant until mid 1990s. Directed credit, regulated interest rate, public ownership of major banks lasted until the mid 1990s.

Korea, 1982   In the second half of the 1970s, the Korean government embarked on a program subsidizing heavy and chemical industries. This experiment ceased in 1981. Entry of small and medium sized firms was encouraged in the early 1980s, while the government streamlined its own

organization at the same time. This failed experiment led the government to delegate the role of investment planning to the private sector. Control on capital flows was eased first in 1979 (inward), then in 1982 (inward), and then again in 1985 (inward and outward). Significant distortions of the financial markets remained until the mid 1990s. Directed lending and regulated interest rates were phased out beginning in 1995 (to join the OECD) and in 1998 (IMF conditionality).

Mauritius, 1981 Starting with the negotiation of a structural adjustment loan with the World Bank in 1980, a process of reform began that progressively removed various distortions. These reforms include the elimination of price controls, quantity restrictions on imports, export taxes on sugar, and a gradual reduction of tari s. As part of these reforms, the government eliminate the di erential tax treatment for companies under various special regimes, e.g., export promotion zones, import substitution regimes (Gulhati and Nallari, 1990).

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