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Yu-Fu Chen, Michael Funke and Kunyu Tao

Financial market reform –  
A new driver for  
China's economic growth?



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## Financial market reform – A new driver for China's economic growth?

### Abstract

This paper analyses the financial distortions – growth nexus in China using a tractable general equilibrium modelling approach in which heterogeneous private and state-owned firms interact. The focal points of the model are financial frictions and reallocations of factors of production across firms. The calibrated version of the model elicits the important message that the adoption of a comprehensive financial market reform package abolishing financial distortions will lead to substantial output gains. Thus, structural policies leading to more efficient allocation of factors of production will remain a key policy challenge in China in the years to come.

Keywords: financial distortions, financial liberalisation, general equilibrium model, China.

JEL-Classification: C68, G1, G38, O1.

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# 1 Introduction

Experience gained from other East Asian countries such as Japan, South Korea and Taiwan suggest that extremely high GDP growth rates will eventually slow down and so one can presume that China's past experience of more than 8 percent annual GDP growth will not last. In accordance with this view, among the cyclical ups and downs China has indeed seen its growth momentum slowing. Has China's GDP per capita gap now been narrowed enough so that China is approaching a growth slowdown? Recently, Chen and Funke (2013) projected China to grow by about 6 percent per year in the 2011 – 2020 decade and about 5 percent in the subsequent decade 2021 – 2030. The theoretical underpinning of this forecast is a calibrated unified endogenous growth model in which a sequencing of physical capital accumulation, human capital accumulation and innovation drives the rise in China's GDP per capita. The first stage is characterized by physical capital accumulation; the second includes both physical and human capital accumulation, and in the final stage innovation is added to the mix. The calibrated slowing of future growth is consistent with the middle-income trap suggested in the cross-country review of growth performance by Eichengreen et al. (2011, 2013). What emerges from this thought-provoking strand of the literature is a critical threshold: on average, growth slowdowns occur when GDP per capita reaches around US dollar 16,740 at purchasing power parity. China is expected to reach that trigger in the near future.<sup>1</sup>

Whenever the effect of one set of previous Chinese reforms on total factor productivity (TFP) growth seems to be exhausted, the Chinese government has unlocked new drivers of economic growth.<sup>2</sup> In accordance with this approach, the new Chinese Xi-Li administration has voiced its aspiration to come up with a new framework for the next stage of China's economic growth. In particular, deregulating financial markets is seen as a key catalyst to spur long-run growth.<sup>3</sup> Since the growth rate inevitably slows as the country

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<sup>1</sup> The authors also tested which variables significantly influence the probability of a slowdown. They find that trade openness delays a slowdown, and they attribute the anomalous performance of places like Hong Kong and Singapore to this factor. Factors that bring forward the moment of growth-slowing include a high old-age dependency ratio, an undervalued currency, and a low consumption share in GDP. China suffers from all of these. The latter points will expose China's future growth to heightened risk.

<sup>2</sup> Previous efforts to sustain growth include the state-owned-firms reform in the late 1990s and WTO admission in 2001. Both shake-ups have propelled economic growth in the 2000s. China's WTO accession was an important factor given that there is strong empirical evidence linking trade barriers to aggregate productivity. See, for example, Alcalá and Ciccone (2004) for empirical cross-country evidence.

<sup>3</sup> In line with this, the third plenum of the Chinese Communist Party in November 2013 has called for equal competition where firms must freely make resource allocation decisions considering market-based input prices.

matures, China is reaching a critical point where the country needs to address the supply side in order to spur long-term growth. In particular, financial reform is required to convey financial resources to growth-oriented firms so as to further boost growth. This focus follows the widespread conception that financial liberalisation benefits growth by lowering interest rates, broadening access to credit, and better allocating resources in the economy. The first step has to be interest rate reform. Administered interest rates reduce the ability of the Chinese banking system to allocate funds to the right firms and shield the banking sector from the need to build the risk-management capacity. This, in turn, makes the Chinese economy less productive. This was not such an urgent problem while the economy was growing at double-digit rates, but now that it has lower growth-potential, China needs to restore market pricing mechanisms in order to alleviate the problem of capital distortion and increase the efficiency of investment. Correspondingly, a flurry of market-oriented reform initiatives and proposals which are far more systematic than earlier initiatives have recently been put forward in an effort to move towards a more liberalised financial system.

At present, protected state-owned enterprises (SOEs) have easier access to financial markets than private firms (POEs). Favouritism is caused by the government's objective to employ the banking system as a tool to finance SOEs. Early evidence on the detrimental effect of private ownership on access to external finance was delivered by Huang (2003) who argued that financial distortions take the form of inefficient capital allocations on the basis of a political as opposed to commercial pecking order of firms that on average favours SOEs at the expense of the more efficient POEs. This in turn translates into lower output growth. Using firm-level data, Guariglia et al. (2011) find evidence of discrimination in access to credit for private sector firms and Poncet et al. (2010) document that private firms face severe financial constraints while SOEs tend to be unconstrained.

A corollary is the abundant empirical evidence of a negative impact of state ownership on TFP in China. Hale and Long (2011a) analysed the TFP consequences of overcoming financial frictions in China. The authors argue that private firms defy financial constraints by managing working capital more efficiently. Brandt and Zhu (2001) have built a model showing that protected SOE's operating in strategic sectors and granted with government monopoly are less productive because the government will keep providing loans even if they make poor investment decisions. In the same vein, Dollar and Wei

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es. Thus, the party is committed to giving state-owned and private firms an equal playing field in the future by dismantling regulatory barriers that have thus far protected SOEs.

(2007) found that, even after a quarter-century of reforms, state-owned firms still on average achieve significantly lower returns to capital than domestic private or foreign-owned firms. As a result, by reallocating its capital more efficiently, China could reduce its investment intensity by 5 percent of GDP without sacrificing economic growth. Other studies have reached qualitatively similar conclusions. Hsieh and Klenow (2009) measured sizable gaps in marginal products of labour and capital across Chinese plants. When capital and labour are hypothetically reallocated to equalise marginal products, TFP gains of 30–50 percent in China are feasible.<sup>4</sup> The most recent evidence showing large-scale inefficiencies and misallocations due to policy distortions favouring SOEs comes e.g. from Brandt et al. (2012), Liu and Siu (2011) and Song et al. (2011). All these studies point to the salient feature of an ownership-dependent productivity pecking order in China. Accordingly, modelling POEs vs. SOEs in a more granular way is vital.

In view of this, an important Chinese policy objective is to move towards a more market-based financial system that encourages more productive investments. On 19 July 2013 the People's Bank of China (PBoC) announced the removal of controls on bank lending rates, allowing banks to lend at whatever rate they like. Another decision by the PBoC still pending is on the removal of the deposit rate ceiling. Abolishing the deposit rate ceiling will narrow the banks' interest margins and so put pressure on them to raise lending rates. Higher lending rates will increase the probability that banks will find it profitable to lend to previously excluded private firms and will lead SOEs that have benefitted from artificially low rates to improve their efficiency. This should in turn boost the average labour productivity, as capital and labour move towards higher-productivity firms and sectors, in response to financial reform.

One immediate question springs to mind. Will the reforms be effective? Is this the appropriate headwind to correct the ill of elevated POE funding costs? Given the financial system reform initiatives and proposals, it is surprising that despite the growing importance of the Chinese economy, the impact of financial reform on future Chinese growth has not yet been rigorously investigated. In this paper, we attempt to quantify the potential long-run gains to the Chinese economy from a comprehensive financial market reform package. To that end we develop a general equilibrium growth model as in Hopenhayn (1992), Hopenhayn and Rogerson (1993) and Restuccia and Rogerson (2008), augmented with a

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<sup>4</sup> Hsieh and Klenow (2009) make use of the gaps between marginal products. In our framework, in contrast, we formally model financial frictions leading to a misallocation of capital.

banking sector and firms with different ownership structures. Building a dynamic macroeconomic model that puts SOEs up against POEs with different degrees of accessibility of external finance at the core will enrich the analysis of financial distortions and aggregate output in China. This is, to the best of our knowledge, the first structural general equilibrium modelling approach studying financial liberalisation in China. In the model calibrations, we investigate the consequences of broad financial reform aimed at addressing financial system bottlenecks.<sup>5</sup>

The analysis in this paper is in five sections. In Section 2 we lay out the theoretical general equilibrium framework on which our analysis is based. A key component of the model is the difference in financial frictions faced by POEs vs. SOEs. In Section 3 we show how one can calibrate the model. Based on this information, we then describe the results of our numerical model simulations in Section 4. We also explore the sensitivity of our findings to the parameterisation. Section 5 draws together policy implications of the analysis, discusses open issues for future work, and concludes. A diagrammatic drawing of the modelling framework is available in Appendix A. Because analytical solutions cannot be computed, a numerical solution algorithm is set out and employed in Appendix B.

