Growing Like China*

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Abstract

This paper constructs a growth model that is consistent with salient features of the recent Chinese growth experience: high output growth, sustained returns on capital investment, extensive reallocation within the manufacturing sector, falling labor share and accumulation of a large foreign surplus. The building blocks of the theory are asymmetric financial imperfections and heterogeneous productivity. Some firms use more productive technologies, but low-productivity firms survive because of better access to credit markets. Due to the financial imperfections, high-productivity firms – which are run by entrepreneurs – must be financed out of internal savings. If these savings are sufficiently large, the high-productivity firms outgrow the low-productivity firms and attract an increasing employment share. The downsizing of the financially integrated firms forces a growing share of domestic savings to be invested in foreign assets, generating a foreign surplus. A calibrated version of the theory can account quantitatively for China's growth experience during 1992-2007.

JEL Codes. F43, G21, O16, O47, O53, P23, P31.

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1 Introduction

Over the last thirty years, China has undergone a spectacular economic transformation involving not only fast economic growth and sustained capital accumulation, but also major shifts in the sectoral composition of output, increased urbanization and a growing importance of markets and entrepreneurial skills. Reallocation of labor and capital across manufacturing firms has been a key source of productivity growth. The rate of return on investment has remained well above 20%, higher than in most industrialized and developing economies. If investment rates have been high, saving rates have been even higher: in the last fifteen years, China has experienced a growing net foreign surplus: its foreign reserves swelled from 21 billion USD in 1992 (5% of its annual GDP) to 2,130 billion USD in June 2009 (46% of its GDP); see Figure 1.

FIGURE 1 HERE

The combination of high growth and high return to capital, on the one hand, and a growing foreign surplus, on the other hand, is puzzling. A closed-economy neoclassical growth model predicts that the high investment rate would lead to a fall in the return to capital. An open-economy model predicts a large net capital inflow rather than an outflow, owing to the high domestic return to capital. In this paper, we propose a theory of economic transition that solves this puzzle while being consistent with salient qualitative and quantitative features of the Chinese experience. The focal points of the theory are financial frictions and firms' reallocation of resources across firms. In our theory, both the sustained return to capital and the foreign surplus arise from the reallocation of capital and labor from less productive externally financed firms to entrepreneurial firms that are more productive, but have less access to external financing. As financially integrated firms shrink, a larger proportion of the domestic savings is invested in foreign assets. Thus, the combination of high growth and high investment is consistent with the accumulation of a foreign surplus.

Our paper is part of a recent literature arguing that low aggregate total factor productivity (TFP) – especially in developing countries – is the result of micro-level resource misallocation (see Parente *et al.*, 2000; Caselli and Coleman, 2002; Banerjee and Duflo, 2005; Restuccia and Rogerson, 2008; Gancia and Zilibotti, 2009; and Hsieh and Klenow, 2009). While pockets of efficient firms using state-of-the-art technologies may exist, these firms fail to attract the large share of productive resources that efficiency would dictate, due to financial frictions and other imperfections. Most existing literature emphasizes the effects of resource misallocation on average productivity. In contrast, our paper argues that when a country starts from a situation of severe inefficiency, but manages to ignite the engine of reallocation, it has the potential to grow fast over a prolonged transition, since efficient firms can count on a highly elastic supply of factors attracted from the less productive firms.

To analyze such a transition, we construct a model in which firms are heterogeneous in productivity and access to financial markets. High-productivity firms are operated by agents with entrepreneurial skills who are financially constrained and who must rely on retained earnings to finance their investments. Low-productivity firms can survive due to their better access to credit markets, since the growth potential of high-productivity firms is limited by the extent of entrepreneurial savings. If the saving flow is sufficiently large, high-productivity firms outgrow low-productivity ones, progressively driving them out of the market. During the transition, the dynamic equilibrium has AK features: within each type of firms, the rate of return to capital is constant due to labor mobility and to the financial integration of the low-productivity firms. Due to a composition effect, the aggregate rate of return to capital actually increases. Moreover, the economy accumulates a foreign surplus. While investments in the expanding firms are financed by the retained earnings of entrepreneurs, wage earners deposit their savings with intermediaries who can invest them in loans to domestic firms and in foreign bonds. As the demand for funds from financially integrated domestic firms declines, a growing share of the intermediated funds must be invested abroad, building a growing foreign surplus. This prediction is consistent with the observation that the difference between deposits and domestic bank loans has been growing substantially, tracking China's accumulation of foreign reserves (see again Figure 1). After the transition, the economy behaves as in a standard neoclassical model, where capital accumulation is subject to decreasing returns.

Reallocation within the manufacturing sector – the driving force in our model – has been shown to be an important source of productivity growth in China. In an influential paper, Hsieh and Klenow (2009) estimate that reallocation across manufacturing firms with different productivity accounted for an annual 2 percentage point increase in aggregate TFP during 1998–2005. Brandt *et al.* (2009) estimate that between 42% and 67% of the aggregate TFP growth in Chinese manufacturing was due to productivity differences between entering and exiting firms during 1998-2005.

Our theory yields several additional predictions consistent with the evidence of China's transition.

1. The theory predicts that the surplus – savings minus investment – should increase with the share of entrepreneurial firms.

   Consistent with this prediction, we find that the net surplus is significantly higher in Chinese provinces in which the employment share of domestic private firms has increased faster.

2. In our basic, benchmark model, all firms produce the same good and differ only in TFP. We extend the theory to a two-sector model in which firms can specialize in the production of more or less capital-intensive goods. This extended model predicts that financially constrained firms with high TFP will specialize in labor-intensive activities (even though they have no technological comparative advantage). Thus, the transition proceeds in stages: first low-productivity firms retreat into capital-intensive industries, and then they gradually vanish. This is consistent with the observed dynamics of sectoral reallocation in China, where young high-productivity private firms have entered extensively in labor-intensive sectors, while old state-owned firms continue to dominate capital-intensive industries.

The theory is related to the seminal contribution of Lewis (1954), who constructs a model of reallocation from agriculture to industry where the supply of labor in manufacturing is unlimited due to structural overemployment in agriculture. While his mechanism is similar in some respects to ours, productivity increases in his model rely on some form of hidden unemployment in the traditional sector. Lewis' theory captures aspects of the reallocation between rural and urban areas in China, while our focus is on the reallocation within the industrial sector. Our paper is also related to Ventura (1997), who shows that in economies engaging in external trade, capital accumulation is not subject to diminishing returns because resources are moved from labor-intensive to capital-intensive sectors. Ventura's model does not assume any initial inefficiency, nor does it imply that TFP should grow within each industry – a key implication of our theory.[1]

[1] In this respect, our work is related to the seminal papers of Kuznets (1966) and Chenery and Syrquin (1975), who study soruces of productivity growth during economic transitions.

Neither Lewis' nor Ventura's theory has any implication regarding trade imbalances. Matsuyama (2004 and 2005) shows that financial frictions may induce trading economies to specialize in industries in which they do not have a technological comparative advantage. See also the work of Antras and Caballero (2009). In our model, by a similar mechanism, less efficient firms can survive and even outgrow more productive ones. Our two-sector extension also predicts that financial constraints generate specialization in spite of the lack of any technological comparative advantage, though the mechanism is different.

Gourinchas and Jeanne (2007) document that it is common to observe capital outflow from fast-growing developing economies with high marginal product of capital. As in the case of China, countries with fast TFP growth tend to have both large capital outflows and large investment rates, while the opposite is true for slow-growing countries. They label this finding the "allocation puzzle". Our theory can provide a rationale to this observation. In a related paper, Buera and Shin (2009) focus on the current account surpluses experienced by a number of Asian economies in the 1980s (with the notable exception of China, which experienced current account deficits during the 1980s). Buera and Shin argue – as we do – that financial frictions can contribute to the explanation of this puzzle. While in our paper the foreign surplus is driven by the dwindling demand for domestic borrowing, due to the declining financially integrated firms, they emphasize increased domestic savings by agents who are planning to become entrepreneurs but need to save to finance start-up costs.

A few recent papers address the more specific question of why China is accumulating a large foreign surplus. Most papers emphasize the country's high saving rate. Kuijs (2005) shows that household and enterprise saving rates in China are, respectively, 11.8 and 8.6 percentage points higher than those in the United States. Demography, an imperfect financial sector, and the lack of welfare and pension benefits are among the factors proposed as explanations for this (e.g. Kraay, 2000). However, it remains unclear why domestic savings are not invested domestically given the high rate of return to capital in China. Mendoza *et al.* (2009) argue that this may be explained by differences in financial development inducing savers in emerging economies to seek insurance in safe US bonds (see also Caballero *et al.*, 2008, and Sandri, 2009). Dooley *et al.* (2007) propose a strategic political motive: the Chinese government would influence wages, interest rates and international financial transactions so as to foster employment and export-led growth.

Our paper is organized as follows. Section 2 describes some empirical evidence of China since 1992. Section 3 describes the benchmark model and characterizes equilibrium. Section 4 discusses quantitative implications of the theory with the aid of a calibrated economy. Section 5 presents an extension to a two-sector environment that captures additional features of the Chinese transition. Section 6 concludes. A technical Appendix available from our web pages contains the formal proofs.

2 The Transition of China: Empirical Evidence

2.1 Political Events and Macroeconomic Trends

China introduced its first economic reforms in December 1978. The early reforms reduced land collectivization, increased the role of local governments and communities, and experimented with market reforms in a few selected areas. After a period of economic and political instability, a new stage of the reform process was launched in 1992, after Deng Xiaoping's Southern Tour, during which the leader spoke in favor of an acceleration of reforms. Since then, China has moved towards a full-fledged market economy. The process gained momentum in 1997, as the 15th Congress of the Communist Party of China officially endorsed an increase in the role of private firms in the economy.

The focus of this paper is on the post-1992 Chinese transition, a period characterized by fast and stable growth and by a pronounced resource reallocation within the manufacturing sector. In spite of very high investment rates (39% on average), the rate of return to capital has remained stable: While the aggregate return to capital has fallen slightly (from 28% in 1993 to 21% in 2005), the rate of return to capital in manufacturing has been increasing since the early 1990s and climbed close to 35% in 2003, according to Figure 11 in Bai *et al.* (2006). High corporate returns have not been matched by the return on financial assets available to individual savers: the average real rate of return on bank deposits, the main financial investment of Chinese households, was close to zero during the same period. Wage growth has been lower than growth in output per capita in recent years.[2] Similarly, the labor share of aggregate output fell gradually from 59%

[2] According to Banister (2007, Table 10, based on the China Labor Statistical Yearbook) the average real annual growth of wages in the urban manufacturing sector between 1992 and 2004 was 7.5 percent, and a mere 4.6 percent if one excludes state-owned and collectively owned enterprises. In the same period, the average growth rate of real GDP per capita was about 9 percent. Using data from the NBS Urban Household Surveys 1992–2006, Ge and Yang (2009) report an annual growth rate of 4.1 percent for the basic wage (the lowest skill category) and of 6.2 percent for workers with "middle-school education and below." These are useful benchmarks since they separate the wage growth due to technological progress from that due to human capital accumulation – which reflects the increasing

in 1998 to 47% in 2007 (Bai and Qian, 2009, Table 4).[3] The falling labor share has contributed to rising inequality even across urban households (Benjamin *et al.*, 2008).

FIGURE 2 HERE

2.2 Reallocation in Manufacturing

The reallocation of capital and labor within the manufacturing sector is a focal point of our paper. Figure 2 plots alternative measures of the evolution of the employment share of private enterprises. Our preferred measure is based on annual firm-level surveys conducted by China's National Bureau of Statistics (NBS), which include the universe of Chinese industrial firms (manufacturing, mining and construction) with sales over 5 million RMB. The solid line plots the proportion of domestic private enterprises (DPE) as a percent of DPE plus state-owned enterprises (SOE) in the NBS surveys. It shows an increase from 4% in 1998 to 56% in 2007. This is the most relevant measure for our theory.[4] However, it excludes two important firm categories: foreign enterprises (FE) and collectively owned enterprises (COE). Therefore, for completeness, we also report a broader measure of the private employment share, namely, (DPE+FE)/(DPE+FE+SOE+COE), see the dashed line. The NBS measures of private employment share could be biased downwards, due to the exclusion of small firms and non-industrial firms. Therefore, we also report the corresponding ratios from aggregate statistics from the China Labor Statistical Yearbook (CLSY).[5] According to this measure, the DPE/(DPE+SOE) share was 19% in 1997 and 54% in 2007. All measures suggest that the share of DPE was low until 1997 and that most of the transition took place thereafter. This accords well with the political events outlined above.

quantity and quality of education. Two additional remarks are in order. First, wages are deflated using the provincial consumer price index (CPI). The annual CPI growth rate was on average 0.9 percentage points lower than that of the GDP deflator in these years. Second, the compliance rate for pension contributions paid by employers declined dramatically in this period. Both considerations suggest that the growth of labor costs per worker for firms was lower than the figures above.

[3] Bai and Qian (2009) report data until 2004. The estimates for 2004–07 were kindly provided by Bai and Qian.

[4] NBS data are only available since 1998. The figure shows the share of firms classified as DPE by the NBS. If, instead, we classify as DPE all firms with a private ownership share above 50%, the DPE shares would rise from 12% in 1998 to 59% in 2007.

[5] One problem with the CLSY is that it does not classify ownership for all urban employment. More precisely, the provincial data classifying employment according to ownership adds up to only 60% of the aggregate measure of urban employment. The dotted line is then computed by assuming that the ratio of DPE to SOE in the unclassified aggregate data is the same as that in the provincial data.

2.3 Productivity and Credit Frictions

DPE and SOE differ in two important aspects: productivity and access to financial markets. SOE are, on average, less productive and have better access to external credit than do DPE. This makes ownership structure a natural proxy for the different types of firms in our theory. Figure 3 shows a measure of profitability, i.e., the ratio of total profits (measured as operation profits plus subsidies plus investment returns) to fixed assets net of depreciation. Based on this measure, the gap between DPE and SOE is about 9 percentage points per year, similar to that reported by Islam *et al.* (2006).[6] Large productivity differences also emerge from TFP accounting: Brandt *et al.* (2008, Table 17.3) estimate an average TFP gap between DPE and SOE of 1.8 during 1998–2004, while Brandt and Zhu (2009) estimate a gap of 2.3 in 2004. Using a different methodology, Hsieh and Klenow (2009) estimate a "revenue-TFP gap" of 1.42.

FIGURE 3 HERE

FIGURE 4 HERE

Financial and contractual imperfections are also well documented. In a cross-country comparative study, Allen *et al.* (2005) find that China scores poorly in terms of creditor rights, investor protection, accounting standards, non-performing loans and corruption.[7] In this environment, Chinese firms must rely heavily on retained earnings to finance investments and operational costs. Financial repression is far from uniform: private firms are subject to strong discrimination in credit markets. The Chinese banks – mostly state owned – tend to offer easier credit to SOE (Boyreau-Debray and Wei, 2005). As a result, SOE can finance a larger share of their investments through external financing. Figure 4 shows that SOE finance more than 30% of their investments through bank loans compared to less than 10% for DPE. Similarly, Dollar and Wei (2007, Table 3.1)

[6] A concern with the official data is that the ownership classification is based on ownership at the time of initial registration. However, many firms have subsequently been privatized. This problem is addressed by Dollar and Wei (2007), who use survey data on 12400 firms, classified according to their *current* ownership. They find the average return to capital to be twice as high in private firms as in fully state-owned enterprises (Dollar and Wei, 2007, Table 6). Interestingly, collectively owned firms also have a much higher productivity than SOE.

[7] Interestingly, some reforms of the financial system have been undertaken, including a plan to turn the four major state-owned commercial banks into joint-stock companies. This effort involves consulting foreign advisors to improve the managerial efficiency of banks (Kwan, 2006). In section 3.7 we discuss the role of financial development during the economic transition.

and Riedel *et al.* (2007, Table 3.1) report that private enterprises rely significantly less on bank loans and significantly more on retained earnings and family and friends to finance investments. Other forms of market financing are marginal for private firms. Despite the rapid growth of the Chinese stock market in recent years, equity and debt markets continue to play an insignificant role for DPE, while these markets have become increasingly important for large semi-privatized SOE (Gregory and Tenev, 2001; and Riedel *et al.,* 2007, ch. 7).

Another sign that DPE are financially repressed is that both capital-output and capital-labor ratios are substantially lower in DPE than in SOE. In 2006, the average capital-output ratio was 1.75 in SOE and 0.67 in DPE (China Statistical Yearbook (CSY), 2007). In the same year, the capital per worker was almost five times larger in SOE than in DPE, although part of this difference reflects the higher average educational attainment of SOE workers. This gap arises from both an intensive and an extensive margin. First, SOE are more capital intensive even within three-digit manufacturing industries, both in terms of capital per worker and in terms of the capital-output ratio (Figure A1 in the Appendix). Second, DPE have taken over labor-intensive industries, while the share of SOE remains high in capital-intensive industries. Panel 1 of Figure 5 plots the 2001 SOE share of total employment across three-digit manufacturing industries against the capital intensity that each of these industries had in the United States (2001 is the first year for which data are available). Already in 2001 were SOE significantly more represented in those industries which are more capital intensive in the United States. For instance, the SOE employment share in the ten most capital-intensive industries was 57.9%, while in the ten least capital-intensive industries it was 25.8%.[8] The withdrawal of SOE from labor-intensive sectors has continued thereafter. Panel 2 of Figure 5 plots the percentage change in the SOE employment share between 2001 and 2007 against the capital intensity of the corresponding industry in the United States. The correlation coefficient is highly positive (0.576).

