

# Productivity Growth and Capital Flows: The Dynamics of Reforms

Francisco J. Buera\*      Yongseok Shin<sup>†</sup>

July 19, 2009

## 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 non-financial 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. We use our model to analyze the welfare consequences of opening up capital accounts. We find that the marginal welfare impact of capital account liberalization is negative for workers while it is positive for entrepreneurs and wealthy individuals.

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\*Department of Economics, University of California at Los Angeles and NBER; fjbuer@econ.ucla.edu.

<sup>†</sup>Department of Economics, Washington University in St. Louis and Federal Reserve Bank of St. Louis; yshin@wustl.edu.

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 experiencing 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 TFP growth follow large-scale reforms and economic liberalizations. The periods of increasing net foreign asset positions (capital outflows) coincide with such episodes. A successful explanation of these phenomena requires both a theory of TFP dynamics and a model of international factor reallocation. This is the goal of our paper.

We develop a quantitative framework where economy-wide growth-enhancing reforms and liberalizations lead to a sustained period of productivity growth and capital outflows. We then use the model to evaluate the welfare consequences of capital account liberalization.

We study the transitional dynamics of open economies with heterogeneous production units and imperfect domestic financial markets. In our model, a reform initiates reallocation of resources from previously-subsidized producers to productive entrepreneurs who were not subsidized previously and were hence relatively poor. The reallocation is gradual because of the frictions in the domestic financial market. In the early stages of the post-reform transition, the problem for this economy is misallocation of capital, not under-accumulation. With demand for capital restricted by the poorly-functioning domestic financial markets, the surplus capital goes overseas in search of a higher return.

Heterogeneous production units and imperfect financial markets are important elements of endogenous TFP dynamics (Buera and Shin, 2008). We model financial frictions in the form of collateral constraints founded on imperfect enforceability of contracts. We consider economies where, in addition to financial frictions, individual entrepreneurs are subject to idiosyncratic distortions, e.g., idiosyncratic taxes/subsidies, and sector-specific or size-dependent policies/regulations. Such distortions help explain resource misallocation and resulting low aggregate productivity levels in less developed economies (Hopenhayn and Rogerson, 1993; Lagos, 2006; Restuccia and Rogerson, 2008; Guner et al., 2008; Hsieh and Klenow, 2007).

There are three kinds of reforms that we consider for our model economies: (i) a reform that addresses idiosyncratic distortions; (ii) trade and capital account liberalization; (iii) a reform of domestic financial institutions.

In our main exercises, we consider two different sequencing of reforms. Both exercises start with the same initial condition. We construct this initial condition by computing a stationary equilibrium of an economy that (i) has idiosyncratic distortions, (ii) is closed to goods and capital flows, and (iii) has poorly-functioning domestic financial markets.

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 immediately following the reform. 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 and higher rental rate of capital. The surplus capital gets employed overseas.

Capital flows mirror the difference between saving by domestic residents and domestic investment. Along the transition, domestic residents increase their saving in response to the higher interest rate. The removal of idiosyncratic distortions also affect individuals' saving and investment decisions. 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 promptly because of the domestic financial constraints. As the productive entrepreneurs enter and increase their scales of operation over time, domestic demand for capital goes up. However, this increased demand are partly offset by accumulation of assets (supply of capital) by these entrepreneurs for self-financing purposes, and hence capital does not flow back into this economy. In summary, the central economic force driving capital flows in the model, like in the data, is the increase in domestic residents' saving that overwhelms the changes in domestic investment.

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 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 neoclassical 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).

Our model lends itself well to a quantitative welfare analysis. Of particular interest is the welfare consequence of capital account liberalization. Given that economists agree on the desirability of removing idiosyncratic distortions, we ask whether it is better to open up to international capital flows at the same time or not. Comparing the results of our first exercise (removal of distortions

while opening up) and the other case where distortions are eliminated while the economy remains closed, we find that not all individuals benefit from concurrent capital account liberalization. Obviously the wealthy directly benefit from capital account liberalization, which instantaneously give them higher return—the world interest rate—on their financial assets (income effect). High-ability individuals, who will choose to be entrepreneurs and tend to be wealthy, are better off when the economy opens up. On the other hand, low-ability individuals, who will choose to be workers, are better off when the economy remains closed, unless they start out very wealthy. With capital account liberalization, capital flows out of the country following the reform. Holding other things equal, this implies less capital per worker for domestic production, and the wage is lower than in the closed-economy transition temporarily. Wage eventually rises to a higher level with capital account liberalization, but the lower wage along the transition prevails on the overall welfare of low-ability individuals.

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. Furthermore, capital account liberalization may have ambiguous welfare effects, adversely affecting less affluent workers and benefiting the wealthy and entrepreneurs. The rest of this paper is an attempt at a quantitative exploration of this mechanism.

## 1 Empirical Motivation: Allocation Puzzle

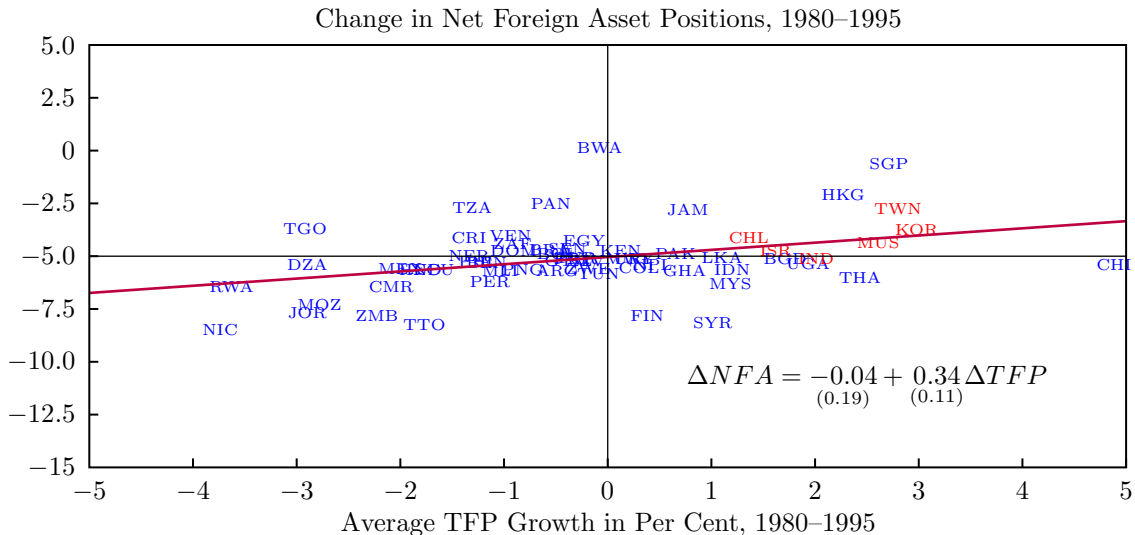
In this section we review the evidence on capital flows and productivity growth. First, we reproduce the findings of Gourinchas and Jeanne (2007) for the 1980–1995 period: countries that exhibit large TFP growth tend to increase their net foreign asset position.<sup>1</sup> We then explore in more detail 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.