## 2 The conceptual general equilibrium framework

To conceptualise the ideas, this section considers a structural general equilibrium framework of borrowing constraints and factor reallocations. A careful understanding of the financial distortions – output interface may be essential to the effective design of economic policies. The modelling framework is related and complementary to a vibrant and thought-provoking literature addressing the role of financial constraints in aggregate output [see Hopenhayn and Rogerson (1993) and Restuccia and Rogerson (2008)]. We expand Restuccia and Rogerson's (2008) stylised model to account for external finance through borrowing and misallocation of loans across SOEs vs. POEs in China, generating an additional

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<sup>5</sup> Micro-level distortions interfering with efficient allocation of capital have been the subject of careful scrutiny in the literature and have provided a host of new results about the ways in which financial distortions affect economies. See, for example, Buera et al. (2011), Greenwood et al. (2013), Guner et al. (2008) and Midrigan and Xu (2014). Other theoretical work has focused on the role of financial development in boosting R&D and growth [see, e.g., Aghion et al. (2005) and Morales (2003)]. Recently, the macro-finance literature has also emphasized the scarcity of entrepreneurial capital in propagating and amplifying business cycles. For a recent survey, see Brunnermeier et al. (2013). We abstract from this strand of the literature, although the two can interact in interesting ways.



source of dynamics.<sup>6</sup> With the dual economy feature, the assignment of inputs to firms impacts directly on aggregate productivity (relative to the frictionless benchmark).<sup>7</sup> The model is aimed at shedding new light on the characteristics of the Chinese economy.

Following Restuccia and Rogerson (2008) we abstract from firm-level productivity dynamics by assuming that the TFP level of a firm remains constant over time. Firms have access to decreasing returns to scale technology, pay a fixed cost of entry as well as a fixed cost of operation every period. Furthermore, firms may fail stochastically at an exogenous rate and hence in equilibrium there is continuous entry and exit. One of the conclusions to emerge is that investment in the economy comes from new entrants. Firms have liabilities to banks with indefinite maturity and service loans at market interest rates as long as firms exist. The banking sector provides loans to new entrants amounting to all interest payments received. Financial distortions kick in via a misallocation of credit across producers. More precisely, we assume that Chinese SOEs have easier access to loans than POEs – the total of available lending to SOEs is on average greater than that for POEs:  $l_{SOE} > l_{POE}$ . This analytically convenient constraint can be motivated by the limited enforcement problem.<sup>8</sup> This is not the case for SOEs, which enjoy favourable access to loan markets. In other words, capital markets are imperfect so that not all generally profitable firms can get the necessary loans to operate.<sup>9</sup> The next step is to describe the decision rules of the banking sector, consumers, and firms. A focal point of this is the steady-state competitive equilibrium of the model leading to both selection and misallocation effects. This point lies at the heart of the current Chinese policy debate.

To fix ideas, imagine that a firm entering the market for production needs to pay an entry cost  $c_e$  in instalments using a perpetual loan ( $c_e > l$ ) from the banking sector, where the firm promises to pay a constant inflation-busting yield ( $r^l$ ) every period as long as the firm exists. Banks are assumed to make zero expected profits and firms face a con-

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<sup>6</sup> This literature draws on insights from Hopenhayn (1992) on modelling firms so that they differ in their total factor productivity.

<sup>7</sup> The simplifying model in the spirit of Ljungqvist and Sargent (2012) is an explanatory tool which conveys the essence of the misallocation – productivity nexus in a coherent way. For an advanced and complete textbook treatment of stochastic growth models, see Acemoglu (2008), pp. 566-579.

<sup>8</sup> Up to this day, the Chinese banking sector is predominantly state owned, and bank credit is frequently directed to state-favoured companies and projects. We sidestep the consideration that not only the SOEs themselves, but also POEs that are connected to SOEs via supply linkages firms may be less affected by financial market distortions. Another consideration that is missing from the closed-economy framework is foreign-owned firms which also may be less affected by borrowing constraints.

<sup>9</sup> For a diagrammatic drawing of the hidden deadweight loss and resource transfer associated with China's two-tier financial system, see Lee et al. (2012), pp. 14-15.

stant exit rate  $\lambda$ . More formally, the loans provided are computed from the discounted cash flow of the perpetual loan interest payments with the required real loan rate  $\rho_t$  as

$$(1) \quad l = \frac{r_t^l l (1-\lambda)}{(1+\rho_t)} + \frac{r_t^l l (1-\lambda)^2}{(1+\rho_t)^2} + \dots$$

Equating the intertemporal value of the loan cash flows and the loan itself determines the loan rate  $r^l$ , which is used to approximate the real rate  $\rho_t$ :

$$(2) \quad \rho_t l = r_t^l l - \lambda l$$

According to equation (2), the loan interest rate  $r_t^l$  can be split into the required loan rate  $\rho_t$  and the exit rate of firms  $\lambda$ . The above setup is not tailored to a specific firm. However, it is agreed that SOE loans are (implicitly) guaranteed by the government and therefore have a lower probability of default. Thus protected SOEs have easier access to bank loans. In line with much actual experience, this implies  $r_t^{l_{poe}} > r_t^{l_{soe}}$  and  $l^{soe} > l^{poe}$ . These assumptions are well rooted in the aforementioned empirical studies.

We now address the objective function of households. Using the notation of Restuccia and Rogerson (2008), the choice problem of the continuum of identical households is

$$(3) \quad V = \max_{C_s, X_s, Z_s^{soe}} \mathbb{E}_t [\sum_{s=t}^{\infty} \beta^s u(C_s)],$$

where  $\beta \in (0,1)$  is the constant subjective discount factor,  $\mathbb{E}_t$  is the expectations operator for the current state in  $t$ ,  $X_s$  is investment at  $s$ ,  $Z_s^{soe}$  denotes the gross changes (equivalent to SOE loan investment) in level of loans for SOEs and  $C_s$  is consumption at  $s$ . To avoid corner solutions, the utility function is assumed to be concave ( $u' > 0$  and  $u'' < 0$ ) and continuously differentiable in its argument. The solution to (3) implicitly also defines the optimal level of POE loans. The planning horizon of consumers starts in  $t$  and is infinite. The household faces the following budget constraint in every period  $s$ :

$$(4) \quad C_s + X_s + Z_s^{soe} + Z_s^{poe} = w_s N_s + r_s K_s + \Pi_s + r_s^{l_{soe}} L_s^{soe} + r_s^{l_{poe}} L_s^{poe}, \quad s = t, t+1, \dots$$

where  $X_s$  denotes aggregate gross investment,  $Z_s^{soe}$  ( $Z_s^{poe}$ ) is the gross increase in total SOE (POE) loans in the economy,  $w_s N_s$  is the wage bill,  $r_s K_s$  is total aggregate rental in-

come from capital,  $\Pi_s$  denotes aggregate profits of all firms, and  $r_s^{lsoe} L_s^{soe}$  ( $r_s^{lpoe} L_s^{poe}$ ) is the total interest payment on outstanding SOE (POE) loans. As is standard, the aggregate capital accumulation constraint over all firms is given by

$$(5) \quad K_{s+1} = (1 - \delta)K_s + X_s, \quad s = t, t + 1, \dots$$

where  $\delta$  is the constant depreciation rate. The amount of loans over all firms must sum to the loan total  $L$ . Thus, the law of motion of aggregate loans for both SOEs and POEs is governed by

$$(6) \quad L_{s+1}^i = (1 - \lambda_i)L_s^i + Z_s^i, \quad i = SOE, POE; \quad s = t, t + 1, \dots$$

where  $0 < \lambda_i < 1$  is the exit rate for firms as well as the attrition rate for loans to SOEs and POEs. With this in mind, we can plug (5) and (6) back into (3), to yield the multi-period Lagrangian that guarantees the optimality of consumers' decisions:

$$(7) \quad L = \sum_{s=t}^{\infty} [\beta^t u(C_s) + \mu_s (w_s N_s + \Pi_s - C_s - K_{s+1} + (1 + r_s - \delta)K_s - L_{s+1}^{soe} - L_{s+1}^{poe} + (1 + r^{lsoe} - \lambda_{soe})L_s^{soe} + (1 + r^{lpoe} - \lambda_{poe})L_s^{poe})]$$

where  $\mu_s$  is the Lagrange multiplier on the time  $s$  budget constraint, and  $r^{lsoe}$  and  $r^{lpoe}$  are the steady state constant loan rates for SOEs and POEs, respectively. The interior solution to the planning problem obeys the following intuitive first-order condition:

$$(8) \quad \beta^s u'(C_s) = \mu_s, \quad s = t, t + 1, \dots$$

For this economy, optimising with respect to investment  $X_t$  is equivalent to the optimisation of  $K_{t+1}$ . Therefore the first-order condition guaranteeing optimality can also be written as

$$(9) \quad -\mu_s + (1 - r_{s+1} + \delta)\mu_{s+1} = 0 \quad s = t, t + 1, \dots$$

Optimising with respect to the gross change in the SOE loan level  $Z_t^{soe}$  is equivalent to the optimisation of  $L_{t+1}^{soe}$ . Hence

$$(10) \quad -\mu_s + (1 - r^{lsoe} + \lambda_{soe})\mu_{s+1} = 0 \quad s = t, t + 1, \dots$$

Once consumption, investment, and gross change in SOE loan level are determined, the aggregate budget constraint (4) delivers the gross changes in POE loans and hence the aggregate loan level. Having derived optimal consumption and investment from first principles implies that the first-order condition for SOE loans can also be obtained by partial differentiation of the Lagrangian with respect to  $L_{t+1}^{poe}$  set equal to zero. Working with the resulting first-order condition

$$(11) \quad -\mu_s + (1 - r^{lpoe} + \lambda_{poe})\mu_{s+1} = 0 \quad s = t, t + 1, \dots$$

Equations (9), (10), and (11) yield in equilibrium

$$(12) \quad \rho = r^{lsoe} - \lambda_{soe} = r^{lpoe} - \lambda_{poe} = r_{t+1} - \delta .$$