FIGURE 5 HERE

[8]Industries are classified according to the capital-labor ratio in the United States in 1996 (classifying according to their respective Chinese ratios would create an endogeneity problem). The US data are from NBER-CES Manufacturing Industry Database, http://www.nber.org/nberces. We match the industries listed by the China Industrial Economy Statistical Yearbook (CIESY 2002, 2003 and 2004) to the SIC codes. Among 31 industries in CIESY, only 27 can be matched, 18 at the SIC 2-digit level and 9 at the SIC 3-digit level. Details are available upon request.

2.4 Income Inequality

The economic transition of China has been accompanied by increasing income inequality – even within the urban sector. For instance, the Gini coefficient of income in China grew from 0.36 in 1992 to 0.47 in 2004. Our theory suggests that this development may be due in part to the slow growth of wages relative to entrepreneurial income. The pattern of income inequality across regions can offer some insight. We classify Chinese provinces by the percentage of industrial workers who are employed in DPE. Figure 6 shows a high positive correlation between the Gini coefficient at the provincial level in 2006 and the employment share of DPE: provinces with more private firms have a substantially higher income dispersion.

FIGURE 6 HERE

2.5 Foreign Surplus and Productivity Growth

Finally, the reallocation process in manufacturing has an interesting statistical relationship with the accumulation of a foreign surplus and the productivity growth. Consider, first, the foreign surplus. At the aggregate level, the timing of structural change from SOE to DPE follows quite closely that of the accumulation of foreign reserves: Both accelerate around year 2000 (Figures 1 and 2). Interestingly, the breakdown of the net surplus (savings minus investment) across provinces suggests the same pattern in the cross section: The net surplus is systematically larger in provinces with a larger increase in the DPE employment share.

We document this pattern by using data for 31 provinces with data from 2001 to 2007 from the NBS.[9] The dataset allows us to construct province-level measurements of investment in fixed assets and savings (defined as provincial GDP minus private and government consumption expenditures). In column 1 of Table 1, we report the results of regressing of the provincial net-surplus-to-GDP ratio on the annual change in the employment share of DPE, defined as the employment in DPE divided by the sum of employment in DPE and SOE at the province level. To avoid that the correlation be driven by a common trend in the two variables, we include time dummies. The estimated coefficient is positive and highly significant: a 10 percentage points larger increase in the

[9] The data cover all Chinese provinces for the years 2001–2003 and 2005–2007 (data for 2004 are not available). The employment statistics for 2001–2003 are from CIESY 2002-2004. The CSY 2006-2008 provide data for 2005-2007. Annual data for investment, saving and GDP are from the CSY (2002-2008).

DPE employment share is associated with an average 10 percentage point larger net surplus relative to GDP.[10] Controlling for lagged provincial GDP per capita reduces the estimated coefficient from 1.0 to 0.89, which is significant at the 10% confidence level.[11]

Consider, next, productivity growth. Columns 3-4 of Table 1 show that labor productivity has grown faster in provinces where the DPE employment share has grown faster. A 10 percentage points larger increase in the DPE share is associated with a 1.9 percentage points higher annual productivity growth rate. Similar evidence emerges from looking at the variation of the speed of reallocation across industries, see columns 5-6.[12] In this case, a direct measure of the DPE employment share is not available before 2005, so we use the employment share of non-SOE over total employment as a measure of reallocation. The coefficient of interest is positive and significant. The quantitative effect is even larger: a 10 percentage points larger increase in the non-SOE employment share is associated with a 14.3 percentage points higher growth rate of productivity. The correlation is strengthened when controlling for industry-specific lagged productivity.

TABLE 1 HERE

The province-level results of columns 1-4 are mainly driven by cross-province variation. The estimated coefficients become smaller and statistically insignificant when province fixed effects are included (only marginally insignificant in the productivity regressions of columns 3-4). In contrast, the cross-industry results hold up to the inclusion of industry fixed effects, which leave the estimated coefficient almost unchanged. Thus the results of section 5-6 are mostly driven by within-industry variation.

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[10] There is also a positive and highly significant (>99%) correlation between the ratio of net surplus to provincial GDP and the *level* of the DPE employment share. A 10 percentage points difference in the DPE employment share is associated with a 3.5 percentage point larger net surplus relative to GDP. In the theory presented in section 3, both a high level and a high growth of the DPE share increase the foreign surplus, consistent with the evidence in Table 1.

[11] All regressions described in this subsection are of the form

$$DEP\_VAR_{rt} = \alpha_t + \beta_1 \cdot \left(EMPL_{rt}^{PRIV} - EMPL_{rt-1}^{PRIV} \right) + \varepsilon_{rt},$$

where the dependent variable, DEP_VAR_{rt}, is the provincial net surplus (savings minus investments) over GDP in columns 1 and 2, the growth rate of provincial GDP pc in columns 3 and 4, and the growth rate of the industry-level value added per worker in columns 5 and 6. $EMPL_{rt}^{PRIV}$ denotes the DPE (or non-SOE, as discussed in the text) employment share. In columns 2, 4 and 6, control for lagged GDP per capita (value added per worker) is included. α_t denotes time-dummies, included in all regressions. Standard errors are clustered at the province (industry) level. The coefficient of interest is β_1.

[12] The data cover 28 major manufacturing industries. The sample period is 2001-07 (data for 2004 are not available). The data for 2001-03 are from the CIESY (2002-04). The data for 2005-07 are from the CSY (2006-08).

3 The Benchmark Model

In this section, we develop a theory of economic transition consistent with the empirical facts documented in the previous section.

3.1 Preferences, Technology and Markets

Preferences and Population: The model economy is populated by overlapping generations of two-period lived agents who work in the first period and live off savings in the second period. Preferences are parameterized by the following time-separable utility function:

$$U_t = \frac{(c_{1t})^{1-\frac{1}{\theta}} - 1}{1 - \frac{1}{\theta}} + \beta \frac{(c_{2t+1})^{1-\frac{1}{\theta}} - 1}{1 - \frac{1}{\theta}}, \tag{1}$$

where β is the discount factor and θ is the intertemporal elasticity of substitution in consumption c_t. We focus on the case when agents' savings are non-decreasing in the rate of return, i.e., when $\theta \geq 1$.

Agents have heterogeneous skills. Each cohort consists of a measure N_t of agents with no entrepreneurial skills (*workers*), and a measure μN_t of agents with entrepreneurial skills (*entrepreneurs*), whose skills are transmitted from parents to children.[13] The population grows at the exogenous rate ν; hence, $N_{t+1} = (1 + \nu) N_t$. The rate ν captures demographic trends, including migration from rural to urban areas, assumed to be exogenous, for simplicity.

Technology: There are two types of firms, both requiring capital and labor as well as one manager. *Financially integrated* (F) firms are owned by intermediaries (to be defined below) and operate as standard neoclassical firms. *Entrepreneurial* (E) firms are owned by old entrepreneurs. The entrepreneurs are residual claimants on the profits and hire their own children as managers. The key assumption is that, due to financial and contractual imperfections, some firms (F firms) have access to the deep pocket of banks, which are perfectly integrated in international financial markets. Other firms (E firms) are owned by agents who have superior skills and can run more productive technologies. However, there are frictions restricting the flow of funds from the agents with a deep pocket to those with superior skills. As a result, the latter end up being credit constrained. This, in turn, allows less productive firms to survive in equilibrium.

[13] Lowercase characters will denote per capita or firm-level variables; upper case, aggregate variables.

Different microfoundations would be consistent with this form of credit constraints to arise in equilibrium. Here, we present one such example: Following Acemoglu *et al.* (2007), we assume that each firm can choose between two modes of production: Either the firm delegates decision authority to its manager, or it retains direct control of strategic decisions. There is a trade-off. On the one hand, delegation leads to higher total factor productivity (TFP) – e.g., the manager makes decisions based on superior information. Thus, a firm delegating authority can attain $\chi > 1$ extra efficiency units per worker compared with a firm retaining centralized authority. On the other hand, delegation raises an agency problem: the manager can divert a positive share of the firm's output for his own use. Such opportunistic behavior can only be deterred by paying managers a compensation that is at least as large as the output which they could steal. The key assumption is that entrepreneurs are better at monitoring their managers, so that E firm managers can only steal a share $\psi < 1$ of output. In contrast, F firms are weak at corporate governance and cannot effectively monitor their managers: under delegation, all output would be stolen. Thus, F firms will always choose a centralized organization, while E firms opt for delegation, given a condition that will be spelled out below.

The technology of F and E firms are described, respectively, by the following production functions:

$$y_{Ft} = k_{Ft}^{\alpha} \left(A_t n_{Ft}\right)^{1-\alpha}, \qquad y_{Et} = k_{Et}^{\alpha} \left(\chi A_t n_{Et}\right)^{1-\alpha},$$

where y is output and k and n denote capital and labor, respectively. Capital depreciates fully after one period. In the case of F firms, the input of the manager is equivalent to that of a regular worker and is included in n_F. The technology parameter A grows at an exogenous rate z; $A_{t+1} = (1+z)\,A_t$.

Savings: Young workers earn a wage w and deposit their savings with a set of competitive intermediaries (*banks*) paying a gross interest rate R^d. These workers choose savings so as to maximize utility, (1), subject to an intertemporal budget constraint, $c_{1t}^W + c_{2t+1}^W/R^d = w_t$. This yields the optimal savings $s_t^W = \zeta^W w_t$, where $\zeta^W \equiv \left(1+\beta^{-\theta}R^{1-\theta}\right)^{-1}$. Young entrepreneurs in E firms earn a managerial compensation, m_t. Their savings can be invested either in bank deposits or in their family business.

Banks: Banks collect savings from workers and invest in loans to domestic firms and foreign bonds. The bonds yield a gross return R. Contractual imperfections plague the relationship between banks and entrepreneurs. The output of E firms is non-verifiable, and entrepreneurs can only pledge to repay a share η of the second-period net profits.[14]. In a competitive equilibrium, the rate of return on domestic loans must equal the rate of return on foreign bonds, which in turn must equal the deposit rate. However, lending to firms is subject to an *iceberg cost* ξ, which captures operational costs, red tape, etc. Thus, ξ is an inverse measure of the efficiency of intermediation. In equilibrium, $R^d = R$ and $R^l = R/(1-\xi)$, where R^l is the lending rate to domestic firms.[15]

F firms: Profit maximization implies that R^l equals the marginal product of F firms' capital and that wages equal the marginal product of labor:

$$w_t = (1-\alpha)\left(\frac{\alpha}{R^l}\right)^{\frac{\alpha}{1-\alpha}} A_t. \tag{2}$$

E firms: The value of a firm owned by an old entrepreneur with capital k_{Et} is the solution to the following problem:

$$\Xi_t(k_{Et}) = \max_{m_t, n_{Et}} \left\{ (k_{Et})^\alpha (\chi A_t n_{Et})^{1-\alpha} - m_t - w_t n_{Et} \right\} \tag{3}$$

subject to the incentive constraint that $m_t \geq \psi (k_{Et})^\alpha (A_{Et} n_{Et})^{1-\alpha}$, where m_t is, again, the payment to the manager, and arbitrage in the labor market implies that the wage is as in (2).[16] The optimal contract implies that the incentive constraint is binding:

$$m_t = \psi (k_{Et})^\alpha (\chi A_t n_{Et})^{1-\alpha}. \tag{4}$$

Taking the first-order condition with respect to n_E and substituting in the equilibrium wage given by (2) yields that

$$n_{Et} = ((1-\psi)\chi)^{\frac{1}{\alpha}} \left(\frac{\alpha}{R^l}\right)^{-\frac{1}{1-\alpha}} \frac{k_{Et}}{\chi A_t}. \tag{5}$$

Plugging (4) and (5) into (3) yields the value of the firm:

$$\Xi_t(k_{Et}) = (1-\psi)^{\frac{1}{\alpha}} \chi^{\frac{1-\alpha}{\alpha}} R^l k_{Et} \equiv \rho_E k_{Et}, \tag{6}$$

where ρ_E is the E firm rate of return to capital. In order to ensure that $\rho_E > R^l$, we make the following assumption.

[14] The assumption that output is not verifiable rules out that financially integrated firms hire old entrepreneurs. If the entrepreneurs could commit to repay, all firms would be run by private entrepreneurs.

[15] In the analysis of this section, ξ plays no role, so we could set $\xi = 0$ without loss of generality. However, ξ will become important in the extension about financial development.

[16] The managerial compensation must also exceed the workers' wage rate ($m_t > w_t$). We restrict attention to parameters such that the participation constraint is never binding in equilibrium.

In constrast, F firms are not subject to any incentive constraint since their managers make no discretionary decisions. Thus, the managers' participation constraint is binding, and they earn the same wage as ordinary workers.

Assumption 1 $\chi > \underline{\chi} \equiv \left(\frac{1}{1-\psi}\right)^{\frac{1}{1-\alpha}}$.

Given this assumption, (i) E firms prefer delegation to centralization and (ii) young entrepreneurs find it optimal to invest in the family business. If Assumption 1 were not satisfied, there would be no E firms in equilibrium. Thus, a sufficiently large productivity difference is necessary to trigger economic transition.

Consider, next, the contract between banks and entrepreneurs. The E firm's capital stock comprises the savings of the young entrepreneur and the bank loan, $k_{Et} = s_{t-1}^E + l_{t-1}^E$. The incentive-compatibility constraint of the entrepreneur implies that $R^l l^E \leq \eta \rho_E \left(s^E + l^E\right)$. This constraint is binding if and only if $\eta < R^l / \rho_E$, which we assume to be the case. Thus, the share of investments financed through bank loans is

$$\frac{l_E}{l_E + s_E} = \frac{\eta \rho_E}{R^l}. \tag{7}$$

The entrepreneur's investment problem can be expressed as the choices of l_E and s_E that maximize discounted utility, U, subject to $c_1 = m - s_E$, $c_2 = \rho_E (l_E + s_E) - R^l l_E$, and the incentive-compatibility constraint, (7). If we use (7) to substitute away l_E, the problem simplifies to

$$\max_{s_E} \frac{(m - s_E)^{1-\frac{1}{\theta}} - 1}{1 - \frac{1}{\theta}} + \beta \frac{\left(\frac{(1-\eta)\rho_E R^l}{R^l - \eta \rho_E} s_E\right)^{1-\frac{1}{\theta}} - 1}{1 - \frac{1}{\theta}}.$$

This implies that the optimal savings are $s_E = \zeta^E m$, where $\zeta^E \equiv \left(1 + \beta^{-\theta} \left(\frac{(1-\eta)\rho_E R^l}{R^l - \eta \rho_E}\right)^{1-\theta}\right)^{-1}$.

3.2 Discussion of Assumptions

Before discussing our model's equilibrium dynamics, we review the main assumptions made so far.

The theory describes a growth model characterized by heterogeneous firms that differ in productivity and access to credit markets. In the application to China, the natural empirical counterparts of E firms and F firms are private and state-owned enterprises, respectively. In our model, we do not emphasize the public ownership of less productive firms. However, we focus on two salient features that are related to the ownership structure. First, due to their internal bureaucratic structure, SOE are weak in corporate governance and grant less autonomy and incentives to their management. This feature is well documented. For instance, Liu and Otsuka (2004) show that profit-linked managerial compensation schemes are rare for SOE, while they are ten to twenty times more prevalent for township and village enterprises. The rigidity of the SOE structure is emphasized by Chang and Wong (2004). Second, thanks to connections to state-owned banks, SOE enjoy better access to borrowing (as suggested in the evidence discussed in Section 2).

In assuming F firms to be "competitive," we abstract from other institutional features, such as market power or distortions in the objectives pursued by firms and their managers, that may be important in Chinese SOE. We do so partly for tractability. Chinese SOE have been subject to an increased competitive pressure that has forced many of them to shut down or restructure. Thus, to focus on the two distortions discussed above, we find the abstraction of competitive profit-maximizing firms to be fruitful (in section 5.2 we explore the implications of granting F firms market power). Also for simplicity, we model the labor market as competitive and frictionless. While the Chinese labor market is characterized by important frictions (e.g., barriers to geographical mobility), we do not think that including such frictions would change any of the qualitative predictions of the theory, although it would affect the speed of reallocation and wage growth.

The assumption that private firms are less financially integrated is also well rooted in the empirical evidence discussed in section 2, showing that Chinese private firms rely heavily on self-financing and receive only limited funding from banks and insignificant equity funding. The assumption that monitoring is easier within flexible organizations – and most notably in family firms – seems natural. In the model, we do not emphasize inter-family altruistic links: parents transmit genetically entrepreneurial skills to their children, but also must provide them with incentives to avoid opportunistic behavior. Alternatively, we could have focused on parental altruism and assumed that incentive problems are altogether absent in family firms. In such an alternative model, parents would leave voluntary bequests to their children, who in turn would invest in the family firm.

The essential feature of our model's reallocation mechanism is that financial and contractual frictions obstruct the flow of capital towards high-productivity entrepreneurial firms. If the entrepreneurs could borrow external funds without impediments, the transition would occur instantaneously, and only the more efficient E firms would be active in equilibrium. The fact that entrepreneurs must rely on their own savings implies a gradual transition.