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.<sup>2</sup> As is clear from the figure, there is a significant positive relationship

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<sup>1</sup>Related evidence is presented by Prasad et al. (2007).

<sup>2</sup>We use the series from Bernanke and Gürkaynak (2001) who assume a 7% return to schooling.



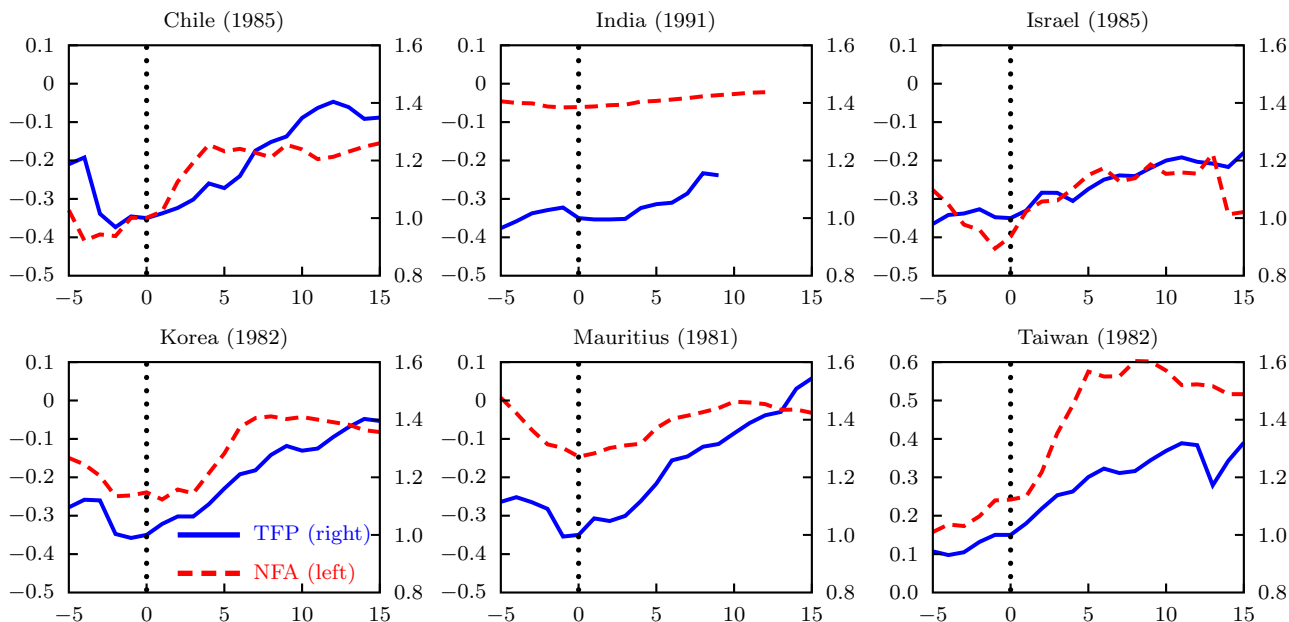
**Fig. 1:** Allocation Puzzle. The horizontal axis measures the average TFP growth rates over 1980–1995. The vertical axis measures the average rate of change in net foreign asset positions relative to PPP GDP over the same period: Negative (positive) number implies capital inflows (outflows). The net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

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. Net foreign assets are measured in US dollars. We use international prices to construct GDP series. We decided to use PPP GDP, as it better reflects actual patterns in capital flows. Another thing to note is that we aggregate the net foreign asset position of a country’s public and private sectors. With capital control, most foreign asset transactions are channeled through government agencies, and hence the public v. private distinction is misleading. For the six countries we discuss below, we consulted their government fiscal balance data and determined that national saving is not largely driven by public saving. The data are from tables in Bosworth et al. (1994), Leipziger (1997), Dommen and Dommen (1999), Dabee and Greenaway (2001), Ben-Bassat (2002), and Kochhar et al. (2006).

We focus on the 1980–1995 period for three reasons. Firstly, the 1980s saw the first wave of capital account liberalizations in emerging economies. Secondly, during the 1990s, innovations in international financial markets (e.g. derivatives and off-balance sheet transactions) made it harder to closely keep track of cross-border capital flows, amplifying measurement problems (Lane and Milesi-Ferretti, 2007). Lastly, 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 off-shore banking centers during this period, and hence interpreting their net foreign asset positions is problematic. 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 off 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).<sup>3</sup> In all six cases, reforms ushered in a period of sustained productivity growth. At the same time, in all these episodes, capital flows out of these countries. Figure 2 shows that the relationship in Figure 1 is not a result of time aggregation.

<sup>3</sup>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 brief description of these reform episodes. These dates are consistent with the documentation of Sachs and Warner (1995) and Wacziarg and Welch (2003).

## 2 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 (non-financial) distortions such as idiosyncratic taxes/subsidies and size-dependent policies. We show how to introduce idiosyncratic distortions into our model in Section 3.1.2.

**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  $\psi$ . With probability  $1 - \psi$ , an individual loses the current ability and has to draw a new entrepreneurial ability. The new draw is from an time-invariant ability distribution, and is independent of one’s previous ability level. One can think of the ability shock as an arrival of new technology making previous production processes obsolete. In Section 3.1.1 we will specify this shock to be of a relatively low frequency (an average duration of ten years).

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 of the economy is normalized to one, and there is no population growth.

**Preferences** Individuals discount their future utility using the same discount factor  $\beta$ . The preferences over contingent plans for the consumption sequence of a dynasty from the point of view of an individual in period  $t$  are represented by the following expected utility:

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

**Technologies** In any given period, individuals can choose either to work for wage or to operate an individual-specific technology. We label the latter option as entrepreneurship. We assume that an entrepreneur with talent  $e$  who uses  $k$  units of capital and hires  $l$  units of labor produces according to the following production function:

$$f(e, k, l),$$

which is assumed to be strictly increasing in all arguments, and strictly concave in capital and labor, with  $f(0, k, l) = 0$  and  $\lim_{e \rightarrow \infty} f(e, k, l) = \infty$ .

**Credit Markets** Productive capital is the only financial asset in the economy. There is a perfectly-competitive financial intermediary that receives deposits, and rents out capital to entrepreneurs. If the economy is open to capital flows, the intermediary can rent capital to and from foreigners at the world rental rate of capital  $r^* + \delta$ , where  $r^*$  is the constant world interest rate and  $\delta$  is the depreciation rate. Alternatively, if the economy is closed to capital flows, the interest rate in period  $t$  is  $r_t$ , and the rental cost of capital is  $r_t + \delta$ .

We assume that entrepreneurs' capital rental ( $k$ ) is limited by a collateral constraint  $k \leq \lambda a$ , where  $a$  is financial wealth and  $\lambda$  measures the degree of credit frictions, with  $\lambda = +\infty$  corresponding to perfect credit markets, and  $\lambda = 1$  to financial autarky where all capital has to be self-financed by entrepreneurs.

Our specification captures the common prediction from models of limited contract enforcement—that is, the amount of credit is limited by individuals' wealth. At the same time, its parsimoniousness enables us to analyze quantitative effects of financial frictions on aggregate dynamics without losing tractability. This same specification has been widely used in the literature on financial frictions and entrepreneurship (Evans and Jovanovic, 1989), and also in the literature on credit frictions and business cycles (Bernanke et al., 1999; Kiyotaki and Moore, 1997).