Substituting back into the consumers' optimisation decision yields the first-order condition for optimality between neighbouring dates:

$$(13) \quad \begin{aligned} u'(C_t) &= \beta(1 + r_{t+1} - \delta)u'(C_{t+1}) \\ &= \beta(1 + r^{lsoe} - \lambda_{soe})u'(C_{t+1}) \\ &= \beta(1 + r^{lpoe} - \lambda_{poe})u'(C_{t+1}) \end{aligned}$$

In the steady-state equilibrium, consumption and the rental rate must be constant. Therefore we have

$$(14) \quad \frac{1}{\beta} = 1 - \delta + r = 1 - \lambda_{soe} + r^{lsoe} = 1 - \lambda_{poe} + r^{lpoe}$$

The equilibrium rental rate of capital is given by

$$(15) \quad r = \frac{1}{\beta} - (1 - \delta)$$

and the real interest rate is

$$(16) \quad \rho = \frac{1}{\beta} - 1$$

Substituting equation (15) into equation (16), yields the equilibrium loan rate for the steady state:

$$(17) \quad r^i = \rho + \lambda_i, \quad i = SOE, POE$$

which is identical to (2) in steady state. Clearly, the assumptions of constant SOE and POE exit rates and a constant discount factor give distinct default rates and loan rates for SOEs and POEs.<sup>10</sup> We set  $r^{poe} > r^{soe}$ , which guarantees that POEs face higher loan rates than SOEs, while we employ  $\lambda_{poe} = \lambda_{soe}$  when computing steady state probability density functions. The constraint  $r^{poe} > r^{soe}$  can be microfounded with (implicit) government guarantees for SOEs.

A further modelling question involves the appropriate functional form for the production function. To simplify matters, this is modelled in the style of Restuccia and Rogerson (2008), except that here the firms differ by sector. The heterogeneous firms operate under a standard decreasing-returns-to-scale Cobb-Douglas technology in capital  $k_i$  and labour  $n_i$ , with a randomly-drawn TFP level  $s_i$ .<sup>11</sup> Here TFP is a collective term for a variety of factors such as entrepreneurial ability, new product ideas, process innovation and so on. We index the firms by  $i = SOE, POE$ . Hence, given the probabilistic TFP level, we have

$$(18) \quad f(s_i, k_i, n_i) = s_i [(1 + \eta_i)k_i]^{\alpha_i} n_i^{\gamma_i}, \quad i = SOE, POE$$

where  $\alpha_i, \gamma_i \in (0,1)$  and  $0 < \alpha_i + \gamma_i < 1$ , and  $s_i$  remains constant once it is randomly drawn from the distributions for each ownership structure  $i$ ,  $i = SOE, POE$ , and the parameter  $\eta_i$  attached to capital mirrors the preferential treatment of SOEs by banks and authorities, which allows them to accumulate more capital than the POEs. For convenience and normalisation, we set  $\eta_{POE} = 0$  and  $\eta_{SOE} = \eta > 0$ . This assumption of more input-intensive SOEs is one way to reconcile our model with the data. The hypothesis of a higher capital intensity can be microfounded by the existence of an implicit government guarantee granted to SOEs. The Cobb-Douglas production function satisfies the boundary conditions

<sup>10</sup> We need to add another constraint for the banking sector. Assume that the average loan is denoted by  $\bar{l}$ . We then have  $L_{t+1} - (1 - \lambda)L_t \leq E_t \bar{l}$ , where  $E$  is total mass of new entrants. In the steady state, we then have  $\lambda M \bar{l} \leq E \bar{l}$ , where  $M$  is total mass of firms. Thus, we have  $\lambda = \frac{E}{M}$ , which is satisfied automatically in the steady state. A problem we do not address for our simple banking sector is the relationship between capital structure and loan rates – higher leverage would lead to higher default rates and hence greater loan rates. As we do not have the mechanism of default risk in our model, we simply assume a constant exogenous exit/default rate. This simplification makes our analysis tractable.

<sup>11</sup> The decreasing returns assumption is arguably more appropriate for studying firm-level facts such as firm dynamics and POE vs. SOE size distribution, and for an assessment of output losses from inefficient capital allocation.

of Inada. Note that firms do not own any input factors; instead, they rent capital and hire labour from households. Note that the TFP levels are static once the entry decisions are made. In this case, we can discuss the steady state conditions without needing to include all  $t$  indices in the above two equations for individual firms.<sup>12</sup> Hence, the profit function of the heterogeneous firms  $i$ ,  $i = \text{SOE}, \text{POE}$ , is defined as

$$(19) \quad \pi_i(s_i, l_i) = \max_{k_i, n_i} [s_i [(1 + \eta_i)k_i]^{\alpha_i} n_i^{\gamma_i} - w_i n_i - r k_i - c_f - (\rho + \lambda_i)l_i], \quad i = \text{SOE}, \text{POE}$$

where  $w_i n_i$  is the wage bill,  $r k_i$  is rented capital bill,  $c_f$  is constant operational costs for both sectors, and  $(\rho + \lambda_i)l_i$  is the credit cost. The first-order conditions for profit maximisation of SOE and POE firms are as follows:

$$(20) \quad \gamma_i s_i [(1 + \eta_i)k_i]^{\alpha_i} n_i^{\gamma_i - 1} = w_i, \quad i = \text{SOE}, \text{POE}$$

$$(21) \quad \alpha_i s_i (1 + \eta_i)^{\alpha_i} k_i^{\alpha_i - 1} n_i^{\gamma_i} = r, \quad i = \text{SOE}, \text{POE},$$

It follows that  $\frac{\gamma_i k_i}{\alpha_i n_i} = \frac{w_i}{r}$ . With empirical estimates of relative wages, production parameters, and the equilibrium rental rate, we are able to obtain the relative levels of  $s_{\text{POE}}$  and  $s_{\text{SOE}}$ , based on the distributions of  $n$ , which are to be discussed in the next section. Equations (20) and (21) jointly yield

$$(22) \quad k_i = \left(\frac{\alpha_i}{r}\right)^{\frac{1-\gamma_i}{1-\gamma_i-\alpha_i}} \left(\frac{\gamma_i}{w_i}\right)^{\frac{\gamma_i}{1-\gamma_i-\alpha_i}} (1 + \eta_i)^{\frac{\alpha_i}{1-\gamma_i-\alpha_i}} s_i^{\frac{1}{1-\gamma_i-\alpha_i}}$$

and

$$(23) \quad n_i = \left(\frac{(1+\eta_i)^{\alpha_i} s_i \gamma_i}{w_i}\right)^{\frac{1}{1-\gamma_i}} k_i^{\frac{\alpha_i}{1-\gamma_i}}.$$

Note that in the steady state, the levels of loans available to firms also affect firms' entry decisions via the free-entry condition. This means that the aggregate levels of  $k_i$  and  $n_i$  are a function of both TFPs and loans available,  $k(s, l)$  and  $n(s, l)$ , once the continuous joint

<sup>12</sup> The analysis with productivity draws at birth could be extended to account for stochastic TFP levels after entry. This would, however, significantly complicate the conceptual modelling setup without adding much insight. As with all models, we consider whether this is important for the issues the model is meant to address. Missing stochastic TFP levels after entry do not mean that the model does not provide a good approximation of the output effects of financial system reform.

distribution of  $s$  and  $l$  is known for both sectors, denoted by  $\mu_i(s_i, l_i)$ , with a probability distribution function (pdf)  $g(s, l)$ . The joint distribution  $\mu_i(s_i, l_i)$  and pdf  $g(s_i, l_i)$  are crucial for calculating the impact of financial distortions on aggregate productivity. As the rental rate and the loan rate are given by equations (15) and (17), the steady state levels of  $k$  and  $n$  for each firm then depend on the real wage, obtained from the free entry condition and labour market clearing condition. Start-ups make their entry decisions knowing that they face a joint distribution over potential draws of the pairs  $(s, l)$  with pdf  $g(s, l)$ . The pdf  $g(s, l)$  contains all the necessary information about the joint distributions of TFPs, loans, and ownership of firms. In addition to profit-maximising behaviour of firms, it is obvious that firms cannot take out loans that lead to negative profits. Furthermore we assume that firms only take out loans up the level such that optimised  $\pi_i(s_i, l_i)$  is greater than or equal to zero.

The firm's objective is to maximize its expected intertemporal value  $W(s_i, l_i)$  taking into account one-off entry costs  $c_e$  and loan costs at entry. The intertemporal value  $W(s_i, l_i)$  of potential production is computed by discounting the cash flows, and a firm only enters into operations when  $W(s_i, l_i) = \frac{(1+\rho)\pi(s_i, l_i)}{\rho+\lambda} \geq 0$ . Thus, the entry decision of start-up firms is the solution to

$$(24) \quad \bar{x}(s_i, l_i)W(s_i, l_i) = \max \left[ \frac{(1+\rho)\pi(s_i, l_i)}{\rho+\lambda}, 0 \right]$$

where  $\pi(s_i, l_i)$  is computed from the optimal levels of  $k_i$  and  $n_i$ , with steady state rental rate  $r$  and labour-market-clearing wages  $w_i$ . When a firm starts up,  $\bar{x}(s_i, l_i) = 1$ ; otherwise  $\bar{x}(s_i, l_i) = 0$ . It is now obvious that only firms with higher productivity will start operating, with lump-sum entry cost of  $c_e(s_i, l_i)$  for an individual firm, bearing in mind that larger firms are confronted with larger entry costs.<sup>13</sup> In the calibration section, we will discuss the relationship between the entry cost and the loan such that availability of a loan would lead to lower entry costs.