3.3 Equilibrium during Transition

In this section, we characterize the equilibrium dynamics during a transition in which there is positive employment in both E and F firms. We drop time subscripts when this causes no confusion. We start by showing that, due to the disadvantage in raising funds, E firms choose in equilibrium a lower capital-output ratio than do F firms. To see this, denote by $\kappa_J \equiv k_J/(A_J n_J)$ the capital per effective unit of labor. As discussed above, in a competitive equilibrium, the lending rate R^l pins down the marginal product of capital among F firms. Thus,

$$\kappa_F = \left(\frac{\alpha}{R^l}\right)^{\frac{1}{1-\alpha}}. \tag{8}$$

Since κ_F is constant, the equilibrium wage in (2) grows at the rate of technical change, z, as in standard neoclassical open-economy growth models. Equation (5) then implies immediately that

$$\kappa_E = \kappa_F \left((1-\psi)\chi\right)^{-\frac{1}{\alpha}}. \tag{9}$$

Lemma 1 *Let Assumption 1 hold, i.e., $\chi > \underline{\chi}$. Then E firms have a lower capital-output ratio ($\kappa_E < \kappa_F$) and a lower capital-labor ratio than have F firms.*

Consider, next, the equilibrium dynamics. The key properties of the model are that (i) K_{Et} and A_t are state variables (whereas K_{Ft} is determined by equation (8) and is therefore not a state variable), (ii) capital per effective unit of labor for each type of firm, κ_E and κ_F, is constant among each type of firm, and (iii) entrepreneurial savings in period t (hence, K_{Et+1}) is linear in K_{Et}. These three properties imply that employment, capital and output among E firms grow at a constant rate during transition.

Lemma 2 *Given K_{Et} and A_t, the equilibrium dynamics of total capital and employment among E firms during transition are given by $K_{Et+1}/K_{Et} = 1+\gamma_{K_E}$ and $N_{Et+1}/N_{Et} = \left(1+\gamma_{K_E}\right)/(1+z) \equiv 1+\nu_E$, where*

$$1+\gamma_{K_E} = \frac{R^l}{R^l - \eta\rho_E}\left(1+\beta^{-\theta}\left(\frac{(1-\eta)\rho_E R^l}{R^l-\eta\rho_E}\right)^{1-\theta}\right)^{-1}\frac{\psi}{1-\psi}\frac{\rho_E}{\alpha}, \tag{10}$$

and $\rho_E = (1-\psi)^{\frac{1}{\alpha}}\chi^{\frac{1-\alpha}{\alpha}}R^l$ and $R^l = R/(1-\xi)$. There exists $\hat{\chi} = \hat{\chi}(\beta,\chi,\psi,\eta,\alpha,\nu,z,R,\xi) < \infty$ such that the employment share of E firms N_E/N grows over time (i.e., $\nu_E > \nu$) if and only if $\chi > \hat{\chi}$. $\hat{\chi}$ is defined in the Appendix. Moreover, $\hat{\chi}$ is decreasing in β and in η and increasing in ν and in z. Thus, the employment share of E firms grows if, ceteris paribus, β or η are sufficiently large or if ν or z are sufficiently small.

Equation (10) follows from the aggregation of the E firm investments, after recalling that $k_{Et+1} = s_t^E + l_t^E$, where $s_t^E = \zeta^E m_t$ (with m_t being determined by (4)), and l_t^E is determined by (7). The constant growth rate of K hinges on the facts that the rate of return to capital in E firms is constant and that young entrepreneurs' earnings and savings are proportional to E firms' profits. To illustrate this point, suppose that $z = 0$. In this case, the workers' wage remains constant during the transition. However, the managerial compensation, m_t, still grows in proportion to the output of E firms. The growing earning inequality between workers and entrepreneurs is key for the transition to occur, since (i) the investment of E firms is financed by entrepreneurial savings, and (ii) constant wages avoid a falling return to investment. If young entrepreneurs earned no rents and just earned a workers' wage, entrepreneurial investments would not grow over time. Substituting the expression of ρ_E into (10) shows that the growth rate is hump-shaped in ψ. If entrepreneurial rents are lows (small ψ), young entrepreneurs are poor, and there is low investment. However, if ψ is large, the profitability and growth of E firms (ρ_E) fall.

Note that both assumptions, that $\chi > \underline{\chi}$ and that $\chi > \hat{\chi}$, require the TFP gap, $\chi^{1-\alpha}$, to be large. Thus, generically, only one of them will be binding. Interestingly, the theory can predict failed take-offs. For instance, suppose that initially both conditions are satisfied. Then, the saving rate ζ^E falls, due to, e.g., a fall in β, so that $\hat{\chi}(.,\beta) > \chi > \underline{\chi}$ after the shock. Then investment by E firms would continue to be positive, but their employment share would shrink over time.

The equilibrium dynamics of the set of F firms can be characterized residually from the condition that $K_{Ft} = \kappa_F A_t (N_t - N_{Et})$, namely, F firms hire all workers not employed by the E firms, and K_F adjusts to the optimal capital-labor ratio. Standard algebra shows that, as long as the employment share of E firms increases, the growth rate of K_F declines over time.[17] Aggregate capital accumulation among F firms is hump-shaped during the transition. Initially, when the employment share of E firms is small, K_F grows at a positive rate (provided that either $\nu > 0$ or $z > 0$). However, as the transition proceeds, its growth rate declines and eventually turns negative.

[17]More formally,

$$\frac{K_{Ft+1}}{K_{Ft}} = \frac{A_{Ft+1}}{A_{Ft}}\frac{N_{Ft+1}}{N_{Ft}} = (1+z)(1+\nu)\left(1 - \frac{N_{E0}}{N_0}\left(\frac{1+\nu_E}{1+\nu}\right)^{t+1}\right) / \left(1 - \frac{N_{E0}}{N_0}\left(\frac{1+\nu_E}{1+\nu}\right)^{t}\right) \equiv 1+\gamma_{K_F t},$$

where $\frac{d}{dt}\left(1+\gamma_{K_F,t}\right) = (1+z)\frac{N_{E0}}{N_0}\left(\frac{1+\nu_E}{1+\nu}\right)^t\left(\ln\frac{1+\nu_E}{1+\nu}\right)(\nu-\nu_E)\left(1-\left(\frac{1+\nu_E}{1+\nu}\right)^t\right)^{-2} < 0$ iff $\nu_E > \nu$.

Finally, standard algebra shows that GDP per worker is given by

$$\frac{Y_t}{N_t} = \frac{Y_{Ft} + Y_{Et}}{N_t} = \kappa_F^{\alpha} \left(1 + \frac{\psi}{1-\psi} \frac{N_{Et}}{N_t} \right) A_t. \tag{11}$$

The growth rate of GDP per worker accelerates during a transition as long as $\chi > \hat{\chi}$, reflecting the resource reallocation towards more efficient firms. Under the same condition, the average rate of return to capital in the economy increases during the transition, even though the rates of return to capital in E firms and F firms are constant. Intuitively, we know that this reflects the increasing share of the capital stock that yields the high return ρ_E.[18]

Figure 7 illustrates the transitional dynamics of employment, wages, output, the average rate of return, foreign reserve over GDP and the saving rate in the model economy. In the figure, the transition ends in period T, when all workers are employed by E firms. During the transition, the employment share of these firms, the average rate of return and output per effective units of labor grow, whereas wages per effective units remain constant.

FIGURE 7 HERE

3.4 Foreign Surplus, Savings, and Investments

In this section, we derive the implications of the model for the accumulation of foreign reserves, which is a focal point of our theory. Consider the banks' balance sheet:

$$K_{Ft} + \frac{\eta \rho_E}{R^l} K_{Et} + B_t = \zeta^W w_{t-1} N_{t-1}. \tag{12}$$

The left-hand side of (12) consists of the banks' assets: lending to F firms, lending to E firms (as in equation (7)), and purchasing of foreign bonds, B_t. The right-hand side of (12) captures their liabilities (deposits). The analysis of the previous section leads to the following Lemma:

Lemma 3 *The country's foreign surplus is given by*

$$B_t = \left(\zeta^W \frac{(1-\alpha)\, \kappa_F^{\alpha-1}}{(1+z)\,(1+\nu)} - 1 + (1-\eta) \frac{N_{Et}}{N_t} \right) \kappa_F A_t N_t. \tag{13}$$

[18] More formally, the average rate of return is

$$\rho_t = \frac{\rho_E K_{E,t} + \rho_F K_{F,t}}{K_{E,t} + K_{F,t}} = \frac{R^l}{1 - \left(1 - \chi \left((1-\psi)\, \chi \right)^{-\frac{1}{\alpha}} \right) \frac{N_{Et}}{N_t}},$$

which is increasing as long as N_{Et}/N_t increases.

As long as the employment share of the E firms (N_{Et}/N_t) increases during the transition, the country's foreign surplus per efficiency unit, $B_t/(A_tN_t)$, increases. When the transition is completed (in period T, say) and all workers are employed by E firms ($N_{ET}/N_T = 1$), the net foreign position becomes $B_T = \left(\zeta^W (1-\alpha)\kappa_F^{\alpha-1}/\left((1+z)(1+\nu)\right) - \eta\right)\kappa_F^{\alpha} A_T N_T$. If E firms are sufficiently credit constrained (i.e., if η is low), then the transition necessarily ends with a positive net foreign position.

The intuition for the growing foreign surplus is that as employment is reallocated towards the more productive E firms, investment in the financially integrated F firms shrinks. Hence, the demand for domestic borrowing falls and banks must shift their portfolio towards foreign bonds. Although there is a potentially increasing demand of loans from E firms, this is small, due to the financial frictions. The growth rate of the foreign surplus can exceed that of GDP, resulting in a growing B_t/Y_t ratio (as in panel 5 of Figure 7). This is the case if ψ and η are sufficiently small, i.e., if (asymmetric) credit market and/or contractual imperfections are sufficiently severe.[19]

During the transition, the country's gross saving rate, S_t/Y_t (where $S_t = \zeta^W w_t N_t + \zeta^E \mu m_t$), increases (panel 6 of Figure 7), whereas the gross investment rate, I_t/Y_t (where $I_t = K_{Et+1} + K_{Ft+1}$), falls. Both forces contribute to the growing foreign surplus during the transition. The aggregate saving rate grows for two reasons. First, workers employed by the F firms earn a constant share, $1-\alpha$, of the output of those firms, and save a fraction ζ^W. In contrast, workers employed by E firms save a fraction $\zeta^W(1-\alpha)(1-\psi)$ of the output of those firms. Second, young entrepreneurs save a share $\zeta^E\psi$. Thus, the saving rate out of the output of E firms equals $(1-\alpha)\zeta^W + \alpha\psi\zeta^E + (1-\alpha)\psi\left(\zeta^E - \zeta^W\right)$ which exceeds the saving rate out of the output of F firms, since $\zeta^E \geq \zeta^W$.[20]

[19] More formally,

$$\frac{B_t}{Y_t} = \frac{\zeta^W \frac{(1-\alpha)\kappa_F^{\alpha-1}}{(1+z)(1+\nu)} - 1 + (1-\eta)\frac{N_{Et}}{N_t}}{1 + \frac{\psi}{1-\psi}\frac{N_{Et}}{N_t}} \kappa_F^{1-\alpha},$$

which is increasing with N_{Et}/N_t provided that

$$\frac{\psi}{1-\eta(1-\psi)} < \frac{\alpha(1+\nu)(1+z)}{(1-\alpha)} \frac{1+\beta^{-\theta}R^{1-\theta}}{R^l}.$$

The set of parameters satisfying this condition together with assumption 1 and the condition of Lemma 2 is non-empty.

[20] To see this, recall that $\rho_E > R^l$. Since the intertemporal elasticity of substitution $\theta \geq 1$, the young entrepreneurs have a higher saving rate than the workers: $\zeta^E \geq \zeta^W$. This is the only result in the paper that hinges on the restriction that $\theta \geq 1$.

Next, consider the country's investment. Suppose, for simplicity, that $z = \nu = 0$. Then every worker who is shifted from an F firm to an E firm works with less capital. Therefore, domestic investment falls during the transition (a result which generalizes to positive z and ν). This prediction is problematic, and we shall return to it in section 3.7. For the moment, we note that the prediction of a growing foreign surplus does not hinge on a falling investment rate since the saving rate is growing during the transition. The following proposition summarizes the main results so far.

Proposition 1 *Suppose that $\chi > \max\{\underline{\chi}, \hat{\chi}\}$. Then, during the transition, the equilibrium employment among the two sets of firms is given by $N_{Et} = K_{Et} / \left(A_t \kappa_F (1-\psi)^{-1/\alpha} \chi^{-(1-\alpha)/\alpha} \right)$ and $N_{Ft} = N_t - N_{Et}$, where κ_F is given by (8), and K_{Et} and A_t are predetermined in period t. The rate of return to capital is constant over time for both types of firms, and higher in the E than in F firms: $\rho_F = R^l$ and $\rho_E = (1-\psi)^{1/\alpha} \chi^{(1-\alpha)/\alpha} R^l$. Capital and employment in E firms grow over time as in Lemma 2. The stock of foreign assets per efficiency unit grows over time, as in equation (13). If ψ and/or η are small (strong contractual imperfections and/or credit market discrimination against entrepreneurs), then the foreign surplus-to-GDP ratio increases during the transition.*

3.5 Post-Transition Equilibrium

Once the transition is completed (in period T in Figure 7) all workers are employed by E firms. Thereafter, the theory predicts standard OLG-model dynamics. Consider, for instance, the case of $\theta \to 1$ (log preferences). Then, the aggregate capital stock is given by $K_{Et+1} = (\beta/(1+\beta)) \left(R^l / \left(R^l - \eta \rho_{Et} \right) \right) m_t$, which implies – after substituting in the equilibrium expressions of m_t and ρ_{Et} – a standard neoclassical law of motion (see Appendix):

$$\kappa_{Et+1} = \frac{\beta}{1+\beta} \frac{\psi}{(1+z)(1+\nu)} \frac{R^l}{R^l - \eta\alpha (1-\psi) \kappa_{Et}^{\alpha-1}} (\kappa_{Et})^{\alpha}. \quad (14)$$

Investments bring about capital deepening until either the rate of return to capital falls to R^l or the capital per efficiency unit converges to a steady state such that the rate of return to capital exceeds R^l. Along the converging path, wages and output per effective units, as well as the net foreign surplus, increase, while the rate of return to capital falls.

3.6 Discussion of Results

China: The theory we have just described fits some salient qualitative features of the recent Chinese growth experience discussed in section 2. First, in spite of the high investment and growth of industrial production, the rate of return of firms does not fall. Second, E firms – similarly to DPE in China – have a higher TFP and less access to external financing than other firms. This induces a lower capital intensity in E firms than in F firms (Lemma 1) – again in line with the empirical evidence. Moreover, the rate of return to capital is higher in E firms than in F firms, just as in the data DPE are more profitable than SOE. Third, the transition is characterized by factor reallocation from financially integrated firms to entrepreneurial firms, which is similar to the reallocation from SOE to DPE in the data. Fourth, such reallocation leads to an external imbalance – as in the data the economy runs a sustained foreign surplus. Finally, the model predicts a growing inequality between workers' wages and entrepreneurial earnings.

Allocation Puzzle: While the focus of our paper is on China, our model can also cast light on the experience of other industrializing countries. Our model provides a potential explanation for Gourinchas and Jeanne's (2007) observation that developing countries with high (low) TFP growth experience current account surpluses (deficits). The hallmark of our model is the reallocation from less to more financially constrained firms, which sustains high productivity growth and feeds a growing gap between domestic saving and investment.[21] According to Gourinchas and Jeanne (2007), capital flows out of Korea and Taiwan in the 1980s represent two canonical examples of the "allocation puzzle". Similar to China twenty years later, those economies experienced an acceleration of productivity growth at a time in which they run large balance of payment surpluses.[22]

Korea: In the 1960s and 1970s, the industrialization process of South Korea relied substantially on foreign loans. As of the early 1980s, Korea had one of the highest ratios of foreign debt to GDP ratio among developing countries. The imbalance was significantly corrected in the 1980s. Especially in the second half of that decade, Korea experienced booming growth and a sequence of large current account surpluses. This structural change coincided with important changes in the Korean development strategy. In the period 1960-80, the government had provided strong support to the large local conglomerates (*chaebol*). One pillar of this strategy was a strong integration between banks and chaebol that granted the latter privileged access to low-cost credit. Barriers to entry were substantial. In 1980, the ten largest *chaebol* accounted for 48% of the Korean GNP (Kim, 1997), while the employment share of manufacturing of small and medium enter-

[21] Note that a low χ can make our mechanism go in reverse. As discussed above, if $\underline{\chi} < \chi < \hat{\chi}$, the employment share of the E firms would fall over time, causing low TFP growth and a falling foreign balance. This is reminiscent of the negative part of the allocation puzzle.