Our collateral constraint can be derived from the following limited enforcement problem. Consider an individual with financial wealth  $a$  (deposited in the financial intermediary) at the beginning of a period. Assume that she rents  $k$  units of capital. Then she may choose to abscond with a fraction  $(1/\lambda)$  of the rented capital. The only punishment is that she will lose her financial wealth  $a$  deposited in the intermediary. In particular, she will not be excluded from any economic activities in the future. In fact, she is allowed to instantaneously deposit the stolen capital  $k/\lambda$  and continue being a worker or an entrepreneur. Note that  $\lambda$  in this context measures the degree of capital rental contract enforcement, with  $\lambda = +\infty$  corresponding to perfect enforcement and  $\lambda = 1$  to zero enforcement. In the equilibrium, the financial intermediary will rent capital only to the extent that no individual will renege on the rental contract, which implies a collateral constraint  $k/\lambda \leq a$  or  $k \leq \lambda a$ .

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  $a \geq 0$ .

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

$$\begin{aligned} \max_{\{c_s, a_{s+1}\}_{s=t}^{\infty}} \mathbb{E}_t \sum_{s=t}^{\infty} \beta^{s-t} u(c_s) \\ \text{s.t. } c_s + a_{s+1} \leq \max\{w_s, \pi(a_s; e_s, w_s, r_s)\} + (1 + r_s)a_s, \quad \forall s \geq t \end{aligned} \quad (1)$$

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:

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

The input demand functions are denoted by  $l(a; e, w, r)$  and  $k(a; e, w, r)$ , and the collateral constraint ( $k \leq \lambda a$ ) is taken into account.

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 labor 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 level 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  $t \geq 0$ , 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 (2) for all  $t \geq 0$ ;
2. The labor and capital markets clear at all  $t \geq 0$ , which by Walras' law implies goods market clearing as well:

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

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

$$G_{t+1}(e, a) = \psi \int_{u \leq a} \int_{a'(e, v)=u} G_t(e, dv) du + (1 - \psi) \sum_{e_-} \mu(e|e_-) \int_{u \leq a} \int_{a'(e_-, v)=u} G_t(e, dv) du.$$

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:

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

### 3 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 different 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,  $G_0(e, a)$ . 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 distortion-free 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.

#### 3.1 Calibration

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

We choose a period utility function of the isoelastic form:

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

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:

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

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  $\alpha$  goes to capital, and  $1 - \alpha$  goes to labor.

The entrepreneurial ability  $e$  is assumed to be a truncated and 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  $\psi$ . With probability  $1 - \psi$ , she draws a new ability realization from the Pareto distribution given above. Obviously,  $\psi$  controls the persistence of ability, while  $\eta$  determines the dispersion of ability in the population.

We now need to specify eight parameter values: two technological parameters  $\alpha$ ,  $\nu$ , and the depreciation rate  $\delta$ ; two parameters describing the process for ability  $\psi$  and  $\eta$ ; the subjective discount factor  $\beta$  and the reciprocal of the intertemporal elasticity of substitution  $\sigma$ .

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 ( $\nu$ ,  $\eta$ ,  $\psi$ , and  $\beta$ ). 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, a relatively undistorted economy.<sup>4</sup>

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 ten percent (Davis et al., 1996). Finally, as the target interest rate, we pick four 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

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<sup>4</sup>In our perfect-credit benchmark, individuals face uninsured shocks to their entrepreneurial ability. We solve the perfect-credit benchmark in two steps. First, given an aggregate supply of capital, we solve for optimal production decisions, occupation choices, and prices. We then use the wage and entrepreneurial profits coming from the production side of the economy to solve for the saving decisions of individuals facing idiosyncratic income shocks. By aggregating over individuals, we obtain the aggregate supply of capital. A stationary equilibrium with perfect credit markets is a (nested) fixed point of these two problems.

	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

moment is primarily affected 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  $\eta$  can be inferred from the tail of the distribution of employment. We can then infer  $\nu$  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  $\nu$  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.

### 3.1.2 Output Distortions and Financial 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. For the purpose of measurement exercises, these frictions can be thought of as idiosyncratic distortions, or individual-specific taxes/subsidies  $(\tau_{yi}, \tau_{ki})$ , that distort the static profit-maximization problem of an entrepreneur into:

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

Note that  $\tau_{ki}$  is a reduced-form representation of the financial frictions in our model.<sup>5</sup> 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:  $\tau_i \equiv (1 + \tau_{ki})^{(1-\nu)\alpha} / (1 - \tau_{yi})$ .<sup>6</sup> They find that idiosyncratic distortions ( $\tau_i$ ) 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). In Table 2 we reproduce these moments for China, India and the US. More dispersion of  $\tau_i$  translates into lower aggregate TFP and output. In the perfect-credit benchmark without non-financial distortions (i.e.,  $\tau_y \equiv 0$ ), measured  $\tau_i$  is zero for

<sup>5</sup>In particular,  $1 + \tau_{ki} = \alpha(1 - \nu)(1 - \tau_{yi})e_i k(a, (1 - \tau_{yi})e_i)^{\alpha(1-\nu)-1} l(a, (1 - \tau_{yi})e_i)^{(1-\alpha)(1-\nu)}$ , where  $k(a, (1 - \tau_{yi})e_i) = \min\{\lambda a, k^u((1 - \tau_{yi})e_i)\}$ , and  $k^u$  denotes the unconstrained profit-maximizing level of capital input.

<sup>6</sup>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  $1 - \nu = 0.81$  (Atkeson and Kehoe, 2005).

all production units indexed by  $i$ . There are two reasons for omitting non-financial distortions ( $\tau_y$ ) 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 3.1.1) is cleaner without  $\tau_y$ 's.

	90 – 10	TFP	Wealth Share of Top 5% $e$
US	1.04	...	...
China/India	1.73–1.87	...	...
$\lambda = 1.5, \tau_y \equiv 0$	0.82	0.81	0.47
$\lambda = 1.5, \tau_y \neq 0$	0.86	0.66	0.37

**Table 2:** Measured Distortions. The column ‘90–10’ reports the log difference between the 90th and the 10th percentile production units in terms of  $\tau_i$ . 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 ( $\lambda = +\infty$ ) with no distortions ( $\tau_{yi} \equiv 0$  for all production units). The last column reports the share of wealth held by the top five percentile of the true ability distribution.

We impose a  $\tau_{yi}$  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 1), and use our model to compute the stationary equilibrium.<sup>7</sup> We discipline our choice of  $\tau_{yi}$  so that, among the active entrepreneurs in the stationary equilibrium, the log difference between the 90th and the 10th percentiles (in terms of  $\tau_i$ ) is around 0.8 (the difference between China/India and the US).<sup>8</sup> Last but not least, we also impose that the subsidies and taxes through  $\tau_y$  cancel out across all active establishments, so that the net tax revenue/subsidy is zero.

The second-to-last row of Table 2 corresponds to an economy with financial frictions but no  $\tau_{yi}$ . The difference between the 90th and the 10th percentiles ( $\tau_i$ ) is around 0.82 log points. In this economy, TFP is only affected by capital distortions, and TFP is 19 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 benchmark level).