Aggregate wages need to be handled with care, as we have two sectors with different wages. We assume that on average the wages of POE firms are higher than in SOEs, reflecting the different marginal products of labour due to different values of TFP and pro-

<sup>13</sup> The sunk entry costs can be regarded as a lump-sum tax, a tax that entrants have to pay when they start a new business.

duction function parameters. Without loss of generality we assume that the wage ratio across sectors is given by

$$(25) \quad 1 - \theta = \frac{w_{\text{POE}}}{w_{\text{SOE}}}, \quad \theta \geq 0.$$

While taking out a loan lowers the operational profit, firms also find it easier to enter by paying lower effective entry costs, which is equivalent to  $c_e - l_i$ , leading to a greater mass of start-ups. For a potential entrant, the expected discounted value ( $W_e$ ) computed over the distribution pair  $(s_i, l_i)$  is given by

$$(26) \quad W_e = \sum_i \sum_{s,l} [\bar{x}(s_i, l_i)W(s_i, l_i)g(s_i, l_i) - c_e(s_i, i)g(s_i, l_i) + l_i g(s_i, l_i)]$$

In the free-entry intertemporal general equilibrium we have  $W_e = 0$  because otherwise more firms would enter. In this case,  $W(s_i, l_i)$  is determined by the values of the endogenous variables  $r$  and  $w_i$ . Another intuitive condition is  $l_i \leq c_e(s_i, i)$ .

In the presence of reallocation, the invariant exit pdf for the pair  $(s_i, l_i)$  must be the same pdf as the entry distribution, which is  $\bar{x}(s_i, l_i)g(s_i, l_i)$ . Therefore, the entry distribution is  $\bar{x}(s_i, l_i)g(s_i, l_i)E$ , where  $E$  is the entry mass of firms. In equilibrium, the job losses due to exit,  $\lambda N$ , are matched by the job creation due to entry. Working with this condition yields

$$\lambda N = \sum_i \sum_{s,l} n(s_i, l_i) \bar{x}(s_i, l_i) g(s_i, l_i) E$$

with equal exit rates for SOEs and POEs. The associated distribution of firms in the steady-state is  $\mu_i(s_i, l_i) = \frac{E \bar{x}(s_i, l_i) g(s_i, l_i)}{\lambda}$ . With the labour-market-clearing condition and inelastic (normalised) labour supply equal to  $L = 1$ , the entry mass becomes

$$(27) \quad E = \frac{1}{\sum_i \sum_{s,l} n(s_i, l_i) \mu_i(s_i, l_i)}$$

and the aggregate capital  $K$  stock is governed by

$$(28) \quad K = K_{\text{POE}} + K_{\text{SOE}} = \sum_i \sum_{s,l} n(s_i, l_i) \mu_i(s_i, l_i),$$

where we denote by  $K_{\text{POE}}$  ( $K_{\text{SOE}}$ ) the total POE (SOE) capital stock in the economy, after incorporating the factor  $(1 + \eta)$  according to (18). Solving for the steady state output  $Y$  in the economy yields



$$(29) \quad Y = Y_{POE} + Y_{SOE} = \sum_i \sum_{s,l} f(s_i, k(s_i, l_i), n(s_i, l_i)) n(s_i, l_i) \mu_i(s_i, l_i),$$

where  $Y_{POE}$  and  $Y_{SOE}$  are the outputs for the economy's POEs and SOEs, respectively. Hence, the mass of firms becomes

$$(30) \quad M = M_{POE} + M_{SOE} = \sum_i \sum_{s,l} n(s_i, l_i) \mu_i(s_i, l_i)$$

Last but not least, aggregate loans for POEs and SOEs can be obtained in a similar vein. This concludes the conceptual modelling setup. In summary, equations (15), (17), (25) – (31) depict the steady-state competitive equilibrium in which households maximise utility, and capital, loan and labour markets clear. Furthermore, firms take the wage and the rental price of capital as given, and make zero expected profit, and banks make zero profits. Finally there exists a stationary distribution of firms across types.

Next we turn to the aforementioned TFP distribution of SOEs vs. POEs in China. This is a key component of the model and enables the analysis of economic growth under ownership heterogeneity and incomplete financial markets. The empirical evidence cited above indicates that the TFP of POEs is higher than that of SOEs on average, i.e.  $s_{POE} > s_{SOE}$  for small and medium sized firms. In addition it must be remembered that policy distortions give rise to  $l_{SOE} > l_{POE}$ . In plain language this means that the Chinese financial intermediation process prefers to finance SOEs over POEs. This is consistent with empirical studies showing that financial repression in China mainly takes the form of credit controls in favour of the least efficient firms and at the expense of the most efficient firms [Huang and Wang (2011)].

We also estimate the corresponding production parameters for POEs and SOEs, i.e.  $\alpha_{SOE}$ ,  $\alpha_{POE}$ ,  $\gamma_{SOE}$ , and  $\gamma_{POE}$ . In light of the above, we proceed to discuss the continuous joint distribution function (pdf) for  $s_i$  and  $i$ . To simplify the model setup, we have already assumed the same operational cost  $c_f$  and entry cost  $c_e$  for both types of firms, and the same rental rate  $r$ , required real interest rate  $\rho$ , and exit rate  $\lambda = \lambda_{SOE} = \lambda_{POE}$ , too.<sup>14</sup> To obtain the aggregate pdf for all firms irrespective of ownership, we first postulate that SOEs and POEs have distinct firm distributions with pdf  $h(s_{SOE})$  and  $h(s_{POE})$ , respective-

<sup>14</sup>  $\lambda_{SOE}$  also reflects the underlying process of cleaning-up and, where appropriate, liquidation of Chinese SOEs in order to strengthen corporate governance. This process had a huge impact on the balance between SOEs and POEs since the 1990s.

ly. After having obtained both pdfs, we need the distribution probabilities for both pdfs to obtain the aggregate pdf distributions. Let the state-space matrix  $h(s_i)$  be

$$(31) \quad h(s_i) = [h(s_{\text{SOE}}) \ h(s_{\text{POE}})]$$

With the empirical probabilities  $P(s_i, i)$  for both ownership types  $i$ ,  $i = \text{SOE}, \text{POE}$ , we then have the joint pdf  $g(s_i, i) = h(s_i)P(s_i, i)$ . This is a key expression of the paper since it can be used to compute  $E$ ,  $K$ ,  $Y$ , and  $M$  in the model.

In summary, the conceptual framework with a firm mapping to economic theory sets the scene for the calibration exercise. Once calibrated, the model can be used to assess the effects of an unobservable or counterfactual change in policies or other parameters. In other words, the model allows us to paint an informed picture of what might happen after financial reforms, addressing the current financial distortions.<sup>15</sup>

### 3 Baseline model parameters

With the model setup behind us, we turn to the parameterisation of the model. In calibrating the general equilibrium model the numerical values of some model parameters are set exogenously, while others, the calibrated parameters, are endogenously determined so as to reproduce the benchmark data as an equilibrium solution.

We begin by detailing the data sources and construction of the baseline parameters. We choose parameters that allow the model to reproduce the main features of the Chinese economy in the decade preceding the subprime crisis. In order to generate the above-derived measures for the financial system of distortions in factor allocation, data for both the state and non-state sectors are required. A natural approach is to rely on firm-level micro data for the calibrated parameters. Below we provide some details on the specific data and variables that we use. Furthermore we present some preliminary descriptive analyses and select the calibrated and assigned parameters of the model such that they jointly pin down the salient features of the Chinese data. Experiments with alternative parameter values are also conducted, to assess the sensitivity of the results.

Since the model emphasizes firm heterogeneity at a disaggregate level, we use mainly firm-level data on Chinese enterprises as compiled by the National Bureau of Sta-

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<sup>15</sup> A diagrammatic drawing of the modelling framework is available in Appendix A.

tistics (NBS) of China. This database is the most comprehensive and representative Chinese firm level database and has been employed among others by Brandt et al. (2012), Hsieh and Klenow (2009) and Song and Zilibotti (2009). The dataset covers 90% of the gross output of Chinese industrial firms (manufacturing, mining, and construction), and 42% of the total output, representing 71 percent of the total industrial employment. We use annual data for the years 1998 – 2007. The dataset covers all SOEs and POEs (non-SOEs) with sales of more than 5 million RMB.<sup>16</sup> Most of the variables contained in the dataset are based on balance sheet and income statement items. In line with standard practice, we have deleted implausible and outlying observations that may bias the calibrated and/or estimated coefficients.<sup>17</sup> One limitation of the dataset is that it only accounts for a fraction of small POEs. Therefore the missing data have been supplemented using the Chinese “Statistical Yearbook of Small and Medium Sized Enterprises 2008”.

The construction of the firm sample is essentially driven by the nature of our financial pecking order model. SOEs are identified as firms where the state has at least 25 percent of ownership and therefore de facto controlling power over the firm [Poncet et al. (2010)]. Apparently it is not straightforward to define POEs for a number of reasons. Foremost is the diversity of arrangements that come under the POE umbrella. For our purposes, POEs include local private individual firms, local private limited companies and local private equity companies. We have excluded foreign-owned firms since they can rely on outside sources to finance their growth. Either they have access to financial markets abroad or they rely on intra-firm financial transfers provided by affiliated firms abroad. In other words, they bypass the financial constraints.<sup>18</sup> Finally, we eliminated urban and rural collectively owned enterprises. Collectively owned enterprises should rank quite high in the financial pecking order and are expected to receive better access to external funds than POEs.