[22] The annual growth rate of GDP per worker went up from 4.5% (1972-82) to 6.9% (1982-92) in Korea, and from 5.3% (1972-82) to 6.8% (1982-92) in Taiwan (Penn World Tables 6.2).

prises (SME) with fewer than 200 workers had declined from 68% in 1960 to less than 50% in 1980. Following the crisis of 1979-80, the Korean government set out a major policy shift. The Fair Trade Act of 1980 introduced a set of measures aimed to favor competition and the entry of small firms, by, e.g., reducing subsidies to large firms, regulating the chaebol' monopoly power, and offering tax breaks to SME (Smith, 1994). As a result, the activity of SME soared. Their number more than doubled between 1980 and 1990 (Suh 1998, Table 3.13), and their employment share in manufacturing increased to 62%, a trend that continued in the early 1990s (Nugent and Yhee, 2002, Table I). While the Korean reform package included a minimum financial liberalization (privatization of commercial banks) there were no major financial reforms until the 1993-97 Financial Sector Reform Plan. Thus, throughout the 1980s and early 1990s, while growing in number and importance, SME continued to be subject to heavy discrimination in credit markets (Park, 1994, and Shin and Park, 1999). Similar to China, the differential access to bank loans in Korea resulted in different capital intensities: in the period 1979-97 the ratio of gross value added to total assets was 46% higher in large enterprises than in SME. Moreover, again similar to China, "*in the latter half of the 1980s the chaebol placed an increasingly disproportionate emphasis on capital-intensive industries, using their ability to raise funds as the main source of their competitiveness*" (Smith, 2000, p. 64). During the same period, the chaebol system showed increasing cracks, resulting in a growing share of non-performing loans and frequent government-sponsored bail-outs.[23]

Taiwan: Taiwan recorded trade deficits in all but two years during 1951-70 (the surpluses in 1964 and 1966, were merely 0.75% and 0.27% of GDP, respectively). Thereafter, the trade balance turned consistently positive, except during the oil shock (1974-75) and in 1980 which had a tiny deficit. The size of the surplus became especially remarkable in the 1980s: the annual net export-GDP ratio was a staggering 12% in 1982-88. Compared with Korea's, the Taiwanese SME played a more important role all along the process of industrialization. Nevertheless, the U-shaped trajectory of the Taiwanese SME share is reminiscent of that of Korea: the employment share of firms employing fewer than

[23] Park and Kim (1994, p. 212) note that "*...it was an open secret that Korea's commercial banks were awash in a sea of nonperforming loans.*" To remedy this situation, the government often identified healthy companies in the same chaebol and induced them to absorb the troubled companies in exchange for subsidies or preferential credit arrangements. For instance, in 1978 and 1986, Daewoo acquired at the government's request the Kyungnam enterprise, receiving in exchange preferential loans for 230 million USD and a transfer from the Korean Development Bank for 50 million dollars to bail out its shipbuilding activity that was in distress. This influx of money contributed significantly to the subsequent expansion of Daewoo. The Daewoo case is a good example of how credit arrangements were biased in favor of large chaebol.

100 persons fell from 58% in 1961 to 36% in 1971, and then went up again to 59% in 1991. This reversal was encouraged by policy changes, such as the plan of economic liberalization of 1984 (Smith 1997).

Although bank-firm ties were weaker than in Korea and mainland China, access to credit markets was highly unequal across Taiwanese firms. Public and large private enterprises satisfied more than 90% of their external borrowing from the formal financial sector, while SME had to rely on the informal curb market for a large fraction of their financial needs.[24] Shea (1994) reports that "*over the 1965-88 period the rate of loans from financial institutions relative to value added averaged 47 percent for public enterprises but only 29 percent for private enterprises*" (p. 242). This was largely due to an "*emphasis on collaterals rather than the profitability or productivity of the borrowers*" (p. 241). The interest in the informal lending market were more than twice as high as the bank lending rate for unsecured loans (see Smith, 1997, Table 6). Shea (1994) concludes that "*easier access to bank loans by public enterprises and large firms inevitably induced them to adopt more capital-intensive technologies, the result of which is a higher productivity for labor and a lower productivity for capital in larger enterprises relative to private and medium and small enterprises. If we could reallocate resources in such a way to shift some capital from public and large enterprises to private and medium and small enterprises... the total productivity of the whole economy might increase*" (p. 244). Given these premises, the growth in the share of credit-constrained SME during the 1980s contributed to productivity growth in Taiwan. Interestingly, the timing of reallocation coincides with the massive accumulation of foreign reserves.

Summary: In conclusion, in spite of important differences, the 1980s experiences of Korea and Taiwan share some commonalities with the recent development of China. All featured a pronounced reallocation within the manufacturing sector characterized by a strong growth of credit-constrained high-productivity firms. The reallocation was accompanied on the macroeconomic front by an acceleration in productivity growth and foreign surplus. These features are consistent with the predictions of our theory.

[24] The Taiwanese curb market consists of all borrowing and lending activities occurring outside of the supervision and regulation of monetary authorities. According to Smith (1997), private enterprises borrowed 35% of their external finance from such an informal market in the period 1981-87. In the same period, SME borrowed about four times as much from it as did large enterprises (see Smith, 2000, Table 4.3).

3.7 Financial Development

In section 3.4, we noted that the theory predicts falling investment rates during the transition. Different from a standard neoclassical growth model, the investment rate does not fall in our theory because of capital deepening bringing about decreasing returns. Rather, the fall is due to a composition effect: financially constrained firms – which have a lower capital-output ratio – expand, while financially unconstrained firms contract. However, in the Chinese experience there is no evidence of a falling investment rate: Bai *et al.* (2006) document that this rate has instead followed an U-shaped pattern over the period 1992-2006.

One way to reconcile our theory with the data is to introduce a mechanism that generates capital deepening within both E and F firms. A simple such mechanism is a reduction of financial frictions during the transition. This change is motivated by the observation that over the last decade the Chinese government has made considerable effort to improve the financial system. For instance, the lending market has been deregulated, allowing for both more competition and more flexibility in the pricing of loans.[25] A symptom of the improvement in the efficiency of the banking system is the sharp reduction in the ratio of non-performing loans.[26]

We incorporate financial development into our theory by letting the iceberg intermediation cost, ξ, fall over time: $R_t^l = R/(1-\xi_t)$. *Ceteris paribus*, a reduction in ξ and R_t^l pushes up wages and capital-labor ratios in both E and F firms. A sufficiently sharp reduction in ξ over time can offset the tendency for the investment rate to fall (and for the average rate of return to increase). A reduction of ξ slows transition via two channels: (i) it increases wages, which in turn strengthens the comparative advantage of F firms – entrepreneurs must save more to attract workers from F firms – and (ii) it reduces ρ_E and the saving rate of entrepreneurs.[27] We will return to the effects of financial development in the next section.

[25] Before 1996, banks in China had to lend at the official lending rate. In 1996, a reform allowed them to set the rate between 0.9 and 1.1 times the official rate. The upper limit gradually increased to 1.3 times for small and medium enterprises in the late 1990s and was eventually removed completely in 2004 (Podpiera, 2006). The increase in competition can also be seen in the loan share of the four major state-owned banks which fell from 61% in 1999 to 53% in 2004 and by the growing equity market.

[26] In state-owned banks, the non-performing loan ratio has fallen from 26% in 2002 to 10% in 2005. Although part of this improvement can be attributed to a government bail-out, this ratio for new loans after 2000 is reported to have fallen drastically compared with older loans (Podpiera, 2006).

[27] An alternative form of financial development would be a reduction of η, i.e., better credit market access for entrepreneurs. This would unambiguously speed up transition without affecting either capital intensity (κ_E) or wages. In China, there is no clear evidence that credit market access of DPE improved relative to SOE, see Figure 4.

4 Quantitative Analysis

We have focused so far on qualitative predictions of the theory. In this section, we show that a calibrated version of our theory can also account *quantitatively* for China's growth experience during 1992-2007. In particular, it captures the rise in private employment, the rise in foreign surplus and the U-shaped rates of investment and aggregate savings.

4.1 The Quantitative Multi-Period Model

Given the goal to match the theory with China's experience over the last fifteen years, a two-period OLG model, in which one period corresponds to thirty years, would be inadequate. Therefore, we extend our theory to an Auerbach-Kotlikoff OLG model, in which agents live T periods. Preferences are CRRA as in the model above, $U = \sum_{t=1}^{T} \beta^t \left((c_t)^{1-1/\theta} - 1 \right) / (1 - 1/\theta)$. Agents are born with zero wealth and cannot die with negative wealth. Workers supply one unit of labor each period. They retire after J years of work. Their lifetime budget constraint is $\sum_{t=1}^{T} R^{-t} c_t = \sum_{t=1}^{J} R^{-t} w_t$, where w_t is the wage in period t.

Young entrepreneurs work as managers for $T/2$ periods and as entrepreneurs for the remaining $T/2$ periods – in line with the two-period model above. During their management phase, they deposit their savings in banks. As they become entrepreneurs, they invest their accumulated wealth, $\sum_{t=1}^{T/2} R^{T/2-t} (m_t - c_t)$, in E firms. They borrow part of the capital from banks, as in the two-period model (see equation (7)). After becoming entrepreneurs, their budget constraint becomes

$$c_t + s_{E,t+1} = \frac{R_t^l \rho_{Et}}{R_t^l - \eta \rho_{Et}} s_{Et},$$

where the net return on equity, $R_t^l \rho_{Et} / \left(R_t^l - \eta \rho_{Et} \right)$, incorporates the gain from levering up equity by borrowing at a rate R_t^l.

Given an aggregate entrepreneurial capital K_{Et}, prices and aggregate allocations are determined as in the two-period model. However, capital no longer depreciates fully, so the law of motion for aggregate capital is $K_{t+1} = (1 - \delta) K_t + I_t$, where $\delta < 1$ denotes the constant depreciation rate. Equations (2), (4), (5) and (7) are unchanged, while equations (3), (6), (8) and (9) are modified to incorporate the new assumption that $\delta < 1$. To avoid the counterfactual prediction of declining investment rates, we follow the discussion in Section 3.7 and allow ξ_t to change over time due to financial development. Aggregate savings equal aggregate production minus consumption minus intermediation costs. Aggregate bank deposits is the aggregate financial wealth of workers, retirees and managers. The initial distribution of wealth is the only state variable. Given this, the model is solved by standard iteration on the sequence of wage rates $\{w_t\}_{t=0}^{\infty}$.[28]

4.2 Calibration

The calibration of our multi-period model focuses on matching empirical moments during 1998-2005 because this is the period covered by NBS. Some parameters are calibrated exogenously. The rest are estimated within the model.

Parameters Set Exogenously: One period is one year. Agents enter the economy at age 28 and live until 78 ($T = 50$). The average retirement age in China is 58, so workers retire after $J = 30$ years of work. The annual deposit rate is $R = 1 + 1.75\%$, which is the average one-year real deposit rate (deflated by the CPI) during 1998-2005. The capital share is set to $\alpha = 0.5$, consistent with Bai *et al.* (2006), and the annual depreciation rate of capital is set to $\delta = 10\%$. The annual population growth rate is set to $\nu = 3\%$, which is the average urban population growth during 1998-2005 (according to the World Bank's World Development Indicators). Finally, the intertemporal elasticity of substitution is set to $\theta = 2$.

Parameters Set Endogenously: The remaining parameters are estimated within in the model:

- The discount factor β is calibrated to match China's average aggregate saving rates during 1998-2005. This gives $\beta = 0.997$.

- Recall that SOE report to have a more than three times larger share of investments financed through bank loans than do DPE (Figure 4). Since DPE have some alternative sources of financing in addition to bank loans and withheld earnings, such as friends and family, we assume that E firms can finance externally half their investments. This implies a maximum share profits entrepreneurs can pledge to repay of $\eta = 0.86$.[29]

[28] Given a guess for $\{w_t\}_{t=0}^{\infty}$ and the initial wealth distribution, the prices and allocations are given by the modified version of (2)-(9) and the individuals' savings problems. Recall that in equilibrium w_t must be given by (2) as long as $N_{Et} < N_t$, and it is given by neoclassical dynamics after the end of the transition. If the implied allocations are consistent with the guess for $\{w_t\}_{t=0}^{\infty}$, then an equilibrium has been found. Otherwise, update the guess for $\{w_t\}_{t=0}^{\infty}$. Iterate until convergence.

[29] In the data, even SOE finance about half of their investments through internal savings (China Fixed Asset Investment Statistical Yearbook, various issues). However, this observation is *per se* no evidence of SOE being subject to large credit constraints. For our purposes, it is crucial that DPE be significantly *more* credit constrained than SOE. Therefore, we retain the convenient assumption that SOE are unconstrained.

- The parameters χ and ψ are set so as to match two empirical moments: (i) the capital-output ratio of Chinese SOE is 2.65 times larger than that of DPE (average 1998-2005); and (ii) the rate of return to capital is 9% higher among E firms than F firms (in line with Figure 3 and Islam *et al.*, 2006). This yields $\chi = 4.79$ and $\psi = 0.45$. This calibration implies a TFP gap of 2.2, which is in the upper end of the range of the estimates in the literature discussed in Section 2.[30]

- The initial iceberg intermediation cost ξ is set so that the gross aggregate rate of return to capital is 20% in the 1990s (in line with the estimates of Bai *et al.*, 2006). This implies that $\rho_F = 9.3\%$, $\rho_E = 18.3\%$ and $\xi_t = \xi = 0.069$ for $1992 \leq t < 2000$. For $t \geq 2000$, the sequence of intermediation costs $\{\xi_t\}_{t=2000}^{\infty}$ is calibrated so as to best fit, given the other calibrated parameters, the behavior of aggregate investment. In particular, we assume that $\xi_t = 0$ for $t \geq 2020$ and set $\xi_t = (1 - ((t - 2000)/19)^{\upsilon})\,\xi$ for $t \in [2000, 2019]$, where $\upsilon = 2.38$ is set to match the aggregate investment rate in 2007. The $\rho_{F,t}$ implied by the assumed sequence of ξ_t is illustrated in panel 1 of Figure 8.

- The rate of secular labor-augmenting technical progress is set to $z = 3.8\%$ so as to target an annual 11.2% output growth rate over 1998-2005. This is slightly lower than the output growth rate of China's urban areas (based on the 35 largest cities, 11.7%) and slightly higher than the growth rate of industrial output (10.4%).

Initial Conditions: The initial entrepreneurial wealth is set so as to match the average DPE employment share during 1998-2005. This yields a 1992 E firm employment share of 3%, which is close to the empirical observation. The initial life-cycle distribution of wealth for managers and entrepreneurs is similar to a scaled-up version of the distribution of wealth over the life cycle for workers in the initial steady state. The initial assets of the workers and retirees are set to 60% of the wealth in a steady state where there are only F firms. This ensures that the model matches China's net foreign surplus-to-GDP ratio in 1992.

FIGURE 8 HERE

[30] The comparison between TFP in the model and in the data is complicated by the peculiar technology of our E firms. An income-based TFP calculation that excluded the payments to management would yield a TFP gap of 1.62. Given this ambiguity, we chose to calibrate χ so as to match the observed rates of return to capital rather than matching TFP differences.

4.3 Results

The dynamics of the calibrated multi-period economy are illustrated in Figure 8. Panels 2-6 display various salient macroeconomic outcomes of the model versus the data.

First of all, the calibrated economy generates a speed of employment reallocation comparable to its empirical counterpart (panel 2). Second, the aggregate saving rate (panel 3) tracks remarkably well the U-shaped dynamics of the Chinese aggregate saving rate. Recall that the economy is calibrated to match the *average* saving rate, but not its time path. The decline during the 1990s is due to the assumption of low initial wealth of workers, implying that they save a lot initially. The rise after 2000 is driven by the fast reallocation towards E firms, the managers of which have high saving rates. This is the mechanism driving increased savings in the two-period model (Figure 7). Third, the calibrated model matches closely the trend of the net foreign surplus (panel 5), although the predicted growth is slightly too high in 1998-2002 and slightly too low in 2003-2007. Since the model matches the saving rate, its success in this dimension hinges on predicting accurately the investment rate (panel 4). This was not a calibration target because ξ_t determines the investment's dynamics, not its level. Interestingly, the model predicts an acceleration in the foreign surplus from 2007 onwards. This is driven by a continued increase in the saving rate and a declining investment rate.

Consider now the evolution of aggregate TFP, computed as a standard Solow residual of a one-sector aggregate production function using aggregate capital and labor as inputs. This is plotted in panel 6. The 1998-2005 annualized growth rate is 5.9%. This is in the range of the estimates from empirical productivity studies. Bosworth and Collins (2008) estimate a TFP growth rate in industry of 6.1% over the period 1993-2004. Brandt *et al.* (2009) report estimates of the annual TFP growth of 4% and 7.7%.[31]

We can decompose the TFP growth rate into one part due to exogenous technical change and another part due to reallocation. Reallocation yields 4.2% annual TFP growth. Thus, about 70% of the 1998-2005 TFP growth in our model is driven by reallocation from old, inefficient F firms to new, and more efficient E firms. This large effect is broadly consistent with the findings of Brandt *et al.* (2009), who estimate that between 42% and 67% of the aggregate TFP growth in Chinese manufacturing was due to productivity differences between firms entering and exiting during 1998-2005. They

[31] Brandt *et al.* (2009) use the NBS. The 4% estimate is obtained by calculating the difference between the weighted average productivity level of all firms active in 2006 and in 1998 (Table 7). The 7.7% estimate is the authors' "preferred estimate" found by averaging year-to-year productivity growth over the entire sample of firms (Figure 3).

also document that SOE and collectively owned enterprises represent the lion's share of exiting firms, while most that enter are DPE. See their Figure 1.[32] However, our model implies a substantially larger gain from reallocation than what Hsieh and Klenow (2009) estimate; they find an annual TFP growth gain from reallocation between Chinese manufacturing firms of 2%. Finally, the model predicts an increasing TFP growth over time (panel 6). This is also consistent with Brandt *et al.* (2009), who find an even steeper increase in the growth rate than predicted by our model.

Finally, our model implies an average wage growth of 5% per year, which is resonable. See footnote 2 for a detailed comparison with the data. In the model, wage growth arises from both technical change and capital deepening. The assumption of a competitive and frictionless labor market implies that during transition the growth of DPE has no effect on wages. Introducing frictions may deliver higher wage growth.