<sup>7</sup>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 the 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.

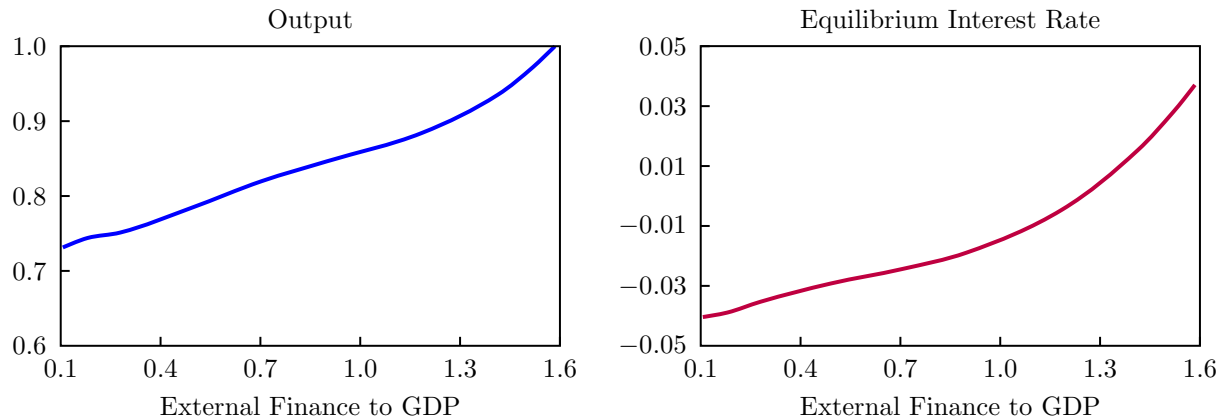
<sup>8</sup>It turns out that the effects on TFP of the underlying distribution of distortions are not necessarily well captured by a limited set of moments. We choose to complement the information provided by the moments reported in Hsieh and Klenow (2007) with a conservative lower bound for the effect on TFP, but still be guided as much as possible by the available data.

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 true ability ( $e$ ) is 0.37 in the economy with financial and non-financial frictions. This is lower than in the economy with  $\tau_{yi} \equiv 0$  (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 ( $\tau_{yi}$ ).

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 3.3. In summary, the pre-reform initial condition is the stationary equilibrium of an economy that (i) has idiosyncratic distortions ( $\tau_{yi}$ ), (ii) is closed to goods and capital flows, and (iii) has poorly-functioning domestic financial markets ( $\lambda = 1.5$ ).

### 3.2 Steady State Results: Financial Frictions and the Return to Savings

We first report the long-run effects of financial frictions in our model. In Figure 3, we consider how allocations and prices of the stationary equilibria respond to changes in the collateral constraint parameter  $\lambda$ . Recall that a lower  $\lambda$  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  $\lambda$  and the equilibrium ratio of external finance to GDP: The higher  $\lambda$ , the higher the external finance to GDP ratio. We plot equilibrium output and interest rate against external finance to GDP ratio, instead of  $\lambda$  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 ( $\lambda$ ). 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  $\lambda$ . Here  $\lambda$  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

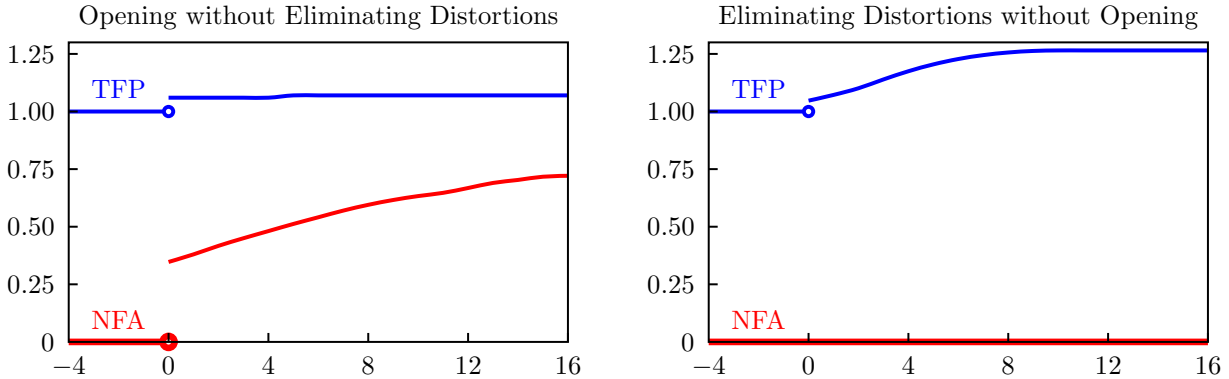


Rogoff (1990), Boyd and Smith (1997), Matsuyama (2005), and Mendoza et al. (2007), among many others. Our contribution is to go beyond this result and explore the joint dynamics of aggregate productivity and capital flows. To the best of our knowledge, we are the first to do so.

### 3.3 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 what is 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). The construction of this initial condition has been discussed in detail in Section 3.1.2.

**Building Intuition: One Reform at a Time** Before we begin, we consider two simple exercises to illustrate the effects of different reforms. In our main exercises below, we open the economy to goods and capital flows, precisely when we implement a reform to eliminate idiosyncratic distortions. In these simple exercises here, starting from the same initial condition, we consider first opening up the economy while leaving idiosyncratic distortions intact. We then look at the alternative exercise 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, but the economy remains closed and 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 3.2. However, without any reform on idiosyncratic distortions, the aggregate productivity (TFP) of the economy barely moves. It actually goes up by six per cent, as the higher rental rate of capital (world level) shuts down marginal production units, who tend 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.<sup>10</sup>

In the right panel of Figure 5, we consider the opposite: implementing a reform to remove all idiosyncratic distortions, while leaving the economy closed.<sup>11</sup> Again, the domestic financial market is left as it was. Following the reform, TFP jumps up 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: Distortion Removal and Opening Up** Here we combine the two reforms considered above. 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 intact. We are thinking of financial frictions as arising from enforcement problem, which is a component of broader institutions and is hence more sluggish. The reform experiences of the countries we study in Section 1 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.<sup>12</sup>

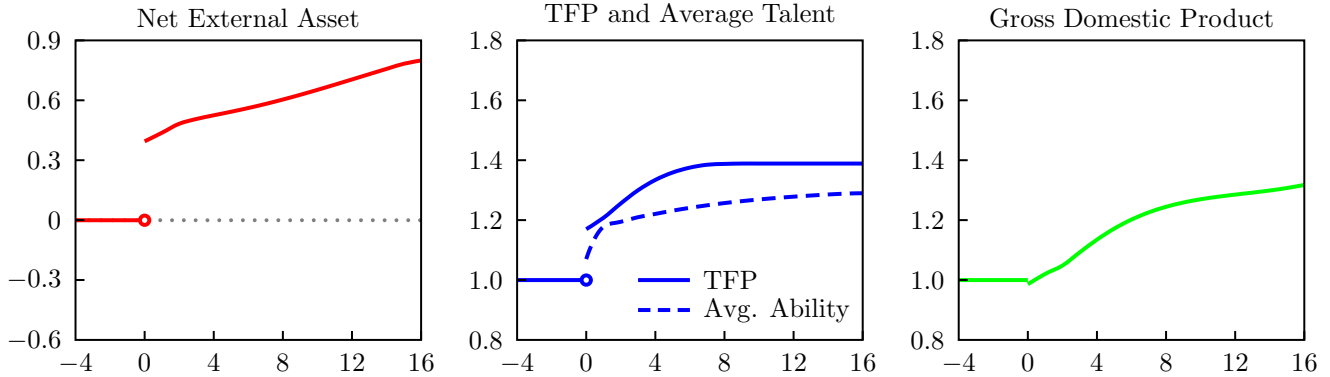
The result of this liberalization episode is shown in Figure 6. From year 0, as the reform is implemented, resources now get reallocated more efficiently. The increasing TFP reflects this reallocation (solid line, center panel). More efficient reallocation of resources occur along two margins. First, 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

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<sup>10</sup>However, this last effect is relatively unimportant, as it is partly negated by easier self-financing for subsidized incompetent entrepreneurs.