Taken together, we end up with an unbalanced panel of firms, with the number of firms increasing from 70,383 in 1998 to 249,002 in 2007. The data are consistent with the notion that China has experienced a dramatic transformation in recent years. The value added share of POEs relative to SOEs (SOEs = 100) as defined above has increased from

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<sup>16</sup> Using data for other years does not significantly change any of the qualitative results reported below.

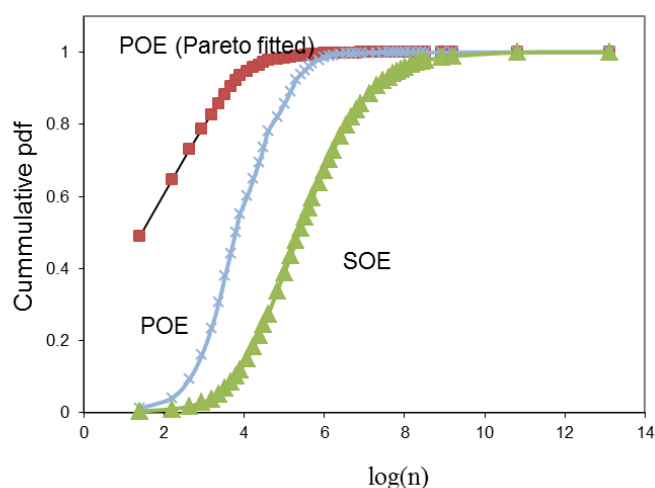
<sup>17</sup> We excluded foreign enterprises and collectively owned enterprises. Furthermore, following Feestra et al. (2011), we deleted observations if any of the following rules are violated: (i) observations with negative/missing/zero value of value added, employment, capital stock, and/or wage compensation; (ii) total assets must be higher than liquid assets; and (iii) total assets must be larger than the net value of fixed assets.

<sup>18</sup> Poncet et al. (2010) confirm that foreign-owned firms in China do not experience any financial constraints.

5.40 percent in 1998 to 99.60 percent in 2007. This change portrays the unprecedented massive shift of capital and labour from the SOE sector to the vibrant POE sector during China's transition process.

Our data set contains all SOEs in the manufacturing industry, with 17,229 firms in 2007. Therefore, we use the SOE pdf drawn from the original data directly without any prior data cleansing. The POE were adjusted for the missing small POE data using a pragmatic approach. First we fitted a POE pdf employing a lognormal distribution. Then, as is customary in the literature, we employed the Pareto distribution to model the shape of the POE firm size distributions.<sup>19</sup> To illustrate the ideas, Figure 1 documents the actual 2007 data and the cumulative density functions obtained. The distributions are broadly consistent with the data and match the size distribution very well. As expected, the empirical firm size distributions in Figure 1 show that private Chinese firms are on average much smaller than SOEs. This finding is consistent with the view that financial frictions cause POEs to operate at an inefficiently small scale. The data in Figure 1 also indicate a substantial firm-level heterogeneity which has to be taken into account in the ensuing numerical analysis.

Figure 1 Cumulative POEs and SOEs firm size distributions



Note: The raw data POE pdf are adjusted after consideration of missing/truncated data of small POE firms. The estimated Pareto distribution for POEs is  $p(n) = 3.3652n^{-1.3924}$ . The available observations are  $n_{POE} = 1,296,000$  and  $n_{SOE} = 17,229$ .

<sup>19</sup> There is ample evidence for the suitability of Pareto distributions in the literature. Zhang et al. (2009) found that the Pareto distribution with exponent near unity – the so-called Zipf distribution – well represents the distribution of Chinese firms. Further evidence on the different size distribution of SOEs vs. POEs is available from the Fortune Global 500 list for 2013. Of the largest 500 firms, 89 are from China and 74 are SOEs ([http://money.cnn.com/magazines/fortune/fortune500/2013/full\\_list/](http://money.cnn.com/magazines/fortune/fortune500/2013/full_list/)).

In order to pin down the production function parameters for POEs and SOEs of different size, well-behaved Cobb-Douglas production functions controlling for industry-fixed effects have been estimated. The availability of rich firm-level panel data makes it possible to employ the semiparametric estimator suggested by Olley and Pakes (1996) allowing one to separate endogenous from exogenous movements in the capital stock. Olley and Pakes (1996) were the first to introduce an intuitive semi-parametric estimation algorithm that controls for the endogeneity bias and allows one to obtain reliable production function estimates and productivity profiles.<sup>20</sup> The idea of the estimator is to invert demand for capital to identify unobserved productivity shocks and then use the estimated productivity shock as a regressor in the production function. Value added and intermediate inputs are adjusted according to Brandt et al. (2012). The input deflators and output deflators are calculated via the national input-output table at the four-digit industry level. The real capital stock is obtained by deflating the initial nominal capital stock by the investment deflator constructed in Brandt and Rawski (2008). We construct the capital stock series using the perpetual inventory method with an annual depreciation rate of 10 percent for both sectors, consistent with Perkins and Rawski (1998). Labour is calculated as the number of employees. TFP can then be determined so as to be consistent with the equilibrium solution to the model. Furthermore,  $\eta = 3.00$  accords with the higher capital intensity of SOE firms in the micro dataset and yields a reasonable SOE share in the economy.

The CD parameters are closely related to the  $s$ -ranges. A nearly standard result in the literature is that  $s_{i,POE} > s_{i,SOE}$  for all  $i$ . In order to estimate the  $s$ -ranges, we employ the Levinsohn and Petrin (2003) method and obtain estimates of the log-relationship between  $s$  and employment. Such estimations are also necessary to obtain the starting points of  $s$ -ranges for both sectors. The resulting starting  $s$ -ranges are 1.264 for POEs and 1.017 for SOEs, respectively. The estimated average labour shares ( $\gamma$ ) are 0.3240 for POEs and 0.4402 for SOEs, while the average capital share ( $\alpha$ ) of POEs and SOEs is 0.5759 and 0.4463, respectively.<sup>21</sup> One takeaway thus is that as a consequence of the differences to financing, the return to capital in the POE sector is higher than in the SOE sector. Based on

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<sup>20</sup> An elaborated exposition of the estimator can be found in Olley and Pakes (1996). In the presence of many inputs and simultaneity issues it is generally impossible to determine the direction of the bias. Levinsohn and Petrin (2003) showed, for a two-input production function with labour as a freely variable input and capital is quasi-fixed, that the estimated coefficient for capital will be biased downward if there is positive correlation between labour and capital. On the contrary, the coefficients for the variable inputs are biased upwards.

<sup>21</sup> The degree of diminishing returns to scale in variable inputs is similar to the 0.85 figure commonly used in the literature [see, for example, Restuccia and Rogerson (2008)].

this, we can then use the relationship  $\frac{n_i}{n_j} = \left(\frac{s_i}{s_j}\right)^{\frac{1}{1-\gamma-\alpha}}$  to obtain relative  $s$  for firm  $i$  and firm  $j$ . With the initial  $s_i$  profiles obtained earlier on, we finally get the  $s$ -ranges [1.264,5.641] for POEs and [1.017,5.597] for SOEs, respectively. The benchmark  $s_i$  parameters in Table 1 indicate that POEs and SOEs are inherently different not only in observed characteristics like firms size, but also in unobserved dimensions such as factor shares and TFP. In general, the TFP levels in the POE sector are higher than those in the SOE sector. These TFP differences support the notion that the more efficient allocation should entail more capital and labour for the financially constrained POE sector with higher TFP levels. Finally, TFP is monotonously increasing with firm size within each sector.

The aggregate loan ratios  $\epsilon$  for POEs and SOEs, drawn from leverage ratios of firms with loans, are 0.51 and 0.62. Note that we need to consider the fact that many firms do not get loans, especially POEs. According to the truncated dataset, the percentage of SOEs with loans is 74% and the percentage of POEs with loans is 20%.