The most problematic feature of our calibration concerns the average rates of return within SOE and within DPE. In the calibration these rates fall due to financial development (recall that ρ_F and ρ_E would be constant in the absence of financial development). However, Figure 3 suggests that both rates of return increased during 1998-2005. This hints at the presence of additional sources of efficiency gains within SOE and DPE that offset the decreasing returns. In part, this discrepancy can be related to the stark way in which we have mapped the theory into the data. In particular, we have interpreted F and E firms as SOE and DPE, respectively, abstracting from within-group heterogeneity. Since our theory emphasizes reallocation across firms of heterogeneous productivities, it is natural to expect that some reallocation took place within each group, e.g., through the exit of less productive SOE and DPE. A simple extension of our theory where entrepreneurs differ in human capital and productivity (i.e., with a distribution of χ_i across E firms) would be consistent with the observation of an increasing return to capital within DPE. Intuitively, since the growth of E firms is constrained by retained earnings, more productive E firms would grow faster, causing an increase of the average productivity of E firms over time.[33] No such straightforward extension works for F firms, since there can

[32] Brandt *et al.* (2009) conclude that "relative to the U.S. experience, productivity growth in China's manufacturing sector is to a much greater extent due to changes at the extensive margin, entry and exit." In our model, the number of firms is indeterminate, due to constant returns to scale. Thus, we cannot distinguish between reallocation along an extensive and an intensive margin. Therefore, our measure of reallocation should be compared with the sum of these two margins.

[33] Let χ_i denote firm i's productivity and K_i be the corresponding capital stock. Then, the rate of return to capital for firm i is $\rho_{iE} = (1-\psi)^{\frac{1}{\alpha}} \chi_i^{\frac{1-\alpha}{\alpha}} R^l$. If $\rho_{Et} = \sum \rho_{iE} K_{it}/K_{Et}$ denotes the average rate of return of E firms, it is easy to show that ρ_E grows over time, because the growth rate of K_{it} is increasing in χ_i. Intuitively, more efficient E firms have higher earnings and can finance larger

be no productivity differences across them in equilibrium. This is due to the simplifying assumption that F firms are subject to no credit constraints. In principle, one could relax this assumption and generate reallocation within SOE. We do not pursue this extension. Instead, in the next section we explore an alternative multi-industry setup in which F firms have market power in some industries. This extension predicts increasing profit rates in surviving SOE.

In conclusion, this calibration exercise has shown that reallocation from F firms to E firms can generate quantitative outcomes that are broadly in line with the empirical facts for China, suggesting that our mechanism might be important for understanding the empirical facts laid out in section 2.

4.4 Robustness

To illustrate the behavior of the model we examine four alternative parametrizations: (1) no financial development, (2) no borrowing for entrepreneurs, (3) log preferences, and (4) low TFP advantage. In each case we change β so as to match the average aggregate saving rates during 1998-2005, as we did in the benchmark calibration. Suppose first that there is no financial development. This case is labeled experiment 1 and is plotted against the benchmark calibration in Figure 9. The dynamics of the no-financial-development economy are very similar to those of the benchmark economy until 1999. As can be anticipated from the discussion in Section 3.7, the investment rate in this experiment falls monotonically during the transition and increases sharply when the transition is completed. The transition is faster than in the benchmark economy because F firms are not able to borrow at lower and lower interest rates after 1999. Thus, without financial development the foreign reserves and TFP would grow substantially faster after 1999.

FIGURE 9 HERE

Consider now the case when entrepreneurs cannot borrow at all, i.e., $\eta = 0$ (experiment 2 in Figure 9). For simplicity, we maintain the assumption that ξ_t is constant (no financial development). The key difference relative to the benchmark economy is that the transition is slower. For example, the E firm employment share reaches 20% in 2015, while in the benchmark this level is reached already in 2000. Consequently, both

investments. So they grow faster than less efficient firms, thereby increasing the average rate of return of DPEs over time. We develop this extension in the Appendix.

the growth in foreign surplus and TFP are substantially slower than in the benchmark economy. The foreign reserves-to-GDP ratio, for instance, only starts to grow after 2000 and then gradually climbs up to 25% in 2017 and 50% in 2021.

To examine the role of intertemporal elasticity to substitution θ we solve the model for $\theta \to 1$, i.e. logarithmic preferences (experiment 3 in Figure 9). We also recalibrated the sequence $\{\xi_t\}_{t=2000}^{\infty}$ so as to match the investment rate in 2007 (recall that the benchmark economy was calibrated in the same way). The results are qualitatively similar to the benchmark case, including a growing foreign surplus. However, the rate of transition is substantially slower. The lower rate of transition implies a higher investment rate and a lower growth of foreign reserves and TFP. The two-period OLG model provides intuition for the slow transition. The entrepreneurs' savings rate ζ^E is lower when θ is lower and Lemma 2 showed that in the analytical model the speed of transition is increasing in ζ^E.

Finally, suppose the TFP advantage of E firms is low, $\chi^{1-\alpha} = 2.0$, compared to 2.2 in the benchmark calibration. This implies a smaller difference $\rho_E - \rho_F$ and a smaller difference between capital-output ratios of E firms and F firms than in the benchmark calibration. This in turn implies a slower transition because entrepreneurial firms are less profitable. To understand why, recall that a lower χ imply a lower return ρ_E. This in turn lowers the rate of transition because entrepreneurs and managers have less income and, hence, less savings. Quantitatively, the low-χ economy is similar to experiment 3, so we omitted it from Figure 9.

5 A Two-Sector Model

In this section, we extend the model to a two-sector environment in which industries have different capital intensities. In such an environment, credit-market discrimination generates an endogenous comparative advantage for E firms in labor-intensive industries, leading them to specialize in labor-intensive industries, and induces F firms to retreat to capital-intensive industries. This prediction is consistent with the empirical evidence of China, where the share of SOE has declined dramatically in labor-intensive industries, while it is still high in capital-intensive industries (Section 2). The retreat from labor-intensive industries has further widened the gap between the capital-output ratio of SOE and that of private firms since the mid-1990s (Dekle and Vandenbroucke, 2006).

For simplicity, we specialize the analysis to logarithmic utility and assume that $\eta = 0$; i.e., entrepreneurs cannot get any external financing. Moreover, we assume that $\nu = \xi = z = 0$. None of these assumptions is essential for the results.

5.1 Capital- and Labor-Intensive Industries

In this section, we assume the final good, Y_t, to be a CES aggregate of two intermediate goods:

$$Y_t = \left(\varphi \left(Y_t^k\right)^{\frac{\sigma-1}{\sigma}} + \left(Y_t^l\right)^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}. \tag{15}$$

The superscripts k and l stand for capital- and labor-intensive intermediate goods, respectively, and σ is the elasticity of substitution between these goods. Both goods can be produced by either E or F firms, with the following technologies:

$$y_J^l = \left(A_J^l\right)^{1-\alpha} \left(k_J^l\right)^{\alpha} \left(n_J^l\right)^{1-\alpha}, \qquad y_J^k = \left(A_J^k\right)^{1-\alpha} k_J^k, \tag{16}$$

where $J \in \{E, F\}$. The production technology for the labor-intensive good is identical to that of our benchmark model. The assumption that the capital-intensive good is produced without labor is for convenience. We assume the same TFP gap between E and F firms in the two industries. More formally, $\chi \equiv A_E^k/A_F^k = A_E^l/A_F^l$. Raising both A_J^k and A_J^l to the power of $1-\alpha$ ensures that the TFP gap is the same across industries.

We set the final good to be the *numeràire*. Profit maximization of final producers subject to (15) yields that

$$\frac{Y^k}{Y^l} = \left(\varphi \frac{P^l}{P^k}\right)^{\sigma}, \tag{17}$$

where P^k and P^l are goods prices. The standard price aggregation holds:

$$\left(\varphi^{\sigma} \left(P^k\right)^{1-\sigma} + \left(P^l\right)^{1-\sigma}\right)^{\frac{1}{1-\sigma}} = 1. \tag{18}$$

When F firms are active in the production of the labor-intensive good, they behave as in the benchmark model of section 3. In particular, the following analogues of equations (2) and (8) hold:

$$w = P_t^l (1-\alpha) A_F^l \left(\kappa_F^l\right)^{\alpha}, \tag{19}$$

$$\kappa_F^l = \left(\frac{P^l \alpha}{R}\right)^{\frac{1}{1-\alpha}}. \tag{20}$$

In addition, when F firms are active in the production of the capital-intensive good, perfect competition pins down its price level:

$$P^k \left(A_F^k\right)^{1-\alpha} = R. \tag{21}$$

Given these equilibrium conditions, we can determine the return E firms require to invest in each industry. The following lemma characterizes the patterns of specialization of F and E firms. Recall that K_{Et} is predetermined by the entrepreneurial savings.

Lemma 4 *(i) If, in period t,* $K_{Ft}^l > 0$ *and* $K_{Ft}^k > 0$*, then* $\rho_{Et}^l > \rho_{Et}^k$*, implying that* $K_{Et}^l = K_{Et}$ *and* $K_{Et}^k = 0$*. (ii) If, in period t,* $K_{Et}^l > 0$ *and* $K_{Et}^k > 0$*, then* $R \geq \rho_{Ft}^k > \rho_{Ft}^l$*, implying that* $K_{Ft}^l = 0$ *and* $K_{Ft}^k \geq 0$*.*

Lemma 4 characterizes the dynamics of the equilibrium in the two-sector model. There are four distinct stages of the transition:

- **Stage 1**: Only F firms invest in the capital-intensive sector, while both E and F firms invest in the labor-intensive sector. The employment share of F firms declines as entrepreneurial investment increases. Consequently, the employment share of F firms decreases over time in the labor-intensive industry. However, the capital-intensive good is produced only by F firms. This is consistent with the retreat of Chinese SOE from labor-intensive industries. Due to this specialization in the capital-intensive industry, the average capital-output ratio of F firms increases during the transition, consistent again with the Chinese evidence. Eventually, F firms completely abandon the labor-intensive activity.

- **Stage 2**: All workers are employed by E firms. Entrepreneurs continue to invest their savings in the labor-intensive sector since it yields a higher return than do both foreign bonds and investment in the capital-intensive industry. However, the labor-intensive sector's rate of return falls over time, because employment cannot grow, and investment leads to capital deepening. Consequently, wages grow. Eventually, the incentive to accumulate capital in the labor-intensive industry comes to a halt. If $\chi^{1-\alpha} > \alpha (1+\beta) / (\beta\psi R)$, entrepreneurs turn to the capital-intensive industry and the economy enters stage 3. If $\chi^{1-\alpha} < \alpha (1+\beta) / (\beta\psi R)$, the economic transition stops and the capital-intensive industry remains dominated by F firms, in spite of their lower productivity.

- **Stage 3**: The investment of E firms in the capital-intensive industry causes the progressive disappearance of F firms. Eventually, no F firms are left, even in the capital-intensive industry.

- **Stage 4**: The economy enters the post-transition equilibrium of section 3.5.

Table 2 summarizes the main features of each of the four stages of the transition. The complete characterization of the equilibrium can be found in the Appendix.

Table 2: Investment Patterns in E and F Firms, across Transition Stages

	Stage 1		Stage 2		Stage 3		Stage 4	
Industry	E	F	E	F	E	F	E	F
Labor-intensive	Yes	Yes	Yes	No	Yes	No	Yes	No
Capital-intensive	No	Yes	No	Yes	Yes	Yes	Yes	No

In conclusion, this extension of our benchmark model has shown that the presence of asymmetric credit frictions generates comparative advantages for credit-constrained firms to specialize in labor-intensive activities. Since the growth of E firms is only gradual, we see F firms first withdrawing from labor-intensive industries and then, possibly, from capital-intensive industries. The theory also offers the interesting possibility that E firms never take over capital-intensive industries. The steady state may be characterized by high-productivity firms in labor-intensive industries and low-productivity firms in capital-intensive industries.

5.2 Monopoly in the Capital-Intensive Industry

As discussed in section 4.3, there is evidence that profits have increased over time in surviving SOE. This may seem puzzling since a large number of SOE have been declining. In this section, we extend the two-sector model and assume that the labor-intensive industry is competitive, while the capital-intensive industry is monopolized by a large F firm. With this setup, the theory predicts that as the transition proceeds, the increased efficiency in the labor-intensive industry increases the profit of the monopolist F firm.

The assumption that SOE have market power in capital-intensive industries is consistent with the industrial policy in China. Since 1997, under the slogan "Zhuada Fangxiao" ("grab the big ones and release the small ones"), the Ninth Five-Year Plan exposed SOE to competition in labor-intensive industries, while promoting the merger and restructuring of SOE in strategic capital-intensive sectors – e.g., petrochemicals, railway and telecommunication – into large trans-regional groups.[34] This strategy gave surviving SOE a significant monopoly power in their industries. Arguably, this has been a main reason why SOE profits have soared over the last ten years (Figure 3).

Without loss of generality, we normalize $A_F^k = 1$. Moreover, to guarantee that the problem of the monopolist is well defined, we assume that $\sigma > 1$. The model is identical to the two-sector model of section 5.1, except that the capital-intensive sector is now a

[34] By the end of 2001, there were 179 Chinese enterprises with value added over 500 million USD. Of them, 165 were state-owned or state-controlled groups. The stated objective of the policy was to help large SOE be competitive internationally like *chaebol* in Korea.

legal monopoly. We assume the monopoly firm to be one-period lived, and to be owned by a set of old agents ("bureaucrats") who are neither workers nor entrepreneurs, and who neither produce nor consume in the first period of their lives. This implies that the monopoly has a static objective function.[35]

Formally, the equilibrium allocation differs from the competitive equilibrium of section 5.1 in two respects. First, $y_E^k = 0$, since E firms cannot enter the capital-intensive industry. Second, equation (21) does not hold, since there is no competition driving profits to zero in the capital-intensive industry. Instead, P^k is determined by the profit-maximizing choice of a price-setting monopolist, $\max_{P^k} \Pi_t^k \equiv \left(P_t^k - R\right) K^k$, subject to technology (16) and the equilibrium conditions (17), (18) and (20).

Proposition 2 *The optimal markup set by the monopolist in the capital-intensive industry, P^k/R, is the unique solution satisfying the following condition:*

$$\left(\sigma \left(\frac{P_t^k}{R}\right)^{-1} - (\sigma - 1)\right) = \left(1 - \left(\frac{P_t^k}{R}\right)^{-1}\right) \left(\sigma - 1 + \frac{1}{1-\alpha} \frac{Y_{Ft}^l}{Y_t^l}\right) \frac{\varphi^\sigma R^{1-\sigma} \left(P^k/R\right)^{1-\sigma}}{1 - \varphi^\sigma R^{1-\sigma} \left(P^k/R\right)^{1-\sigma}}. \tag{22}$$

The optimal markup is decreasing in the share of F firms (Y_F^l/Y^l) in the labor-intensive industry. Thus, monopoly power increases during a transition in which the share of F firms declines in the labor-intensive industry.

Note that the left-hand side of (22) is decreasing in P^k/R, while the right-hand side is increasing in P^k. This guarantees that (22) pins down the unique equilibrium solution. Since the right side is increasing in Y_F^l/Y^l, it is then immediate to establish that the markup is decreasing in the share of F firms in the labor-intensive industry. Intuitively, as the productivity of the labor-intensive industry increases during the transition, so does the demand for the capital-intensive good, which strengthens the power of the monopolist.[36]

[35] Since F firms have no equity capital and perfect access to external finance, they face no dynamic investment problem. However, a long-lived monopoly could use its market power to affect the speed of transition, which in turn would affect its future profits. This is an artifact of the assumption (which is made for simplicity) that there is only one large monopolized industry in the economy. If there were a continuum of monopolized industries, each firm would maximize its period-by-period monopoly profit, and the results would be identical to those in this section.

[36] A closed-form solution obtains as $\sigma \to 1$ (Cobb-Douglas). Then, $P^k/R = 1 + (1-\alpha)(1-\varphi) / \left(\varphi Y_{Ft}^l / Y_t^l\right)$. Note that in this particular case the markup goes to infinity as the share of F firms goes to zero, due to the unit demand elasticity.

6 Conclusions

In this paper, we have constructed a neoclassical model augmented with financial and contractual imperfections that asymmetrically affect different types of firms in the economy. The model is consistent with salient patterns of the recent Chinese experience, most notably sustained high returns on investment in spite of high capital accumulation, large productivity differences across firms, reallocation from low-productivity to high-productivity firms (as documented by Hsieh and Klenow, 2009) and the accumulation of a large foreign surplus. A calibrated version of the model has been shown to be quantitatively consistent with these facts.

A number of simplifications that were made for the sake of tractability will be relaxed in future research. In particular, we do not explore in depth potential determinants of the high household savings in China. Theories of entrepreneurial savings with financial constraints such as Quadrini (1999) and Cagetti and De Nardi (2006) could add new insights to reinforce and complement the mechanism of our theory. Moreover, by assuming an exogenous rate of TFP growth, we have abstracted from endogenous technology adoption, which may be an important driver of China's performance.

In spite of these limitations, we believe the theory explored here offers a useful tool for understanding one of the major puzzles of the recent growth experience: how is it that China grows at such a stellar rate and at the same time increases its foreign surplus? Some commentators have tried to explain this puzzle by attributing it to government manipulation of the exchange rate that holds the value of the Chinese currency artificially low. While it is difficult to falsify theories that rely on such non-economic mechanisms, in this paper we have provided substantial empirical evidence that corroborate the economic mechanism of our theory.