<sup>11</sup>See Buera and Shin (2008) for a detailed analysis of this case.

<sup>12</sup>Beim and Calomiris (2001) also document evidences of capital account liberalizations preceding domestic financial market reforms in numerous developing economies.



**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.

is slowed down by domestic financial frictions. Both TFP and the average entrepreneurial talent are measured relative to their respective pre-reform levels. The GDP per capita (right panel) also increases following the reform, largely mirroring the increase in TFP early on (first eight years) and accumulation of capital later (10 to 20 years after the reform). Per-capita GDP is also measured relative to its pre-reform level.

Notice that capital account liberalization leads to a bigger increase in TFP in the long run, over and beyond the pure effect from the elimination of idiosyncratic distortions (right panel, Figure 5): 32 per cent vs. 25 per cent. With a higher interest rate (owing to the international financial integration) individuals accumulate more assets faster, and hence collateral constraints generate less misallocation of productive capital overall.

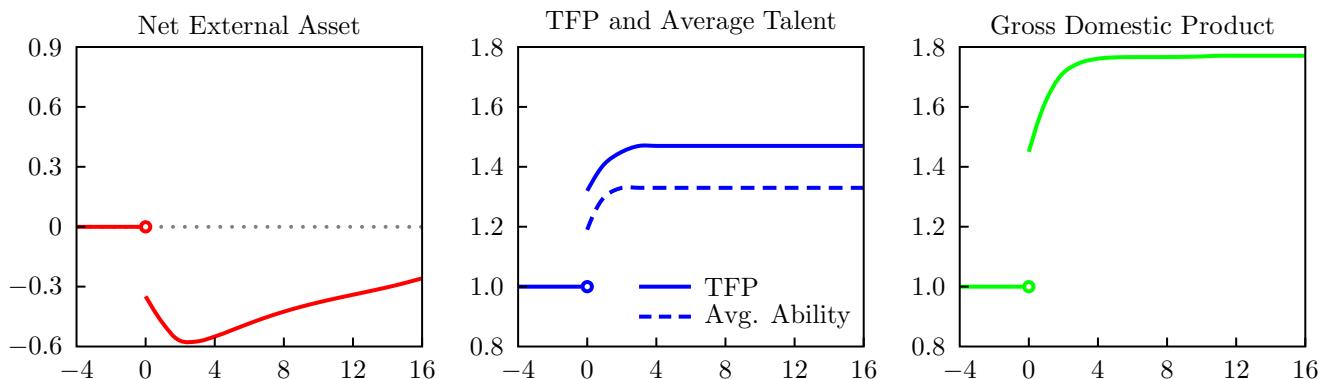
In the left panel, the net foreign asset position jumps up and then goes further up gradually.<sup>13</sup> The increase in the NFA in the beginning is driven by the fall in demand in the domestic capital rental market. Opening up capital accounts implies that the domestic rental rate of capital is equalized 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 domestic 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: They have to work as workers and save up enough collateral first. 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

<sup>13</sup>The NFA is measured relative to the pre-reform capital stock ( $K_{0-}$ ).

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—a consequence of domestic financial frictions that still remain. In addition, the higher interest rate induces individuals to save more, further driving up the net foreign asset position over time. In summary, capital keep flowing out of the country, while its TFP increases, consistent with the data shown in Figure 2.

**Exercise 2: Distortion Removal, Opening Up, and 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, we will also reform the domestic financial market, increasing its  $\lambda$  from 1.5 to 7.5. The choice of  $\lambda = 7.5$  corresponds to the equilibrium external finance to GDP ratio of 1.58 (Figure 3), 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.



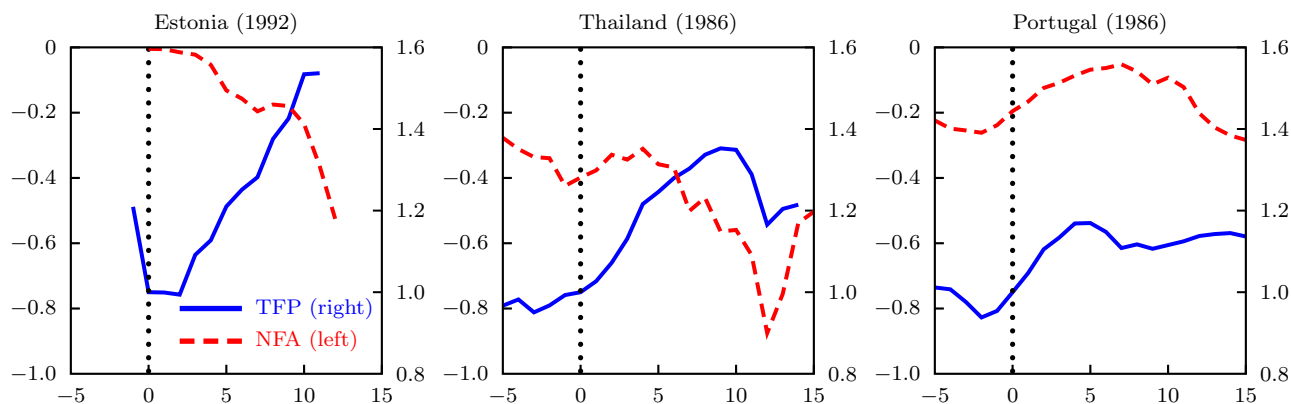
**Fig. 7:** Transition Dynamics with Domestic Financial Market Reform. In year 0, a reform is implemented to remove all idiosyncratic distortions in the economy. At the same time, the economy opens up to the world capital market. Unlike in Exercise 1, domestic financial frictions are partially eliminated ( $\lambda$  from 1.5 to 7.5). In the left panel, net foreign asset positions are measured relative to the pre-reform aggregate capital stock ( $K_{0-}$ ). 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.

The result is shown in Figure 7. Removal of the idiosyncratic distortions leads to more efficient reallocation of resources, as is reflected on the TFP series. The TFP increases faster and rises higher than in Figure 6. So do the average entrepreneurial ability and output. In particular, GDP goes up by 80 per cent over eight years, while in the first exercise the number is about 25 per cent. Note that both exercises have the same initial condition, and that Figures 6 and 7 have the same scale, facilitating visual comparison.