A thorny issue is the measurement of sunk entry costs  $c_e$  which determine how financial frictions and the associated distortions in the allocation of capital translate into aggregate outcomes. Loans facilitate the organisation of firms and hence lower the entry cost with the help of knowledge from the banking sector. In other words, entry costs should be a negative function of loan and a positive function of size or employment level. Even though many papers have identified entry costs as an important element in understanding the dynamics of economies, there are few studies that quantify the entry costs. One-off sunk entry costs are costs of entry borne by entrants (or potential entrants). These are features of the firm's costs or production technologies as well as existing regulatory restrictions. Entry costs may also be the result of strategic behaviour by incumbent firms. Existing evidence is limited as to how entry costs, i.e. the costs for a firm to start up and formally operate, vary across ownership and firm size. This is why theoretical models are mixed or agnostic on the question. The evidence is mostly confined to estimates of the regulatory barriers to entry across countries. Djankov et al. (2002) have documented varying entry costs across countries, pioneering the influential World Bank Doing Business Surveys (<http://www.doingbusiness.org/>) that focus on bureaucracies surrounding entry. Employing the Doing Business Database for China, we construct the opportunity costs of an entrepreneur's time for registering a new POE with 50 employees and obtaining all necessary permits. In other words, the measure translates the number of days required to com-

plete the legal entry procedures into a monetary cost. Furthermore, we consider the World Bank's measures of the minimum capital requirement to start a business.<sup>22</sup> Chen and Zhu (2011) have analysed the market structure and entry barriers in China showing that on average the entry cost for Chinese SOE is 20 percent smaller than for POEs. In the calibration this is embodied as follows. The entry cost data are linearly extrapolated for each specific firm size using the formula  $c_e = 0.075 + 0.0022n - 0.5l$  for SOEs and  $c_e = 0.10 + 0.0025n - 0.5l$  for POEs, where  $n$  is the number of employees and  $l$  is the loan level. This means that firms with 50 employees and without a loan have 0.185 entry costs for SOEs and 0.225 for POEs; firms with 500,000 employees and without a loan have 1,100.075 entry costs for SOEs and 1,250.10. The results reflect the idea that the entry cost of POEs with 50 employees is roughly 20 percent greater than for SOEs, and the entry cost POE/SOE ratio falls to slightly over 15 percent for large firms.<sup>23</sup>

The remaining parameters fall into three categories. The first category includes variables governing financial distortions in the model. The aggregate loan ratios for POEs and SOEs turn out to be 0.51 and 0.62, respectively. As a benchmark we assume that the exogenous death probability is  $\lambda = 0.10$ , which is within the standard range in the literature.<sup>24</sup> The resulting loan rate  $r_{SOE}^l = (1/\beta - 1) + \lambda$  is 14.17 percent and, in line with much actual experience, the corresponding loan rate  $r_{POE}^l$  is assumed to be 16.17 percent. The higher POE loan rate reflects the fact that the growing impact of China's shadow banking sector, i.e. nonbank credit intermediation, is sidestepped in the theoretical framework. This fast moving sector provides alternative ways of borrowing at higher interest rates exceeding those of the conventional banking sector.<sup>25</sup> Bearing in mind the entry cost

<sup>22</sup> Although the entry cost calibration approach has its merits, it must be acknowledged that the entry costs are subject to considerable uncertainties. On the one hand the actual POE entry costs may be even higher, as the estimates do not take corruption costs into account. Levels of entry costs and corruption are highly correlated in the data [see Barseghyan (2008)]. On the other hand the opening of Shanghai's Free Trade Zone in September 2013 marked a breakthrough in reducing the requirements for establishing new companies. In the Free Trade Zone capital requirements were eliminated, and a "one-stop" registration process for new firms was created. This registered capital reform was quickly expanded to the rest of the country, leading to a boom in new company registrations in 2014.

<sup>23</sup> For firms with loans, the effective entry cost  $c_e$  for POE is then computed as  $c_e = (0.10 + 0.0025n) / (1 + 0.5 \epsilon_{POE})$  and SOE  $c_e = (0.075 + 0.0022n) / (1 + 0.5 \epsilon_{SOE})$ , as  $l = \epsilon c_e$ . It should be noted that these estimates only provide rough guidance about entry costs across firms. However, if the methodology is consistent, then the results below should at least give us a good idea about changes over time. For a sensitivity analysis, see Figure 3 below.

<sup>24</sup> There is no consensus in the empirical literature on the value of  $\lambda$ , which is not readily observable. Our estimate is between the 8 percent of Brandt et al. (2012) and the 12 percent of Hale and Long (2011b).

<sup>25</sup> This choice has the virtue of keeping the model simple. The interest rate spread can be derived from a variety of underlying micro foundations. We do not attempt here to model the shadow banking sector, the result-

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level, the POE and SOE loan levels can be computed. In the numerical model simulations an algorithm ensures positive profits for all firms. The second category includes the subjective discount factor, which is assumed to be  $\beta = 0.96$ , a common value for annual data. The  $\beta$  parameter yields a real interest rate of  $r = (1/\beta - 1) = 4.17$  percent per annum as in Restuccia and Rogerson (2008).

The average SOE exit rate is 0.1046 and the POE exit rate is 0.1164, computed over the period 1998–2007. We then adopt a 10 percent exit rate for both sectors, in accordance with the literature. A final prerequisite is the wage level for each sector. Taking into account employee compensation, supplementary benefits and unemployment insurance contributions, wages in the POE and SOE sector are calculated as  $w_{POE} = 12.657$  and  $w_{SOE} = 15.433$ , respectively. The wage ratio  $w_{POE}/w_{SOE}$  is thus 0.82, with  $\theta = 0.18$  for equation (25).

The one consistency check that must necessarily hold before one can proceed with policy analysis is the replication of the initial benchmark, i.e. the calibrated model must be capable of generating the benchmark equilibrium solution. In other words, we obtain the parameters by requiring that the model account for the salient features of the Chinese data. The interplay between best guesses for parameter values, chosen for realism, and calibrated parameters capable of generating the 2007 data as a model solution leads to our base parameters summarised in Table 1.

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ing interest rate wedge or the process of financial regulation behind the rapid expansion of shadow banking in China. Doing this is a topic for future work that allows further realism and additional policy experiments. For a thorough analysis of China's shadow banking sector, see International Monetary Fund (2014), pp. 65–104.



Table 1 Benchmark parameter values used in simulations

	POEs	SOEs
<b>Estimated parameters</b>		
Capital income share $\alpha$	0.5759	0.4463
Labour income share $\gamma$	0.3240	0.4402
Exit rate $\lambda$	0.1	0.1
Capital depreciation rate $\delta$	0.10	0.10
Wage (ratio) $w$	0.82 $w$	$w$
Productivity range $s$	[1.264,5.641]	[1.017,5.597]
Firm distributions $h(s)$	See Figure 1	See Figure 1
Maximum of loan ratio $\epsilon$	0.51	0.62
% of firms with loans	74%	20%
Entry cost functions $c_e$	$0.10 + 0.0025n - 0.5l$	$0.075 + 0.0022n - 0.5l$
Capital-related parameter $\eta$	0.0	3.00
<b>Calibrated parameters</b>		
Discount factor $\beta$	0.94	0.94
Rental rate $r = (1/\beta - 1) + \delta$	14.17%	14.17%
Loan rate $r^l = (1/\beta - 1) + \lambda$	14.17%+2%	14.17%
Loan (if presented) $l$	$\epsilon \cdot c_e$	$\epsilon \cdot c_e$
Operational cost $c_f$	0	0

Note: See Appendix B for a further discussion on the numerical method and model solution. The equilibrium wage is computed with the free entry condition. The wage (ratio) represents the idea that in equilibrium the SOE wage is equal to  $w$ , while POE wage is  $0.82w$ . We introduce a surcharge for POE loan rates to capture the reality that SOEs have access to lower rates. In the computation we ensure that firms do not have negative profits.

The first bloc of parameters was chosen by appealing to plausible empirical estimates while the remaining parameters in the second bloc were calibrated to be consistent with the equilibrium solution to the model. Overall, the summary statistics in Table 1 indicate that private Chinese firms are smaller than SOEs, pay lower wages, have less loans, have a lower capital intensity, and are typically more efficient in investing their capital. The next task is to describe the model's properties.

## 4 Numerical model analysis

What does all this mean as regards financial market imperfections in China? Unfortunately it is not possible to obtain closed-form solutions for the model. For this reason, numerical simulations analysing the quantitative impact of distortions are presented. Experiments with higher and/or lower parameter values are included in the robustness analysis, allowing us to explore the underlying economic mechanisms in more detail. Within the policy simulations, single parameters or exogenous variables are changed and a new (counterfactual) equilibrium is computed. Comparison of the counterfactual and benchmark equilibrium then provides information on the policy-induced changes in economic variables, such as output, capital, and firm entry. The baseline step-by-step results are summarized in Table 2.

In the first row the baseline parameters are used. The simulations in the subsequent rows provide a nuanced picture of various reform scenarios (with or without financial distortions in whole or in part) in terms of subsequent output growth.<sup>26</sup> The purpose of the clean structural modelling exercise is to provide a robust starting point for future economic policy debates.

What are the implications of a comprehensive financial system reform for aggregate output in the model? The table conveys an important message, and several results are noteworthy. First, the results in Table 2 suggest that there is wide scope for economic policy action reallocating capital and labour from the SOE sector to the POE sector. Second, as anticipated, the results in Table 2 indicate that entry costs lie at the heart of the financial distortions-output growth nexus. Intuitively, a lowering of sunk entry costs creates market opportunities for POEs. The resulting market reallocation alone boosts output by 7.98 percent compared to the baseline. Third, the total output growth, taking into account all partial effects, amounts to 10.82 percent. Fourth, taking into consideration a more efficient allocation of capital to the SOE sector in the last row, this effect is reduced to 4.83 percent. Overall, these results make a strong case for the importance of financial liberalisation and live up to reformers' lofty expectations.

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<sup>26</sup> This complements the evidence on the financial-development impact on Chinese listed firms in Didier and Schmukler (2013).