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Table

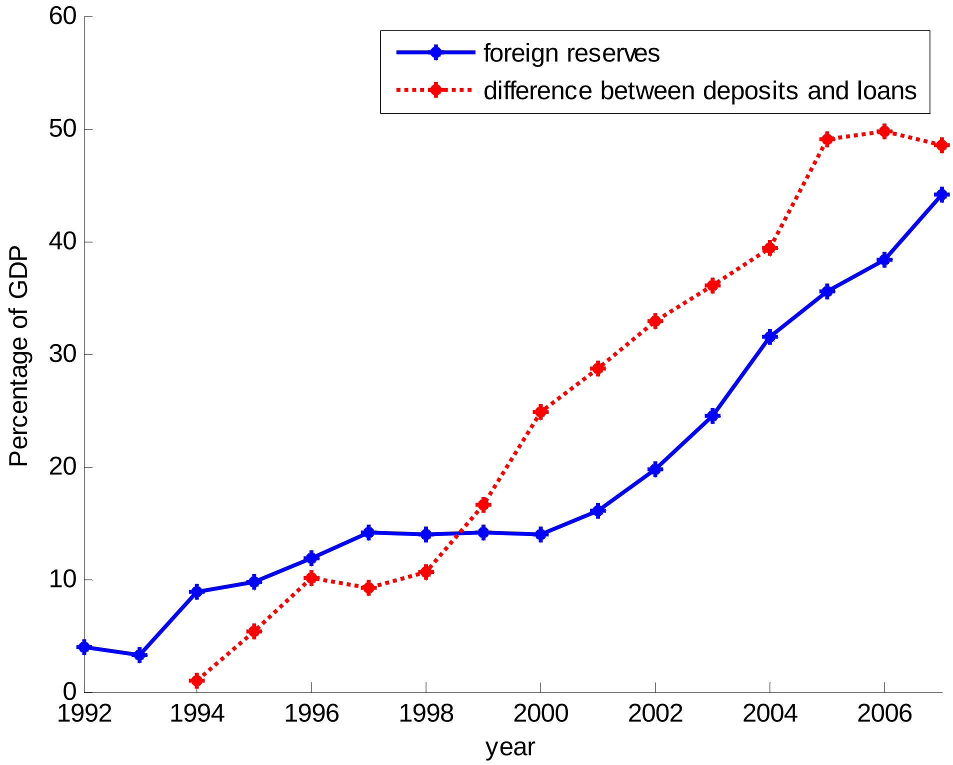
Dep. Variable	(S-I)/GDP		Growth Rate of GDP p.c.		Growth Rate of VA p.w.	
	(1)	(2)	(3)	(4)	(5)	(6)
D.($EMPL^{PRIV}$)	0.9964**	0.8920*	0.1893***	0.1903***	-	-
	(0.4889)	(0.4659)	(0.0603)	(0.0610)		
D.($EMPL^{NONSOE}$)	-	-	-	-	1.4257***	1.5973***
					(0.4785)	(0.3572)
L.(GDP p.c.)	-	6.6268***	-	-0.0646	-	-
		(2.3952)		(0.2136)		
L.(VA p.w.)	-	-	-	-	-	0.1283***
						(0.0152)
Year Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	124	124	124	124	112	112
R^2	0.0424	0.1984	0.2252	0.2258	0.2104	0.2577

(1) Dependent variables: (S-I)/GDP*100 is the provincial ratio of net surplus over GDP. S and I stand for aggregate savings and investment, respectively. S=GDP-C-G, where C and G are household consumption and government consumption expenditures, respectively. GDP p.c. is the real provincial GDP per capita in the value of 10 thousand RMB (adjusted by provincial GDP deflators). VA p.w. is the industry value-added per worker (10 thousand RMB). Growth rates are in percent.

(2) Regressors: $EMPL^{PRIV}$ is equal to DPE/(DPE+SOE)*100, i.e., the ratio of private employment over the sum of private and state employment. $EMPL^{NONSOE}$ is equal to (1-SOE/Total)*100, i.e., the ratio of non-SOE employment over total employment. D.(.) and L.(.) stands for the difference and the one-period lag, respectively.

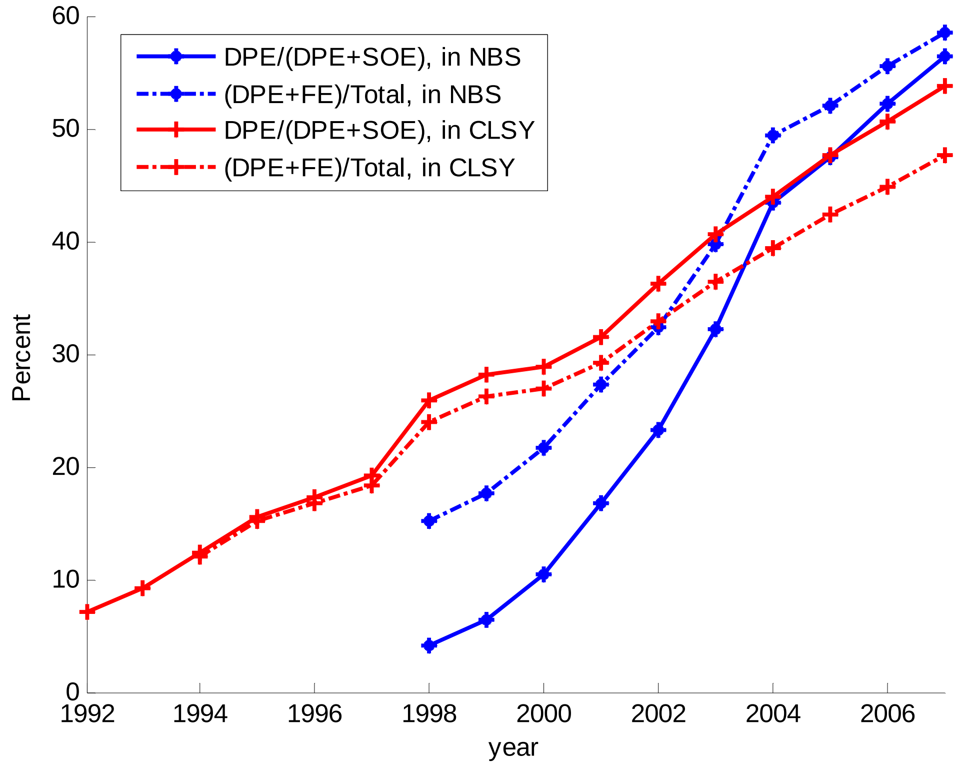
(3) Standard errors clustered at the province or industry level. Robust standard errors are in brackets. ***, ** and * is significant at 1%, 5% and 10%, respectively.

Figure 1 Foreign Reserves and the Difference between Deposits and Loans



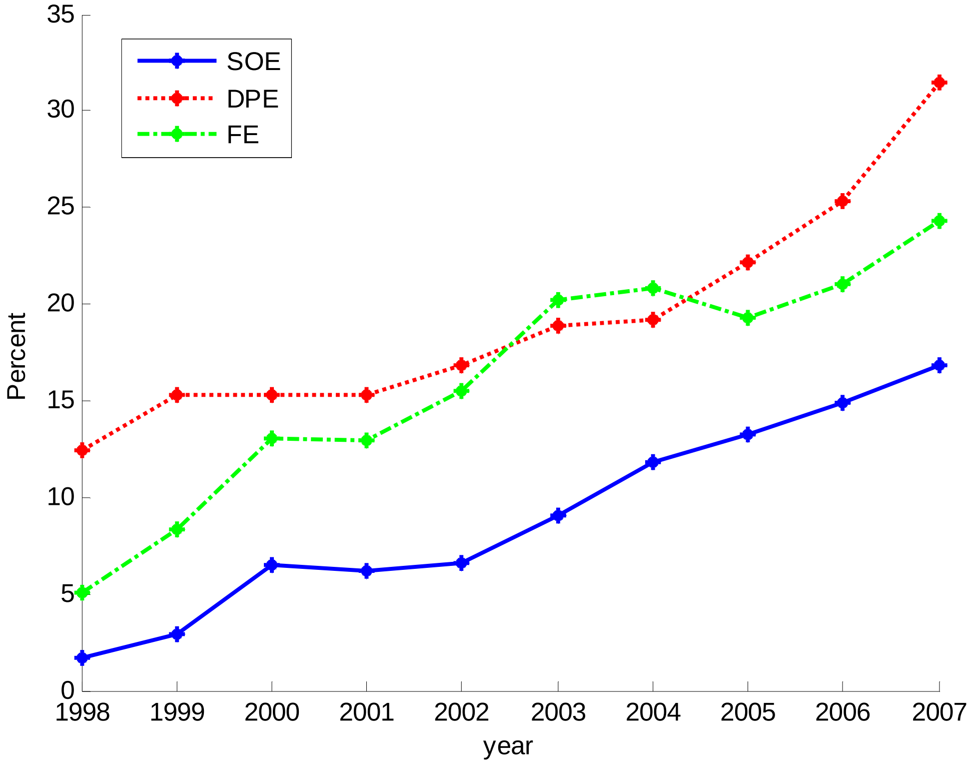
The figure plots China's foreign reserves (solid line) and the domestic bank deposits minus domestic loans (dotted line), both expressed as a percentage of GDP. Data source: CSY, various issues.

Figure 2 Private Employment Share



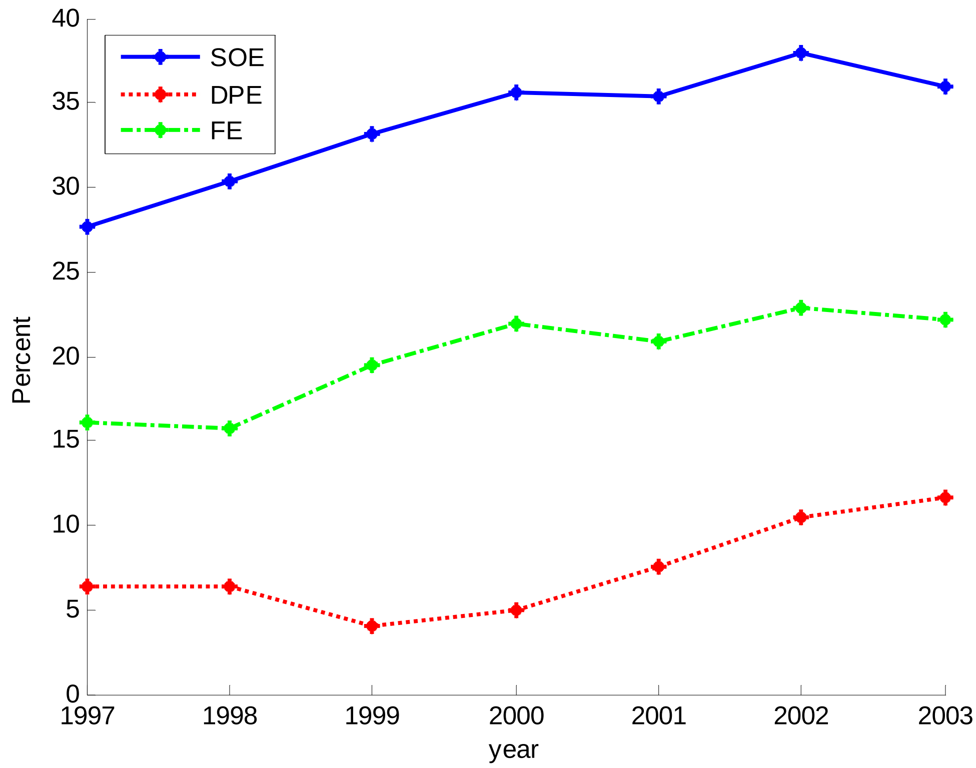
The figure shows, first, the DPE share of employment as a share of SOE+DPE employment in manufacturing (NBS, 1998-2007) and in the urban sector (CLSY, 1992-2007). Second, it plots DPE+FE employment as a share of total employment in manufacturing (NBS, 1998-2007) and in the urban sector (CLSY, 1992-2007). Data source: CSY and CLSY, various issues.

Figure 3 Total Profits over Net Value of Fixed Assets



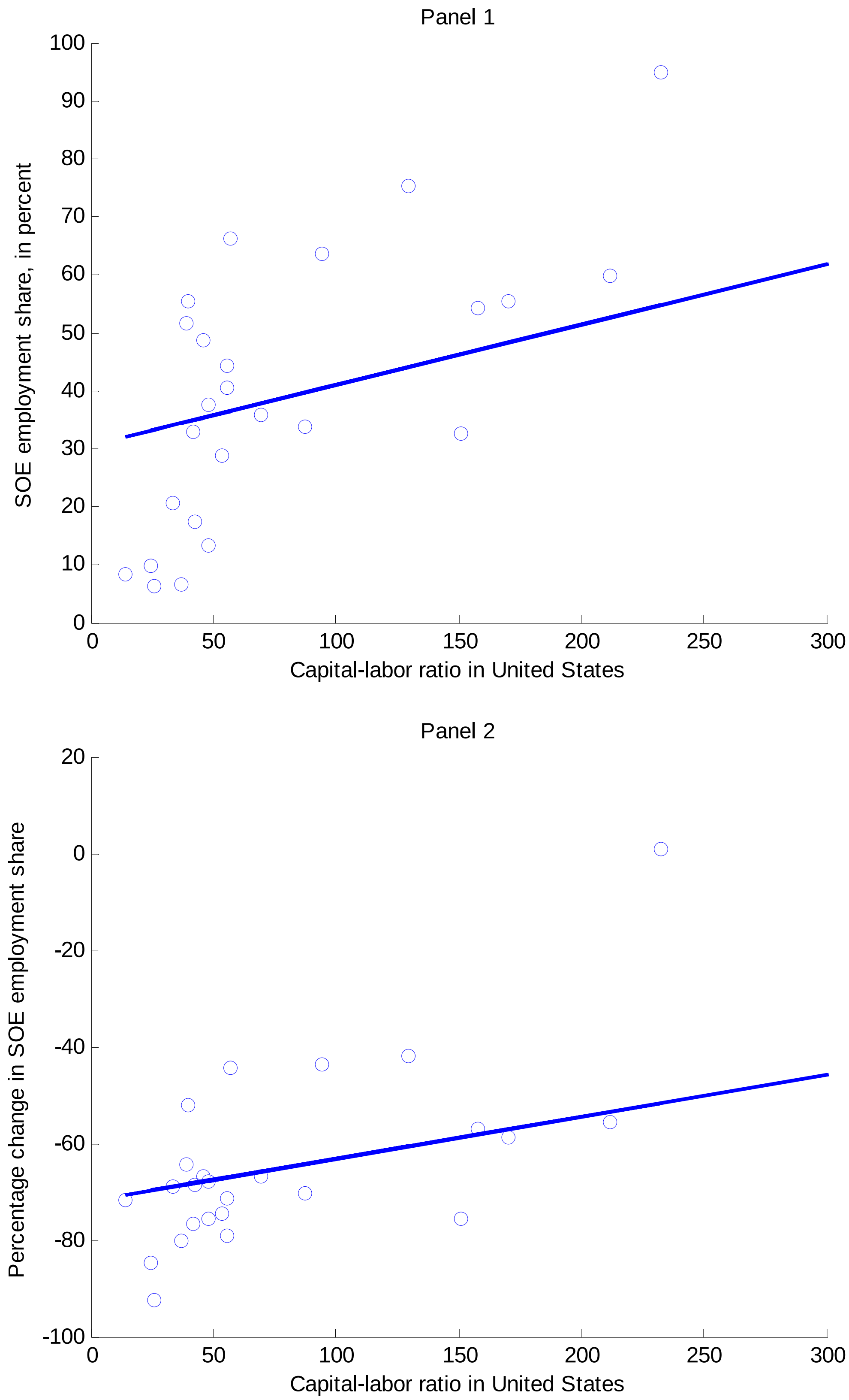
The figure plots the average ratio between total profits and the book value of fixed assets across firms of different ownership, in percent. Data source: CSY, various issues.