The net foreign asset position, on the other hand, looks starkly different from Figure 6. Initially, opening up of capital accounts increases the capital rental rate, and previously-subsidized entrepreneurs exit, reducing the demand in the domestic capital rental market. However, as the

collateral constraints become a lot less strict following the domestic financial sector reform, truly-productive individuals can enter entrepreneurship and start production immediately. This entry more than offsets the fall in demand from the incumbent entrepreneurs, and capital flows in from overseas to meet this excess demand. The NFA jumps downward initially. Afterwards, given the higher level of productivity and swift increases in domestic demand for capital (because of the less strict collateral constraint), capital continues to flow in for the next three years. Note that the entrepreneurs now have weaker self-financing motives given their ability to raise external financing.

Intuitively, if the domestic financial markets are very well-functioning, the economy behaves like a neoclassical model. It is informative to compare the second exercise with one using the standard neoclassical 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.



**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 off the right scale. TFP is normalized by its value in year 0. The unit of the horizontal axis is years.

Empirically, the experiences of Estonia and Thailand can be interpreted as a version of this exercise. Estonia underwent an economy-wide reform in 1992, addressing industrial policies, capital account liberalization, and *domestic banking sector reforms* (Roland, 2000). In particular, large Swedish banks set up local subsidiaries in Estonia and accounted for the majority of domestic financial intermediation. As can be seen in Figure 8, Estonia’s experience is close to the neoclassical model. To some degree, the Thai reform of 1986 also addressed the domestic financial markets (Townsend, 2006). In particular, the fraction of bank loans forcefully channeled to the government dropped sharply. The ensuing TFP and NFA series are consistent with our results in Figure 7, although the latter phases of the transition are muddled by the 1997 crisis.

Castro and Clementi (2009) also document the large-scale reform in Portugal as it joined the European Union in 1986. In addition to reducing idiosyncratic taxes and subsidies, Portugal rewrote its century-old commercial code to enhance investor protection. Castro and Clementi (2009) documents that capital flowed into Portugal, in response to the improved investor protection. The time-series evidence in Figure 8 is less clear cut. TFP increased the most during the five-year period immediately following the reform, while capital inflow begins in earnest seven years after the reform. In our framework, such post-reform dynamics could occur if the domestic banking reforms are done gradually over many years.

### 3.4 Welfare Consequence of Capital Account Liberalization

While economists readily agree on the merits of removing idiosyncratic distortions and reforming domestic financial markets, there seems to be less certainty regarding the benefits of opening up to international capital flows. Our preceding exercises can be used to assess the welfare gains from capital account liberalization. In most studies in the literature, capital account liberalization improves welfare, but the magnitude is rather small.<sup>14</sup>

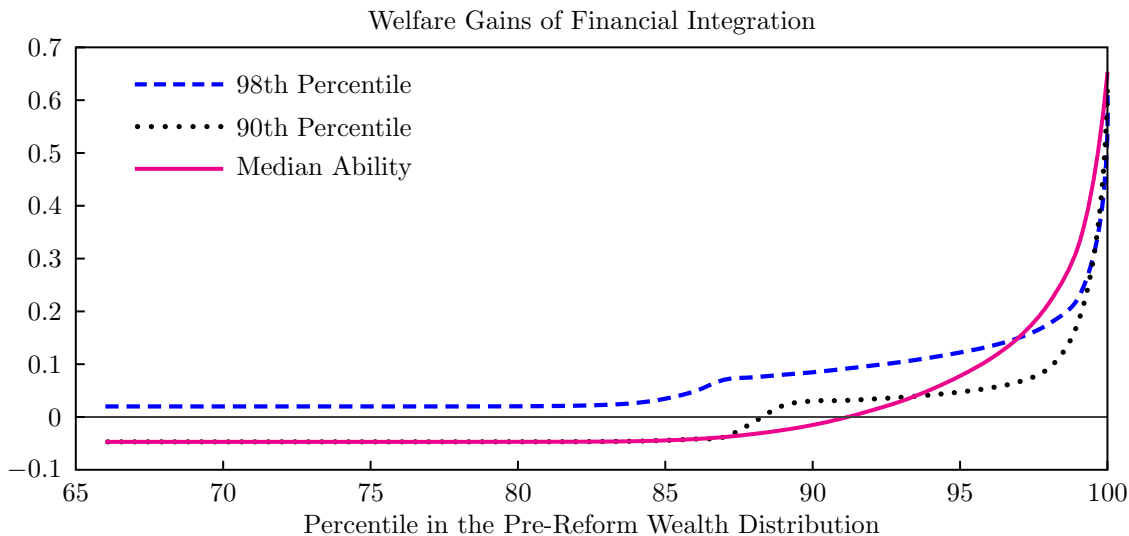
We further study the interaction of capital account liberalization with other reforms. This is a very relevant question, as capital account liberalization is typically accompanied by other reforms that remove distortions in the economy. In particular, we here analyze the welfare gains of capital account liberalization by comparing the economic outcome of removing idiosyncratic distortions while opening up (Exercise 1) with that of removing idiosyncratic distortions while remaining closed to capital flows. The latter has already been analyzed in Section 3.3, as one of the simple exercises (right panel, Figure 5). Here we report the welfare differences between the two exercises.

On the horizontal axis of Figure 9, individuals are sorted according to their wealth prior to their reform. Each curve corresponds to individuals with different ability. The vertical axis measures the welfare difference in units of permanent consumption. A positive number means that this particular type of individual—where type is defined as one’s pre-reform wealth level and ability—prefers the removal of idiosyncratic distortions to be accompanied by opening up of capital accounts. Similarly, a negative number means that the individual prefers the removal of idiosyncratic distortions to be done in a closed-economy environment.

We find that not all individuals benefit from concurrent capital account liberalization. Obviously the wealthy directly benefit from capital account liberalization, which instantaneously give them higher return—the world interest rate—on their financial assets (income effect). High-ability individuals, who will choose to be entrepreneurs and tend to be wealthy, are better off when the economy also opens up. Even the talented-but-poor individuals, as they get rich over time, and hence benefit from the higher interest rate. On the other hand, low-ability individuals, who will

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<sup>14</sup>See Gourinchas and Jeanne (2006) and the references therein. Unlike most work in the literature that assumes a small economy populated by a representative agent, our model has heterogeneous individuals within an economy and can address differential effects of capital flows on these individuals.



**Fig. 9:** The welfare gains from opening up to international capital markets at the same time as the removal of idiosyncratic distortion. The horizontal axis is the percentile in the pre-reform (unconditional) wealth distribution. Each curve corresponds to different ability level. The vertical axis is welfare gains in relative increase of permanent consumption. A positive number implies a particular individual of a given ability and pre-reform wealth is better off with concurrent capital account liberalization. A negative number, on the other hand, indicates that the individual is better off when the removal of idiosyncratic distortions are done in a closed-economy environment.

choose to be workers, are better off when the economy remains closed, unless they start out very wealthy. With capital account liberalization, capital flows out of the country following the reform. Holding other things equal, this implies less capital per worker for domestic production, and the wage is lower than in the closed-economy transition temporarily. Wage eventually rises to a higher level with capital account liberalization, but the lower wage along the transition prevails on the overall welfare of low-ability individuals.