Table 2 Quantitative implications of financial frictions and financial market reform

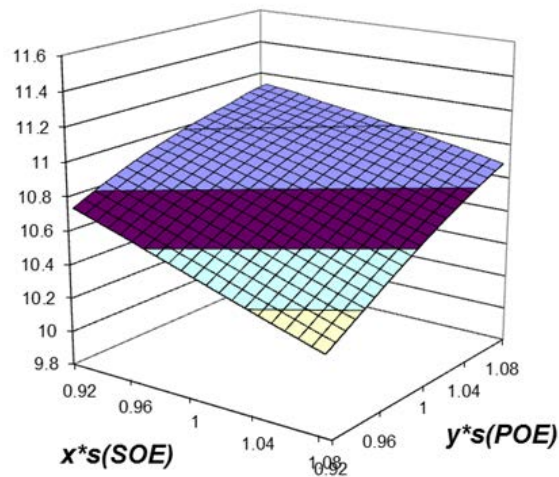
		Output	Capital	Loan levels	Entry mass
Benchmark	SOE	19.99	135.64	4.97	5.53
	POE	61.77	247.21	3.33	416.45
	<b>Total</b>	<b>81.75</b>	<b>382.84</b>	<b>8.30</b>	<b>421.97</b>
(1) Increasing the share of POEs with loans to 50%	SOE	20.13	136.62	5.21	5.79
	POE	62.60	250.53	8.62	436.12
	<b>Δ%</b>	<b>1.19%</b>	<b>1.12%</b>	<b>66.59%</b>	<b>4.72%</b>
(2) Reduction of POE loan rate to the SOE loan rate	SOE	20.03	135.92	5.04	5.60
	POE	62.01	248.17	3.69	422.11
	<b>Δ%</b>	<b>0.35%</b>	<b>0.33%</b>	<b>5.16%</b>	<b>1.36%</b>
(3) Increase of the POE loan ratio analogous to the SOE ratio	SOE	20.01	135.74	5.00	5.56
	POE	61.86	247.57	3.70	418.59
	<b>Δ%</b>	<b>0.13%</b>	<b>0.12%</b>	<b>4.78%</b>	<b>0.52%</b>
(4) Reduction of entry cost to 80% of the baseline level	SOE	20.94	142.09	5.36	7.45
	POE	67.34	269.50	3.60	561.52
	<b>Δ%</b>	<b>7.98%</b>	<b>7.51%</b>	<b>8.02%</b>	<b>34.84%</b>
(1)+(2)+(3)	SOE	20.31	137.79	5.50	6.12
	POE	63.60	254.53	11.08	460.72
	<b>Δ%</b>	<b>2.63%</b>	<b>2.48%</b>	<b>99.77%</b>	<b>10.63%</b>
(1)+(2)+(3)+(4)	SOE	21.27	144.33	5.93	8.25
	POE	69.33	277.47	11.98	621.22
	<b>Δ%</b>	<b>10.82%</b>	<b>10.18%</b>	<b>116%</b>	<b>49.17%</b>
(1)+(2)+(3)+(4)+ reduction of $\eta$ to 2.0	SOE	7.14	41.15	4.85	7.64
	POE	78.57	314.45	11.71	575.60
	<b>Δ%</b>	<b>4.83%</b>	<b>-7.12%</b>	<b>99.48%</b>	<b>38.22%</b>

However, given the parameter uncertainties involved, the point estimates in Table 2 should be taken with a grain of salt. Calculating aggregate output effects of market impediments and misallocation across firms may be sensitive to model parameterisation. Finally, we therefore conduct a sensitivity analysis to cross-check the results and ensure robustness of the findings along several dimensions. To start with, we check the sensitivity with respect to the production function parameters and the related  $s$  ranges. In the three-dimensional

Figure 2 we analyse the effects of shifting the  $s$  ranges for POEs and SOEs within a region of  $\pm 8$  percent surrounding the baseline model solution.

The results show that the impacts are smallest for higher SOE  $s$ -values and lower POE  $s$ -values. The results naturally depict the fact that the financial reforms are less desirable if the SOE sector is not very inefficient. And it is straightforward to see the impacts are the greatest with lower SOE  $s$ -values and higher POE  $s$ -values – a strong argument for reform, due to the greater relative inefficiency of the SOE sector.

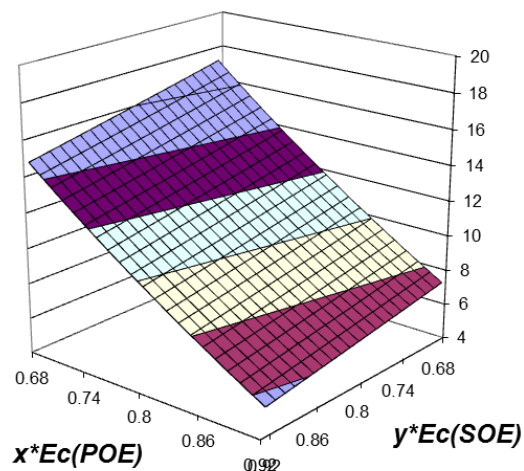
Figure 2 Percentage output impacts of altering the  $s$ -ranges for POEs and SOEs



Note: The Figure shows the aggregate impact of relaxing all four financial distortions on the vertical axis.

In the context of our study, market entry costs play a prominent role and are especially influential regarding the output effects. To explore the matter further and to gain further insights into the drivers of growth after financial liberalisation, we therefore also varied the entry cost levels of both sectors. The parameter space covers 68 – 95 percent of the respective benchmark values. The results are presented in the three-dimensional Figure 3.

Figure 3 Percentage output impacts of altering the entry costs for POEs and SOEs



Note: The Figure shows the aggregate impact of relaxing all four financial distortions on the vertical axis.

It can be seen that the POE and SOE entry cost levels differ. The output effects are far more sensitive with respect to reductions in POE entry costs. This result is intuitively understandable and consistent with conventional wisdom since POEs are more efficient than SOEs and hence the effects of the financial reforms on output are far greater. Altogether, lower entry costs are like a speedboat pulling Chinese GDP out of the middle income trap.<sup>27</sup> Both of these sensitivity analyses reinforce the conclusions we derived using our benchmark parameterisation.

## 5 Conclusion and discussion

China currently undertakes significant efforts to expand the depth and scope of its financial system to unleash growth in the future. Capital and labour should become more efficiently allocated across firms and industries.<sup>28</sup> Against this background, the potential aggregate output gains of financial system reforms have been examined for the first time in a quanti-

<sup>27</sup> As a brief aside, we would like to note that the numbers just laid out have ignored the fact that POEs can potentially overcome financial constraints via loans from the shadow banking sector. The numbers may therefore be interpreted as an upper bound.

<sup>28</sup> The deep causal reason for the policy change may remain untold. Nee and Oppen (2012) have convincingly argued that China's remarkable economic transformation during the last decades was neither instituted by the authorities nor was it the outcomes of experimentation, but resulted from the authorities catching up with what had been going on the ground. This development has driven bottom-up institutional change that has facilitated the private sector's autonomous growth. In other words, economic development happened through the synergistic relationship between local entrepreneurs ("bottom up development") and the responses by the authorities ("top down policies").

tative general equilibrium analysis building on the seminal contributions of Hopenhayn and Rogerson (1993) and Restuccia and Rogerson (2008). The model with capital misallocation and entry where reallocation is the sole driver of output provides a framework, albeit a somewhat stylized one, for thinking about the possible economy-wide implications of such a reform. The novelty of our approach is in the ideas for pinning down heterogeneous POEs and SOEs. Conceptually, the structural modelling setup is by no means the only one that could be used to identify financial market reform impacts. Nonetheless, the model should be considered as an orientation guide drawn up with the most recent evidence available to allow policymakers navigating through a largely unknown transition landscape.

Looking ahead, our numerical results provide evidence that such reforms aimed at alleviating financial distortions can keep growth buoyant by enhancing capital efficiency even as aggregate investment is lowered to sustainable levels. These findings underline the importance of the specifics of financial reform. It is realistic to anticipate that, as with previous reforms, this change will be implemented gradually and cautiously.<sup>29</sup>

The foregoing policy implications of our modelling exercise are in line with a number of recent policy contributions and recommendations for China which have argued that the financial system may hamper future growth. For example, Nabar and N'Diaye (2013) pointed out that in the current situation in China an accelerated pace of reform aimed at enhancing efficient credit allocation is warranted. Going forward, the challenge is therefore to engineer a carefully-calibrated reduction in financial distortions to a path that would spur growth and maximise welfare.<sup>30</sup> In any case, the objective has to be to further enhance the role of the market in channelling financial resources to firms.

Returning to the empirical middle income trap literature reviewed in the introduction, the growth modelling exercise reveals that financial distortions can matter for the timing of take-off among countries that satisfy the prerequisites for take-off. This conclusion is in line with Agénor and Canuto (2014), who demonstrated, using an overlapping generations model, that financial distortions can be the source of a middle income trap. On the contrary, policies aimed at promoting access to external finance may allow countries to escape from an inferior middle income trap equilibrium.

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<sup>29</sup> In principle, the current government backs the idea of letting interest rates float freely to force banks to compete and thus allocate credit more efficiently. However, the Chinese State Council said that the shifts would be carried out in an “orderly way”, usually a code word for moving slowly. In other words, the reform timetable is still uncertain.

<sup>30</sup> A quite likely corollary not modelled in the paper is that when China opens up the financial sector and the financial sector becomes increasingly market-based, greater volatility is a likely side effect.

We close by pointing out some limitations of this study. First and foremost, we have discussed the gains of financial reform in China. But this leaves out the question of how to achieve such reforms. It is evident that the paper does not say anything about the societal factors that could induce China to adopt policies that stimulate output. Therefore, an important avenue for future research is the design of a roadmap for reforms. Delineating the contours of a roadmap is clearly a complex issue. Going forward, this is where we see the financial market reform debate heading over the years ahead. Second, as shown by the entry costs discussed above, financial market reform may require complementary reforms to achieve efficiency improvements. This should be borne in mind when interpreting the numerical results.<sup>31</sup> Third, more granular advice requires further empirical work. In particular, we need to better understand the growth-enhancing microeconomic finance – innovation nexus. Finally, our model, like many others explaining economic growth, abstracts from transition dynamics. It follows that the benefits of financial reform may be less visible in the short- and medium-run than the losses that firms face from increasing competition.<sup>32</sup> It is precisely for this reason that policymakers need to understand the gains from financial reforms. Despite the four caveats mentioned above, we believe that the modelling exercise provides policymakers with a reasonable sense of the growth-potential of financial market reform.