Figure 4 Share of Investment Financed by Bank Loans and Government Budgets



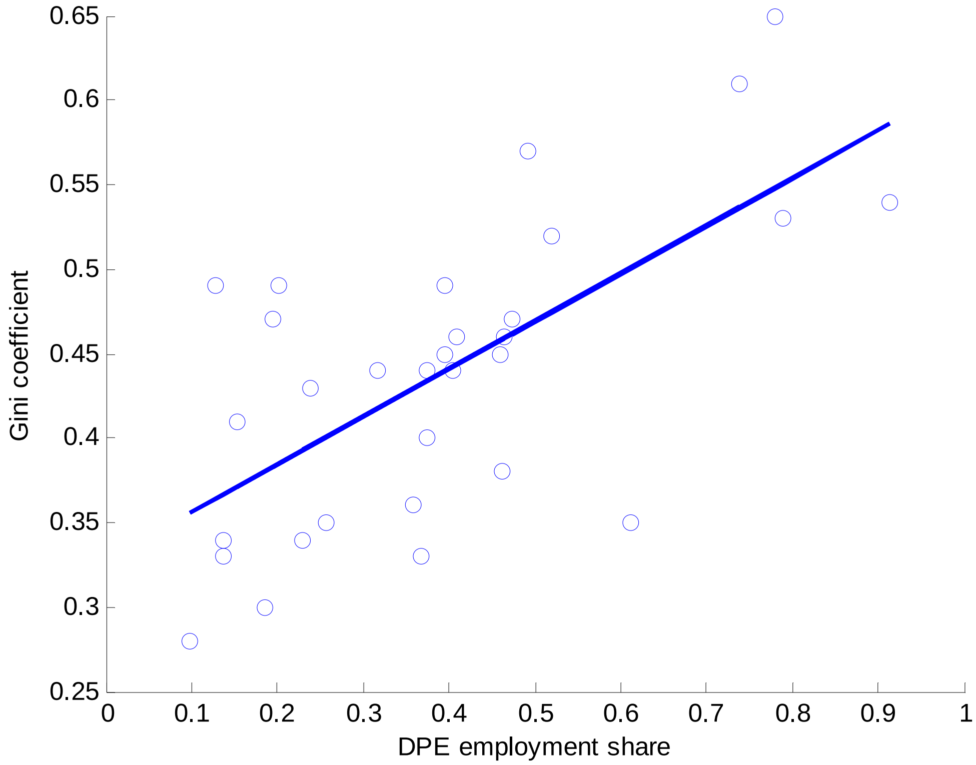
The figure plots the average share of investment financed by bank loans and government subsidies across firms of different ownership, in percent. Date source: CSY 1998 to 2001 and 2003, China Economy & Trade Statistical Yearbook 2002 and 2004.

Figure 5 SOE Employment Shares across Industries



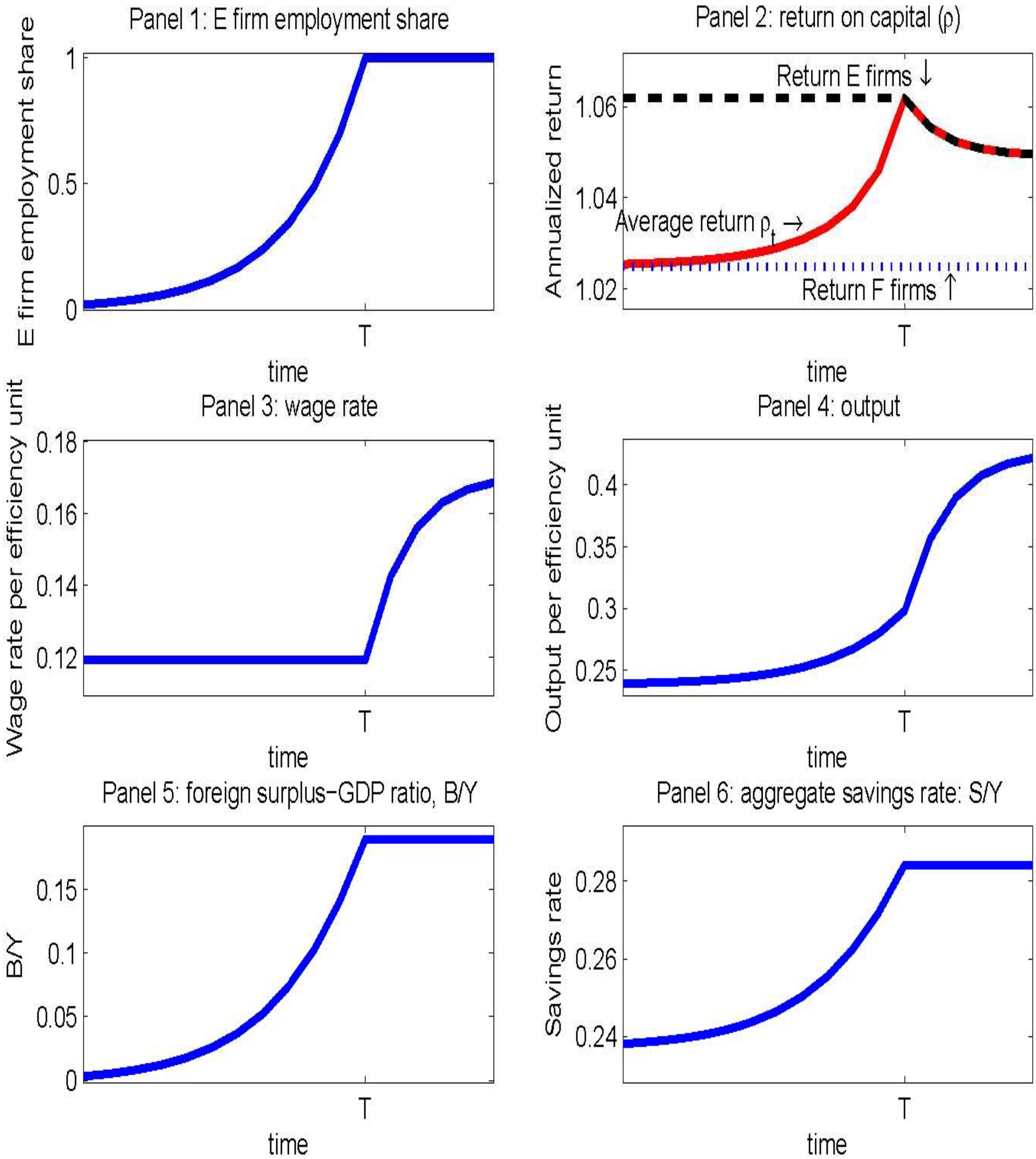
Panel 1 plots the 2001 employment share (in percent) of SOE in 28 major Chinese manufacturing industries against their respective capital-labor ratio in the United States. Panel 2 plots the change in SOE employment share (in percent) for these 28 industries between 2001 and 2007. Data source: CIESY and CSY, various issues. We use the 1996 US capital-labor ratios, computed from NBER-CES Manufacturing Industry Database. The industry Petroleum and Coal Products has extremely high capital labor ratio and is excluded from the figures for visual convenience.

Figure 6 Income Inequality and Private Employment Shares across Provinces



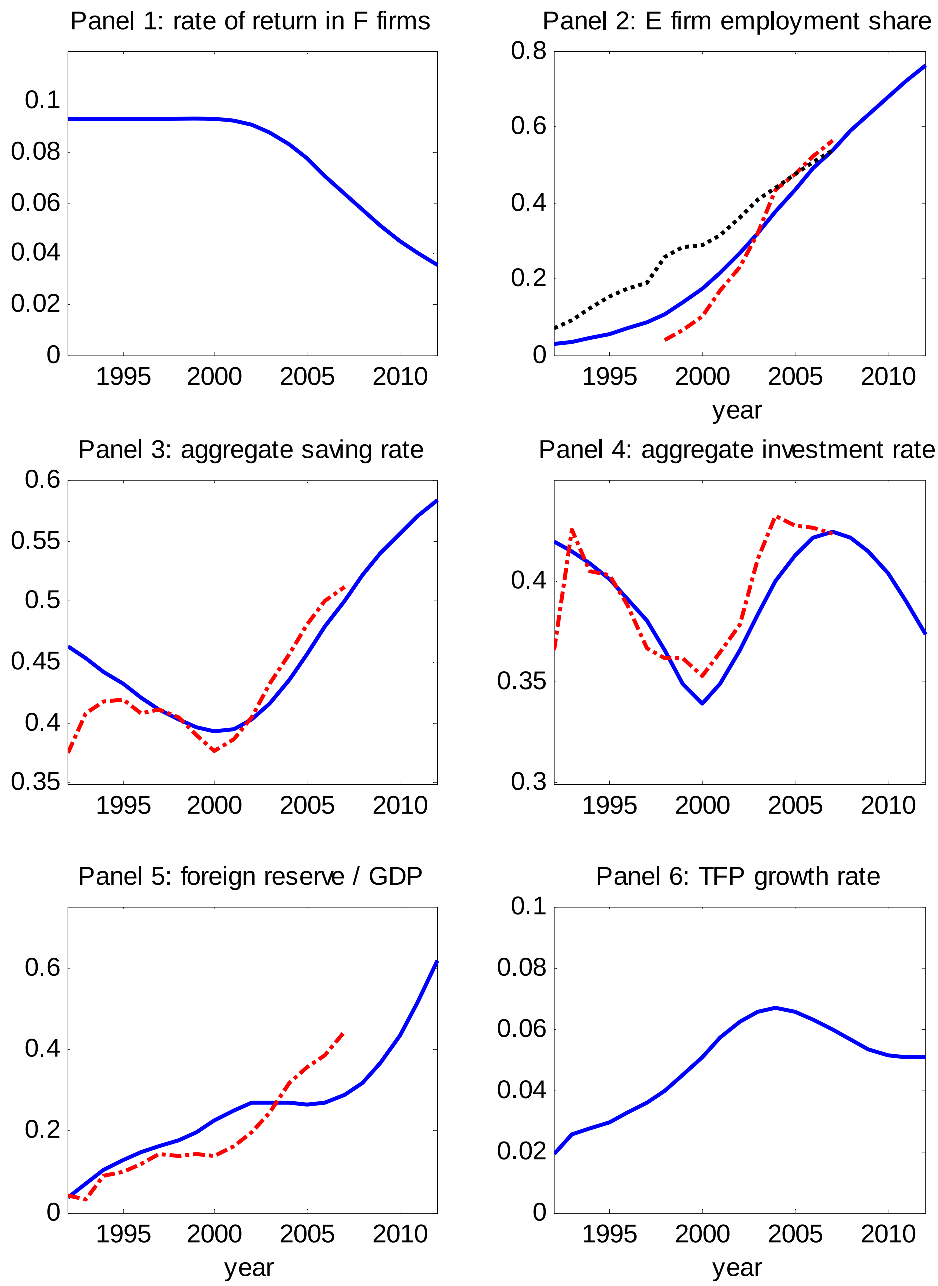
The figure plots the Gini coefficient of income against the DPE employment share across 31 Chinese provinces in 2006. The DPE share is computed as DPE/(DPE+SOE). Data source: CIESY 2007. Provincial Gini is from Report to the Seventeenth National Congress of the Communist Party of China.

Figure 7 Transition in the Analytical Model



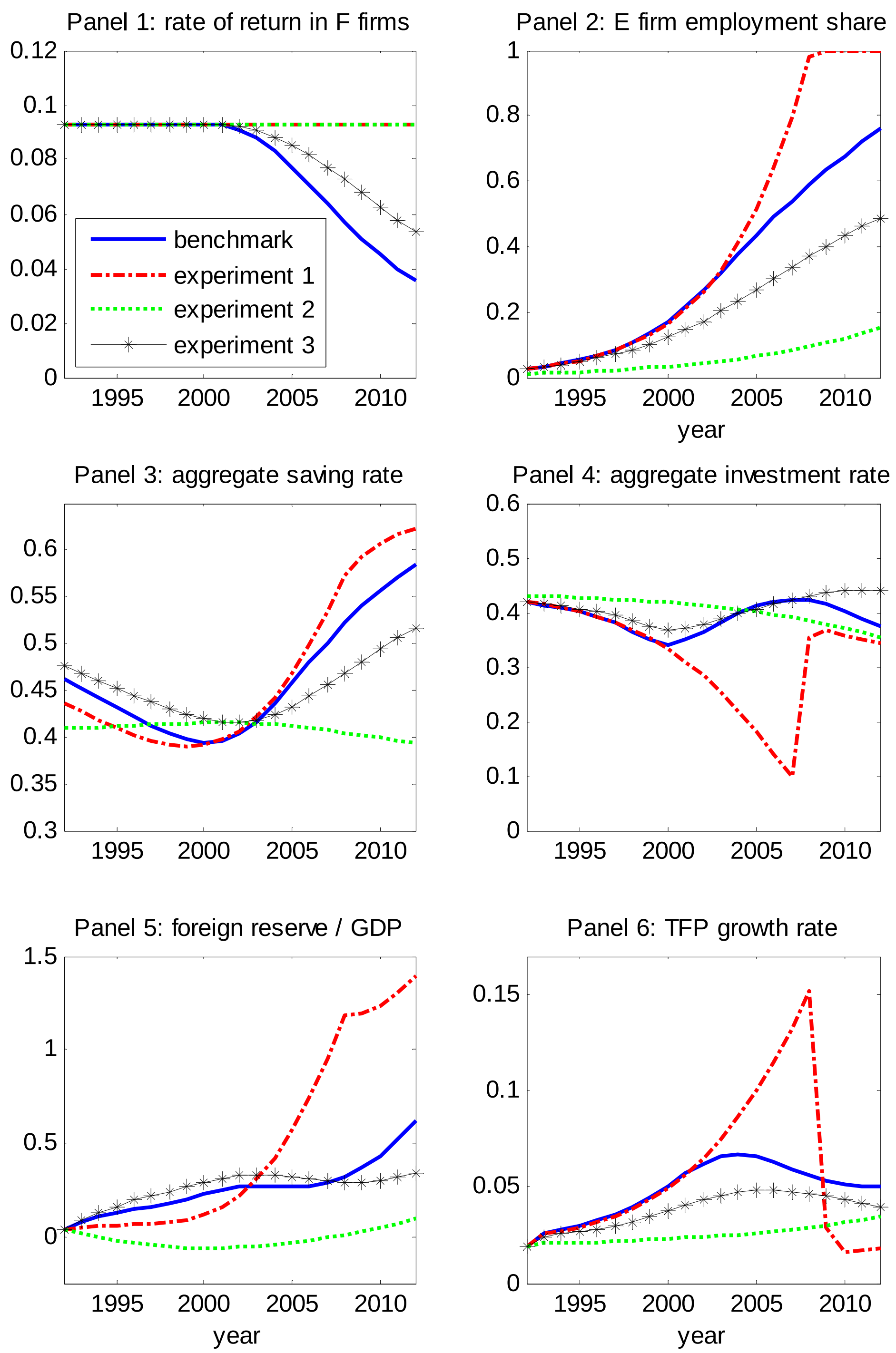
The figure shows the evolution of key variables during and after the transition in the analytical model. Time T denotes the end of the transition, when all workers are employed in E firms.

Figure 8 Transition in the Calibrated Economy



The figure shows the evolution of key variables during and after the transition in the calibrated economy. The solid and dashed lines refer to the simulated results from the model and the data, respectively. The dashed and dotted lines in panel 2 refer to private employment shares in NBS and CLSY data, respectively (see Figure 2).

Figure 9 Sensitivity Analysis



The figure shows the evolution of key variables in the calibrated economy (solid line) and various alternative parameterizations. Experiment 1 has a constant ξ. Experiment 2 has $\eta=0$. Experiment 3 has logarithmic preferences.

7 Appendix: Not for publication

7.1 Proofs of Lemmas and of Proposition 2

Proof of Lemma 1. That the capital-output ratio is higher in F firms follows immediately from the fact that $\kappa_E < \kappa_F$ (shown in the text), since $k_E/y_E = \kappa_E^{1-\alpha} < \kappa_F^{1-\alpha} = k_F/y_F$. Similarly, that the capital-labor ratio is higher in F firms follows from observing that

$$\frac{k_F}{n_F} / \frac{k_E}{n_E} = \frac{\kappa_F}{A} / \frac{\kappa_E}{\chi A} = \left(\frac{\chi}{\underline{\chi}}\right)^{\frac{1-\alpha}{\alpha}} > 1$$

where the inequality again follows from Assumption 1. ■

Proof of Lemma 2. Due to constant-return-to-scale, aggregation holds, thus we can replace individual-firm variables (lower case) by aggregate variables (upper case). Since $\kappa_E \equiv K_{Et}/\left(\chi A_t N_{Et}\right)$ is constant and $N_{Ft} = N_t - N_{Et}$, then

$$N_{Et} = \frac{K_{Et}}{\chi A_t \kappa_E}, \quad N_{Ft} = N_t - \frac{K_{Et}}{\chi A_t \kappa_E}, \tag{23}$$

where κ_E is given by (9).

The next-period capital is given by $k_{t+1}^E = s_t^E + l_t^E = R^l / \left(R^l - \eta \rho_t^E\right) s_t^E = R^l / \left(R^l - \eta \rho_t^E\right) \zeta^E m_t$. Using (4), and aggregating over all entrepreneurs yields:

$$K_{Et+1} = R^l / \left(R^l - \eta \rho_t^E\right) \zeta^E \psi \kappa_E^\alpha A_t N_{Et}. \tag{24}$$

Dividing both sides of (24) by K_{Et}, and substituting κ_E by its equilibrium expression, we obtain (10). That $N_{Et+1}/N_{Et} = \left(K_{Et+1}/K_{Et}\right)/(1+z)$ follows from (23).