Given that the very wealthy and entrepreneurs are but a small fraction of the population, the vast majority would prefer that the elimination of idiosyncratic distortions be carried out with capital account controls in place.

## 4 Concluding Remarks

We show in our quantitative framework that, following a reform that eliminates individual distortions and liberalizes capital flows, there will be a gradual rise in TFP accompanied by capital outflows. The rise of TFP is the consequence of the reallocation of capital and talent, a process that is slowed down by imperfect domestic financial markets. Capital outflows are a result of the rise in domestic savings following the increase in their return, and the sluggish response of domestic investment to the higher productivity, another consequence of the imperfect domestic financial markets. From our exercises, we conclude that it is central to understand the workings of domestic financial markets to evaluate the consequences of capital account liberalization. Indeed, it is likely that opening up capital accounts will have adverse welfare consequences in economies

with underdeveloped domestic financial markets.

Our analysis abstracts from different types of capital flows, e.g., debt contracts vs. foreign direct investment, which could exhibit different dynamics. For instance, in recent years, we have observed developing countries accumulating debt claims on foreigners while receiving foreign direct investment. We conjecture that an extension of our model that allows for the joint mobility of capital and entrepreneurial talents will account for such *gross* flows. As in the current paper, we would observe capital in the form of debt contracts flow out of the reforming economy. At the same time, there will be wealthy foreign entrepreneurs who can bring in their own capital into countries with underdeveloped financial markets to take advantage of their lower factor prices. This extension will also allow us to study the flow of talented-but-undercapitalized entrepreneurs who will migrate into countries with developed financial markets, a phenomenon often referred to as “brain drain.”

## Appendix: Notes on Economic Reforms

We briefly describe six large reform episodes that took place during the 1980s and the 1990s. We emphasize the three components of reforms we use in our model: reduction of idiosyncratic distortion, capital account liberalization, and domestic financial market reform.

**Chile, 1985** Following the debt and banking crisis of the early 1980s, in 1985 the Chilean government started a round of reforms (Bosworth et al., 1994). These included the privatization of state-owned enterprises and of firms taken over during the 1982 financial collapse, the reversal of protective measures introduced during the crisis. This wave of reforms not only reinforced the broad movement toward a more market-oriented allocation of resources that had started in the mid 1970s, but also remedied some shortcomings of earlier reforms—e.g., the earlier process of 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. The reforms of 1985 proved to be longer-lasting. We interpreted these series of reforms as efforts at removing/reducing idiosyncratic distortions in the context of our model.

Controls on capital outflows that had been imposed in 1982 were removed in 1985, although restriction on short-term capital inflows remained.

At the time of the 1985 reform, the domestic financial markets were still reeling from the financial crisis of 1982. While the financial system developed significantly in the following decades, financial intermediation remained relatively limited through the mid 1980s.

**India, 1991** Following an balance of payment crisis, in 1991 India embarked on a broad set of reforms (Kochhar et al., 2006). These reforms included the abolition of industrial licensing and the narrowing of the scope of public sector monopolies to a much smaller number of industries; trade

liberalization which included elimination of import licensing and progressive reduction of non-tariff barriers; the liberalization of investment in important services, such as telecommunications; financial sector reforms.

Deregulation of capital flows began in 1991, with the liberalization of inward foreign direct and portfolio investment. Exchange rates were unified in 1993, and current account convertibility achieved by 1994.

Gradual domestic financial sector reforms started in the mid 1990s, including the removal of controls on capital issues, freer entry for domestic and foreign private banks. However, credit control remains throughout the 1990s.

**Israel, 1985** In 1985 a successful stabilization plan was put into place. As a consequence of budget adjustments and subsequent reforms, the principal markets (capital, foreign exchange, and labor) underwent important changes (Ben-Bassat, 2002). Government interventions in production factor markets and in finances were significantly reduced. The share of government expenditure in the GDP declined by 20 percentage points in the first ten years of the reform. More important, the composition of the budget changed from an emphasis on subsidies to “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-tariff barriers on imports from “third countries” were abolished and replaced with tariffs. In 1992 a process of lowering these tariffs started.

Controls on capital flows that had been imposed in 1970 were reversed by 1987.

Distortions to domestic financial markets remained significant until the 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 large-scale program subsidizing heavy and chemical industries. This was a form of import substitution, and the beneficiaries were steel, petrochemical, nonferrous metals, shipbuilding, electronics and machinery industries. This experiment ceased and began to be reversed in 1981 (Leipziger, 1997). The failed industrial policy led the government to delegate the role of investment planning to the private sector. Entry of small and medium-sized firms was deregulated from the early 1980s. The sector/industry-specific taxes were replaced by flat-rate value added taxes in the late 1970s.

Controls on capital flows were eased first in 1979 (inward), then in 1982 (inward), and then again in 1985 (inward and outward).

Rampant distortions of the financial markets remained until the mid 1990s. Directed lending and regulated interest rates—often thought of the legacy or “scars” from the industrial policies of the 1970s—were phased out beginning in 1995 to join the OECD, and in 1998 to meet the IMF conditionality in the aftermath of the East Asian financial crisis.

**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 (Gulhati and Nallari, 1990; Dabee and Greenaway, 2001). The theme of the reforms was to move away from a focus on import substitution, which accounted for 80 per cent of manufacturing investment during 1978–81. These reforms include the elimination of price controls, quantity restrictions on imports, and export taxes on sugar. Also included were a gradual reduction of tariffs. As part of these reforms, the government eliminate the differential tax treatment for companies under various special regimes, e.g., export promotion zones, and import substitution regimes. Especially in the sugar industry (a major player well into the 1980s), many size-dependent policies were abandoned, leading to consolidations and productivity gains.

Capital account liberalization began in 1981, although it was a gradual process. Exchange rates were unpegged and managed-floated since 1983.

Domestic financial market reforms began towards the end of the 1980s, with interest rate liberalization in 1988. However, pricing and allocation of funds were heavily influenced by the central bank well into the late 1990s. The government's share of domestic commercial bank credit remained at 30–35 per cent until the late 1980s, and then dropped to 25 per cent by the mid 1990s.

**Taiwan, 1982** Much like Korea during the mid 1970s, Taiwan's response to the first oil shock in 1974 was to increase the government's involvement in the economy. The government increased spending on infrastructure (railways, roads, and airports) and implemented policies to replace imported intermediate capital goods with domestically-produced materials. The beneficiaries of such import-substitution policies were petrochemical, machinery, and steel industries. At the same time, trade barriers went up, reversing the decades-long trend of trade liberalization. With their eighth four-year plan (1982–86), the emphasis of the economic policy fell again on liberalization and internationalization, removing many of the industrial policies of the late 1970s (Leipziger, 1997).

Foreign exchange rate and capital account liberalizations took place during the mid 1980s.

Throughout the second half of the twentieth century, domestic financial markets served as instruments for the government's industrial policy. Domestic financial market liberalization started in 1989, with controls on bank loan/deposit rate abolished. New entries to the banking sector was not allowed until 1992-95. Financial markets were still tightly regulated even in the late 1990s, although privatization of some financial institutions and more liberalization began in 1994–95.