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<sup>31</sup> Regarding the regulation of entry, China ranks 128 out of 189 countries in the current Worldbank “Doing Business” database. A high ranking means the regulatory environment is more conducive to the starting of a business.

<sup>32</sup>As a consequence thereof, bridging from the well-identified long-run effects to shorter-run outcomes is an important task for future research.

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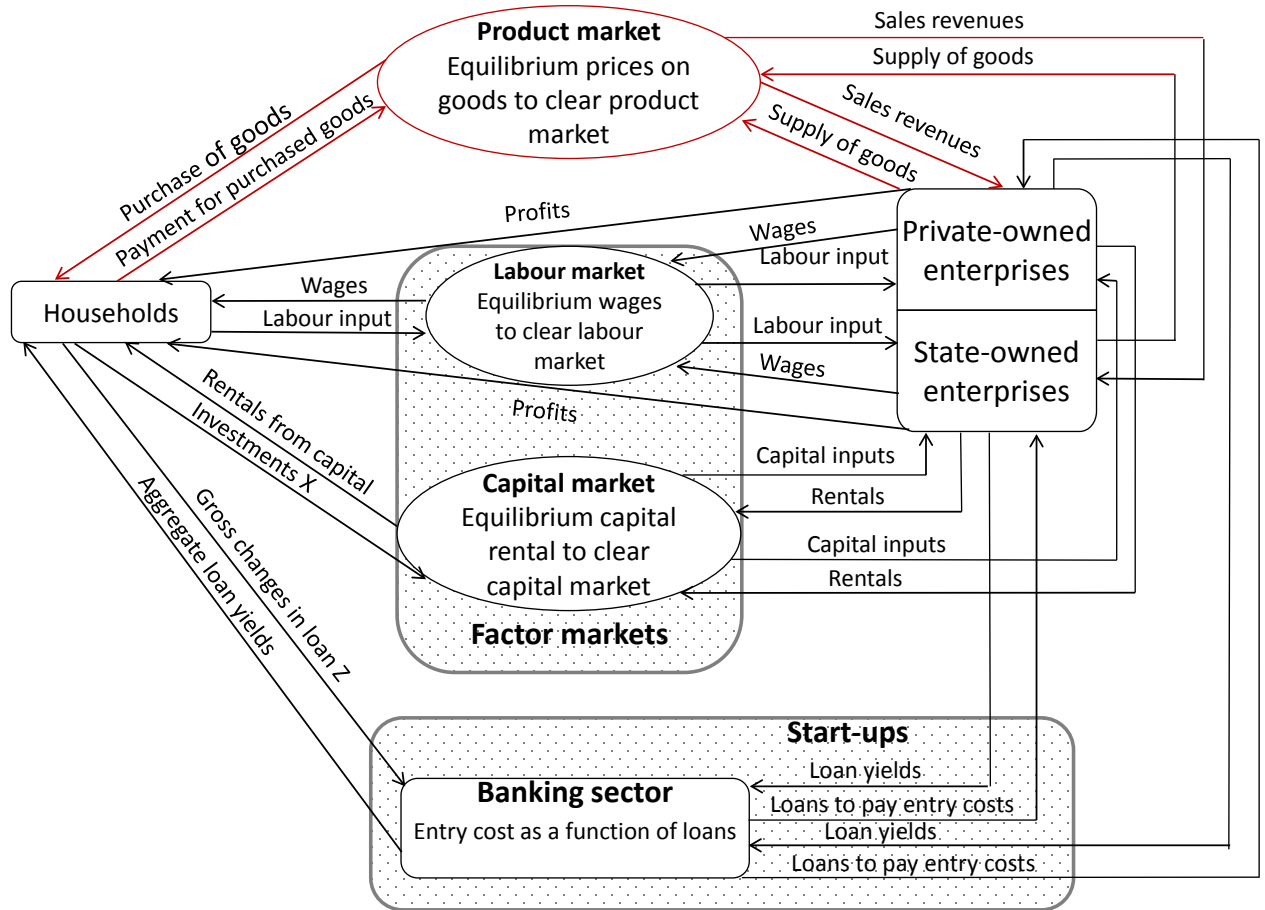
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## Appendix A Structure of the model



## Appendix B Numerical algorithm to recursively solve for the competitive equilibrium

A steady-state competitive equilibrium requires utility maximization by households and profit maximization by firms. The numerical algorithm to recursively solve for the steady-state equilibrium starts with the entry of parameters. First, the discount factor is assumed to be  $\beta = 0.96$ , giving real interest rate  $\rho = 0.0417$ . Second, the exit rate  $\lambda = 0.1$  is assumed for both sectors. Third, the depreciation rate for both sectors is assumed to be  $\delta = 0.1$ . Therefore, we obtain the same rental rate for both sectors,  $r = 0.1417$ , and the loan rates  $r^l$  for SOEs and POEs are 0.1417 and 0.1617, respectively. Fourth, the Cobb-Douglas production function parameters are inputted as  $\alpha = 0.567$  and  $\gamma = 0.319$  for POEs and  $\alpha = 0.438$  and  $\gamma = 0.432$  for SOEs. Fifth, fixed cost are assumed to be  $c_f = 0$ , and finally we set  $\eta = 3.00$ .

The (cumulative) pdf's for both sectors, taking into account the truncation of small POEs, are provided in Figure 1. The initial discrete points for the pdf's have 48 different sizes of firms, from  $n = 4$  to  $n = 500,000$ . We then transform them into a log-space of 100 points (different sizes) of firms, from  $n = 1$  to  $n = 500,000$ , as in Restuccia and Rogerson (2008). We can then compute the relative  $s$ -ranges based on the new 100 points  $n$  sizes, CD parameters, and the relationship  $\frac{n_i}{n_j} = \left(\frac{s_i}{s_j}\right)^{\frac{1}{1-\gamma-\alpha}}$ . With initial values of  $s$ -ranges in Table 1, we can then obtain all  $s$  values for different sizes of  $n$  for both sectors, as shown in Table 1.

We assign probability (1-0.0187) for the POE pdf and 0.0187 for the SOE pdf. In terms of the loan-related parameters, the POE loan leverage  $\epsilon$  is 0.51, while  $\epsilon$  is 0.62 for SOEs. Note that we divide POEs and SOEs into two further sub-groups, as only 20 percent of POEs would have loans and 74 percent SOEs would obtain loans. This means that a high-dimensional pdf space is required. More precisely, we have the four-sector probability-pdf space

$$[(1-0.0187) \cdot 0.2 \cdot \text{pdf}(\text{POEs}), \quad (1-0.0187) \cdot 0.8 \cdot \text{pdf}(\text{POEs}), \quad 0.0187 \cdot 0.74 \cdot \text{pdf}(\text{SOEs}), \\ 0.0187 \cdot 0.26 \cdot \text{pdf}(\text{SOEs})]$$

where the first one is for the POE pdf with loans, the second for the POE pdf without loans, the third for the SOE pdf with loans and the last is for SOE pdf without loans.

The entry-cost functions for both sectors are as in Table 1; combined with loan level  $l = \epsilon c_e$ , we have the effective entry cost  $c_e(\text{POEs}) = (0.10 + 0.0025n) / (1 + 0.5 \epsilon_{\text{POE}})$  and  $c_e(\text{SOEs}) = (0.075 + 0.0022n) / (1 + 0.5 \epsilon_{\text{SOE}})$  for firms with loans. Note that the loan levels  $l = \epsilon c_e$  employed here to compute effective entry costs are the maximal loan levels available for firms. In reality, the actual loans are constrained to a level at which firms do not have negative operating profits. Note that for firms without loans, the effective entry costs are cost  $c_e(\text{POEs}) = (0.10 + 0.0025n)$  and  $c_e(\text{SOEs}) = (0.075 + 0.0022n)$ , respectively, and the loan levels are set to zero.

Finally we set the equilibrium POE wage according to  $[1 - (12.657 - 15.433) / 15.433]$  of the equilibrium SOE wage. Furthermore we compute the equilibrium wage level that ensures the free entry condition of equation (26) in the text. A procedure/subroutine is created to compute equations (22) and (23) in the main text, optimised profits of equation (19) with outcomes of (22) and (23) for employment and capital, and compute the index  $\bar{x}(s_i, l_i)$ . As we set the actual loan levels for firms such that no firms would have negative profits (and such that operative fixed cost  $c_f = 0$ ) and index  $\bar{x}(s_i, l_i) = 1$  for all firms in steady state equilibrium. Equilibrium wages are adjusted to yield zero value for  $W_e$  of equation (26), using an iterative algorithm. After having obtained the equilibrium wages, we obtain the associated steady state density  $\mu_i(s_i, l_i) = \frac{E\bar{x}(s_i, l_i)g(s_i, l_i)}{\lambda}$ , with which we can compute the corresponding output, capital levels, employment shares, entry mass, and aggregate loan levels for both sectors in the competitive equilibrium in which all markets clear.

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