## References

- ATKESON, A. AND P. J. KEHOE (2005): "Modeling and Measuring Organization Capital," *Journal of Political Economy*, 113, 1026–1053.
- BECK, T., A. DEMIRGÜÇ-KUNT, AND R. LEVINE (2000): "A New Database on the Structure and Development of the Financial Sector," *World Bank Economic Review*, 14, 597–605.
- BEIM, D. O. AND C. W. CALOMIRIS (2001): *Emerging Financial Markets*, New York: McGraw-Hill.
- BEN-BASSAT, A. (2002): *The Israeli Economy, 1985-1998: From Government Intervention to Market Economics*, Cambridge, MA: MIT Press.
- BERNANKE, B. S., M. GERTLER, AND S. GILCHRIST (1999): "The Financial Accelerator in a Quantitative Business Cycle Framework," in *Handbook of Macroeconomics*, ed. by J. B. Taylor and M. Woodford, Amsterdam: North Holland, vol. 1C, 1341–1393.
- BERNANKE, B. S. AND R. S. GÜRKAYNAK (2001): "Is Growth Exogenous? Taking Mankiw, Romer and Weil Seriously," in *NBER Macroeconomics Annual*, ed. by B. S. Bernanke and K. Rogoff, Cambridge, MA: MIT Press, 11–57.
- BOSWORTH, B. P., R. DORNBUSCH, AND R. LABÁN (1994): *The Chilean Economy: Policy Lessons and Challenges*, Washington, DC: The Brookings Institution.
- BOYD, J. H. AND B. D. SMITH (1997): "Capital Market Imperfections, International Credit Markets, and Nonconvergence," *Journal of Economic Theory*, 73, 335–364.
- BUERA, F. J. AND Y. SHIN (2008): "Financial Frictions and the Persistence of History: A Quantitative Exploration," Manuscript, Washington University in St. Louis.
- CAMDESSUS, M. (1999): *Second Generation Reforms: Reflections and New Challenges*, available on the internet at <http://www.imf.org/external/np/speeches/1999/110899.HTM>.
- CASELLI, F. AND J. FEYRER (2007): "The Marginal Product of Capital," *Quarterly Journal of Economics*, 122, 535–568.
- CASTRO, R. AND G. L. CLEMENTI (2009): "The Economic Effects of Improving Investor Rights in Portugal," *Portuguese Economic Journal*, Forthcoming.
- DABEE, R. AND D. GREENAWAY (2001): *The Mauritian Economy*, New York: Palgrave.
- DAVIS, S. J., J. C. HALTIWANGER, AND S. SCHUH (1996): *Job Creation and Destruction*, Cambridge, MA: MIT Press.
- DOMMEN, E. AND B. DOMMEN (1999): *Mauritius, an Island of Success: A Retrospective Study 1960-93*, Oxford: James Currey.
- EVANS, D. S. AND B. JOVANOVIĆ (1989): "An Estimated Model of Entrepreneurial Choice under Liquidity Constraints," *Journal of Political Economy*, 97, 808–827.
- GERTLER, M. AND K. ROGOFF (1990): "North-South Lending and Endogenous Domestic Capital Market Inefficiencies," *Journal of Monetary Economics*, 26, 245–266.

- GOURINCHAS, P.-O. AND O. JEANNE (2006): “The Elusive Gains from International Financial Integration,” *Review of Economic Studies*, 73, 715–741.
- (2007): “Capital Flows to Developing Countries: The Allocation Puzzle,” Working Paper 13602, National Bureau of Economic Research.
- GULHATI, R. AND R. NALLARI (1990): *Successful Stabilization and Recovery in Mauritius*, Washington, DC: World Bank.
- GUNER, N., G. VENTURA, AND Y. XU (2008): “Macroeconomic Implications of Size-Dependent Policies,” *Review of Economic Dynamics*, 11, 721–744.
- HOPENHAYN, H. A. AND R. ROGERSON (1993): “Job Turnover and Policy Evaluation: A General Equilibrium Analysis,” *Journal of Political Economy*, 101, 915–938.
- HSIEH, C.-T. AND P. KLENOW (2007): “Misallocation and Manufacturing TFP in China and India,” Manuscript, Stanford University.
- KAMINSKY, G. L. AND S. L. SCHMUKLER (2008): “Short-Run Pain, Long-Run Gain: Financial Liberalization and Stock Market Cycles,” *Review of Finance*, 12, 253–292.
- KIYOTAKI, N. AND J. MOORE (1997): “Credit Cycles,” *Journal of Political Economy*, 105, 211–248.
- KOCHHAR, K., U. KUMAR, R. RAJAN, A. SUBRAMANIAN, AND I. TOKATLIDIS (2006): “India’s Pattern of Development: What Happened, What Follows?” *Journal of Monetary Economics*, 53, 981–1019.
- LAGOS, R. (2006): “A Model of TFP,” *Review of Economic Studies*, 73, 983–1007.
- LANE, P. R. AND G. M. MILESI-FERRETTI (2007): “External Wealth of Nations Mark II: Revised and Extended Estimates of Foreign Assets and Liabilities, 1970–2004,” *Journal of International Economics*, 73, 223–250.
- LEIPZIGER, D. M. (1997): *Lessons from East Asia*, Ann Arbor, MI: University of Michigan Press.
- LUCAS, JR., R. E. (1990): “Why Doesn’t Capital Flow from Rich to Poor Countries?” *American Economic Review*, 80, 92–96.
- MATSUYAMA, K. (2005): “Credit Market Imperfections and Patterns of International Trade and Capital Flows,” *Journal of the European Economic Association*, 3, 714–723.
- MENDOZA, E. G., V. QUADRINI, AND J.-V. RÍOS-RULL (2007): “Financial Integration, Financial Deepness and Global Imbalances,” Working Paper 12909, National Bureau of Economic Research.
- MISHKIN, F. S. (2003): “Financial Policies and the Prevention of Financial Crises in Emerging Market Countries,” in *Economic and Financial Crises in Emerging Market Countries*, ed. by M. Feldstein, Chicago: University of Chicago Press, 90–130.
- PRASAD, E. S., R. G. RAJAN, AND A. SUBRAMANIAN (2007): “Foreign Capital and Economic Growth,” *Brookings Papers on Economic Activity*, 38, 153–230.

- RESTUCCIA, D. AND R. ROGERSON (2008): “Policy Distortions and Aggregate Productivity with Heterogeneous Establishments,” *Review of Economic Dynamics*, 11, 707–720.
- ROLAND, G. (2000): *Transition and Economics: Politics, Markets, and Firms*, Cambridge: MIT Press.
- SACHS, J. D. AND A. M. WARNER (1995): “Economic Reform and the Process of Global Integration,” *Brookings Papers on Economic Activity*, 1995, 1–118.
- STULZ, R. M. (2005): “The Limits of Financial Globalization,” *Journal of Finance*, 60, 1595–1638.
- TOWNSEND, R. M. (2006): “The Thai Economy: Growth, Inequality, Poverty and the Evaluation of Financial Systems,” Manuscript, University of Chicago.
- WACZIARG, R. AND K. H. WELCH (2003): “Trade Liberalization and Growth: New Evidence,” Working Paper 10152, National Bureau of Economic Research.