Recall that the condition $\nu_E > \nu$ is equivalent to

$$\frac{R^l}{R^l - \eta \rho_E} \left(1 + \beta^{-\theta} \left(\frac{(1-\eta)\rho_E R^l}{R^l - \eta \rho_E}\right)^{1-\theta}\right)^{-1} \frac{\psi}{(1-\psi)} \frac{\rho_E}{\alpha} > (1+\nu)(1+z). \tag{25}$$

Using the fact that,

$$\frac{R^l - \eta \rho_E}{R^l \rho_E} = \frac{1}{\rho_E} - \frac{\eta}{R^l} = \frac{1}{R^l}\left((1-\psi)^{-\frac{1}{\alpha}} \chi^{-\frac{1-\alpha}{\alpha}} - \eta\right).$$

and rearranging terms allows us to rewrite (25) as

$$\begin{aligned} \frac{\psi}{(1-\psi)} \frac{1}{\alpha(1+\nu)(1+z)} \quad > \quad & \frac{1}{R^l}\left((1-\psi)^{-\frac{1}{\alpha}} \chi^{-\frac{1-\alpha}{\alpha}} - \eta\right) \\ & + \beta^{-\theta}(1-\eta)^{1-\theta}\left(\frac{1}{R^l}\left((1-\psi)^{-\frac{1}{\alpha}} \chi^{-\frac{1-\alpha}{\alpha}} - \eta\right)\right)^{\theta}. \end{aligned} \tag{26}$$

The right-hand side of equation (26) is monotonically decreasing in χ, while the left-hand side is constant. Moreover, since the right-hand side tends to ∞ (0) as $\chi \to 0$ (∞), there exists a unique $\hat{\chi}$ such that

$$\frac{\psi}{(1-\psi)} \frac{1}{\alpha(1+\nu)(1+z)} = \frac{1}{R^l}\left((1-\psi)^{-\frac{1}{\alpha}} \hat{\chi}^{-\frac{1-\alpha}{\alpha}} - \eta\right) + \beta^{-\theta}(1-\eta)^{1-\theta}\left(\frac{1}{R^l}\left((1-\psi)^{-\frac{1}{\alpha}} \hat{\chi}^{-\frac{1-\alpha}{\alpha}} - \eta\right)\right)^{\theta}.$$

Therefore, the condition $\nu_E > \nu$ will be satisfied when $\chi > \hat{\chi}$.

The following results are immediate.

1. The right-hand side of (26) is decresing in β, η and R^l so this inequality must hold for sufficiently large β, η and R^l.

2. The left-hand side of equation (26) is decreasing in ν and z. Thus, the condition $\nu_E > \nu$ is satisfied for sufficiently small ν and z.

■

Proof of Lemma 3. Using equation (23), and recalling that κ_E and κ_F are constant, we can rewrite (12) as:

$$\begin{aligned}
B_t &= \left(\zeta^W w_{t-1}N_{t-1} - K_{Ft} - \frac{\eta\rho_E}{R^l}K_{Et}\right) \\
&= \left(\zeta^W \frac{w_{t-1}}{A_t}\frac{N_{t-1}}{N_t} - \kappa_F\frac{N_{Ft}}{N_t} - \frac{\eta\rho_E}{R^l}\kappa_E\frac{\chi N_{Et}}{N_t}\right)A_tN_t \\
&= \left(\zeta^W(1-\alpha)\kappa_F^{\alpha}\frac{A_{t-1}}{A_t}\frac{N_{t-1}}{N_t} - \kappa_F\left(1-\frac{N_{Et}}{N_t}\right) - \frac{\eta\rho_E}{R^l}\kappa_E\frac{\chi N_{Et}}{N_t}\right)A_tN_t \\
&= \left(\zeta^W\frac{(1-\alpha)\kappa_F^{\alpha-1}}{(1+z)(1+\nu)} - 1 + (1-\eta)\frac{N_{Et}}{N_t}\right)\kappa_F A_t N_t
\end{aligned}$$

which proves the Lemma. ■

Proof of Lemma 4. Part (i). We start by proving that $\rho_E^l = (1-\psi)^{\frac{1}{\alpha}}\chi^{\frac{1-\alpha}{\alpha}}R$. To this aim, observe that, since (assuming that the incentive constraint is binding) $m_t = \psi P_t^l y_{Et}^l$, then

$$\Xi_t^l\left(k_{Et}^l\right) = \max_{n_{Et}}\left\{(1-\psi)P_t^l\left(k_{Et}^l\right)^{\alpha}(A_{Et}n_{Et})^{1-\alpha} - w_tn_{Et}\right\}$$

The first order condition yields:

$$n_{Et} = \frac{k_{Et}^l}{A_{Et}^l}\left(\frac{(1-\psi)(1-\alpha)P_t^lA_{Et}^l}{w_t}\right)^{\frac{1}{\alpha}}$$

Then, plugging (19) and (20) into the first order condition yields

$$n_{Et} = ((1-\psi)\chi)^{\frac{1}{\alpha}} \left(\frac{P_t^l \alpha}{R}\right)^{-\frac{1}{1-\alpha}} \frac{k_{Et}^l}{A_{Et}^l} \tag{27}$$

Finally, plugging the optimal n_{Et} into the profit function, and simplifying term, yields the value of a E firm in the labor-intensive sector:

$$\begin{aligned} \Xi_t\left(k_{Et}^l\right) &= (1-\psi)\, k_{Et}^l \left(((1-\psi)\chi)^{\frac{1}{\alpha}}\right)^{1-\alpha} \left(\frac{\alpha}{R}\right)^{-1} - (1-\alpha)\,\chi^{-1} ((1-\psi)\chi)^{\frac{1}{\alpha}} \left(\frac{\alpha}{R}\right)^{-1} k_{Et}^l \\ &= (1-\psi)^{\frac{1}{\alpha}} \chi^{\frac{1-\alpha}{\alpha}} R k_{Et}^l \equiv \rho_E^l k_{Et}^l, \end{aligned} \tag{28}$$

where ρ_E^l is identical to ρ_E in the one-sector model of section 3 (see equation (6)). This is the rate of return for E firms when F firms are active in the labor-intensive industry.

Next, we show that, when F firms are active in both industries, the return to investment in the capital-intensive sector for E firms, ρ_E^k, is lower than ρ_E^l. When F firms are active in the capital-intensive industry, the value of a E firm in the labor-intensive sector is

$$\begin{aligned} \Xi_t^k\left(k_{Et}^k\right) &= (1-\psi)\, P_t^k \left(A_{Et}^k\right)^{1-\alpha} k_{Et}^k \\ &= (1-\psi)\,\chi^{1-\alpha} R k_{Et}^k \equiv \rho_E^k k_{Et}^k \end{aligned}$$

where we have used equation (21) to eliminate P_t^k. Finally, Assumption 1 ensures that $\rho_E^l > \rho_E^k$ (since $(1-\psi)^{\frac{1}{1-\alpha}} \chi > 1 \Leftrightarrow (1-\psi)^{\frac{1}{\alpha}} \chi^{\frac{1-\alpha}{\alpha}} > (1-\psi)\chi^{1-\alpha}$). Thus, E firms will not invest in the capital-intensive sector. This completes the proof of part (i) of the Lemma.

Part (ii). We prove the argument by constructing a contradiction. Suppose that, when $K_{Et}^l > 0$ and $K_{Et}^k > 0$, $K_{Ft}^l > 0$. Then, (19) and (20) hold true, and $\rho_E^l = (1-\psi)^{\frac{1}{\alpha}} \chi^{\frac{1-\alpha}{\alpha}} R$ as shown in the first part of the proof, see (28). Moreover, $\rho_E^l = \rho_E^k = (1-\psi)\chi^{1-\alpha} R$, since otherwise E firms would not invest in both industries. Solving for P_t^k yields

$$P_t^k = (1-\psi)^{\frac{1-\alpha}{\alpha}} \chi^{\frac{1}{\alpha}} \frac{R}{\left(A_{Ft}^k\right)^{1-\alpha}} > \frac{R}{\left(A_{Ft}^k\right)^{1-\alpha}}$$

where the inequality follows from Assumption 1, and $P_t^k = R/\left(A_{Ft}^k\right)^{1-\alpha}$ is the condition that guarantees that F firms make zero profits in the capital-intensive industries. Thus, the inequality establishes that F firms would be making positive profits in the capital-intensive sector, which is impossible in a competitive equilibrium. Thus, $K_{Ft}^l = 0$ when E firms are active in both sectors. This concludes the proof of part (ii) of the Lemma.

■

Proof of Proposition 2. The problem of the monopolist is:

$$\max_{K^k} \left(P^k - R\right) K^k,$$

subject to (16), and the equilibrium conditions, (17), (18) and (20). Replacing K^k with $Y^k = \left(\varphi P^l / P^k\right)^\sigma Y^l$ (by equation 17), we can rewrite the problem as

$$\max_{P^k} \left(\left(P^k\right)^{1-\sigma} - R\left(P^k\right)^{-\sigma}\right)\left(P^l\right)^\sigma Y^l.$$

Here, Y^l is given by

$$Y^l = \left(\frac{P^l \alpha}{R}\right)^{-1} \psi\left(\chi\left(1-\psi\right)\right)^{\frac{1-\alpha}{\alpha}} K_E^l + \left(\frac{P^l \alpha}{R}\right)^{\frac{\alpha}{1-\alpha}} A_F N. \tag{29}$$

as proven in Section 7.4. The first-order condition yields:

$$\begin{aligned} 0 &= \left((1-\sigma) + \sigma R\left(P^k\right)^{-1}\right) \\ &\quad + \left(1 - R\left(P^k\right)^{-1}\right)\left(\sigma \frac{dP^l}{dP^k}\frac{P^k}{P^l} + \frac{dY^l}{dP^k}\frac{P^k}{Y^l}\right). \end{aligned}$$

Now we compute the elasticities $\frac{dP^l}{dP^k}\frac{P^k}{P^l}$ and $\frac{dY^l}{dP^k}\frac{P^k}{Y^l}$. Differentiating (18) w.r.t. P^k yields:

$$\frac{dP^l}{dP^k}\frac{P^k}{P^l} = \frac{-\varphi^\sigma\left(P^k\right)^{1-\sigma}}{1-\varphi^\sigma\left(P^k\right)^{1-\sigma}}.$$

Differentiating (29) w.r.t. P^k yields:

$$\frac{dY^l}{dP^k}\frac{P^k}{Y^l} = -\left(1 - \frac{1}{1-\alpha}\frac{Y_F^l}{Y^l}\right)\frac{dP^l}{dP^k}\frac{P^k}{P^l}.$$

Therefore, the first-order condition can be rewritten as

$$\begin{aligned} &\left((1-\sigma) + \sigma R\left(P^k\right)^{-1}\right) \\ &= \left(1 - R\left(P^k\right)^{-1}\right)\left(\sigma - \left(1 - \frac{1}{1-\alpha}\frac{Y_F^l}{Y^l}\right)\right)\frac{\varphi^\sigma\left(P^k\right)^{1-\sigma}}{1-\varphi^\sigma\left(P^k\right)^{1-\sigma}}, \end{aligned}$$

which is expression (22) in the text. ■

7.2 Post-Transition Equilibrium (Section 3.5)

In this section, we provide the details of the analysis in Section 3.5 Under log utility, the equilibrium wage, rate of return on capital, output and foreign balance are given by:

$$\begin{aligned} w_t &= A_{Et}\left(1-\alpha\right)\left(1-\psi\right)\left(\kappa_{Et}\right)^\alpha \\ \rho_t &= \rho_{E,t} = \alpha\left(1-\psi\right)\left(\kappa_{Et}\right)^{\alpha-1} \\ Y_t &= A_{Et} N_t \left(\kappa_{Et}\right)^\alpha \\ \frac{B_t}{A_t N_t} &= \frac{\beta}{1+\beta} w_t \frac{N_t}{A_t N_t} = \frac{\beta}{1+\beta}\chi\left(1-\alpha\right)\left(1-\psi\right)\left(\kappa_{Et}\right)^\alpha \end{aligned}$$

If

$$\alpha(1-\eta)(1-\psi) > \frac{\beta}{1+\beta}\frac{\psi R}{(1+z)(1+\nu)}, \tag{30}$$

then capital in E firms evolves according to (14) and eventually converges to a steady state, where

$$\kappa_E^* = \left(\frac{\beta}{1+\beta}\frac{\psi}{(1+z)(1+\nu)} + \frac{\eta\alpha(1-\psi)}{R}\right)^{\frac{1}{1-\alpha}}.$$

Here we let $R^l = R$ in the steady state. The steady state rate of return to capital is thus equal to

$$\rho_E^* = \frac{\alpha(1-\psi)}{\frac{\beta}{1+\beta}\frac{\psi}{(1+z)(1+\nu)} + \frac{\eta\alpha(1-\psi)}{R}}.$$

Condition (30) ensures that $\rho_E^* > R$; i.e., entrepreneurs never invest in bonds. Otherwise, entrepreneurs will eventually place part of their savings in bank deposits..

7.3 Analysis of Footnote 33 in Section 4.3

In this section, we provide a complete formal argument of the discussion in footnote 33. Assume, for simplicity, log preferences and $\eta = 0$. Let χ_i denote firm i's productivity and K_i be the corresponding capital stock. Then, the rate of return to capital for firm i is

$$\rho_{iE} = (1-\psi)^{\frac{1}{\alpha}} \chi_i^{\frac{1-\alpha}{\alpha}} R^l = \omega^\rho \cdot \chi_i^{\frac{1}{\alpha}},$$

where ω^ρ is a unimportant constant. The law of motion of capital for firm i can be written as

$$\frac{K_{iEt+1}}{K_{iEt}} = \omega^K \chi_i^{\frac{1}{\alpha}}, \tag{31}$$

where ω^K is also a unimportant constant. Denote $\rho_{Et} = \sum \rho_{iE} K_{iEt}/K_{Et}$ the average rate of return of E firms. We now show that ρ_{Et} grows over time, since the growth rate of K_{it} is increasing in χ_i as shown by (31). Specifically, using (31), the next-period average rate of return of E firms is equal to:

$$\rho_{Et+1} = \frac{\sum \omega^\rho \chi_i^{\frac{2}{\alpha}} K_{iEt}}{\sum \chi_i^{\frac{1}{\alpha}} K_{iEt}}.$$

Standard algebra establishes that

$$\frac{\sum \omega^\rho \chi_i^{\frac{2}{\alpha}} K_{iEt}}{\sum \chi_i^{\frac{1}{\alpha}} K_{iEt}} = \sum \frac{\omega^\rho \chi_i^{\frac{2}{\alpha}} K_{iEt}}{\sum \chi_i^{\frac{1}{\alpha}} K_{iEt}} \chi_i^{\frac{1}{\alpha}} > \sum \frac{\omega^\rho K_{iEt}}{\sum K_{iEt}} \chi_i^{\frac{1}{\alpha}} = \frac{\sum \omega^\rho \chi_i^{\frac{1}{\alpha}} K_{iEt}}{\sum K_{iEt}},$$

implying that $\rho_{Et+1} > \rho_{Et}$. Thus, the average rate of return of E firms increases over time in this case.

7.4 Equilibrium in Section 5.1

In this section, we provide a formal characterization of the equilibrium in the two-sector economy of Section 5.1. The equilibrium entails are four stages, described in the text. For notational convenience, we let $A^k_{Jt} = A^l_{Jt} = A_J$.

Proposition 3 *Stage 1 is defined as*

$$\frac{K_{Et}}{A_E N} < ((1-\psi)\chi)^{-\frac{1}{\alpha}} \left(\frac{P^l_t \alpha}{R}\right)^{\frac{1}{1-\alpha}}, \tag{32}$$

where

$$P^l_t = \left(1 - \varphi^\sigma \left(P^k_t\right)^{1-\sigma}\right)^{\frac{1}{1-\sigma}}, \tag{33}$$

$$P^k_t = \frac{R}{A_F^{1-\alpha}}. \tag{34}$$

In the first stage, both of the E and F firms are active in the labor-intensive industry while only the F firms produce capital-intensive goods. Specifically, prices of labor- and capital-intensive goods are determined by (33) and (34). Labor, capital and output in the labor- and capital-intensive industries are such that

$$N^l_{Ft} = N - N^l_{Et},\ N^l_{Et} = ((1-\psi)\chi)^{\frac{1}{\alpha}} \left(\frac{P^l_t \alpha}{R}\right)^{-\frac{1}{1-\alpha}} \frac{K^l_{Et}}{A_E}, \tag{35}$$

$$K^l_{Ft} = \left(\frac{P^l_t \alpha}{R}\right)^{\frac{1}{1-\alpha}} A_F N^l_{Ft},\ K^l_{Et} = K_{Et},\ Y^l_t = \left(\frac{P^l_t \alpha}{R}\right)^{-1} \psi \left(\chi(1-\psi)\right)^{\frac{1-\alpha}{\alpha}} K^l_{Et} + \left(\frac{P^l_t \alpha}{R}\right)^{\frac{\alpha}{1-\alpha}} A_F N, \tag{36}$$

$$Y^k_t = \left(\varphi P^l_t / P^k_t\right)^\sigma Y^l_t,\ K^k_{Ft} = \frac{Y^k_t}{A_F^{1-\alpha}},\ K^k_{Et} = 0, \tag{37}$$

respectively. Moreover, capital of E firms evolves according to

$$\frac{K_{Et+1}}{A_E N} = \frac{\beta\psi}{1+\beta} P^l_t \left(\frac{K_{Et}}{A_E N}\right)^\alpha, \tag{38}$$

and the aggregate output is equal to

$$Y_t = \left(P^l_t\right)^\sigma Y^l_t, \tag{39}$$

Proof. When $K^l_{Ft} > 0$ and $K^k_{Ft} > 0$, it is straightforward from Lemma 4 that $K^k_{Et} = 0$. (33) follows immediately from (18), whereas (34) follows from the zero-profit condition (20) for F firms in the capital-intensive industry. The first part of (36) comes from (20).

The first part of (37) follows from (17). Using the condition that final-good firms make zero profits, together with, (17) and (18) leads to

$$\begin{aligned} Y_t &= P_t^l Y_t^l + P_t^k Y_t^k \\ &= \left(1+\varphi^\sigma \left(\frac{P_t^k}{P_t^l}\right)^{1-\sigma}\right) P_t^l Y_t^l = \left(P_t^l\right)^\sigma Y_t^l, \end{aligned}$$

which establishes (39). (35) follows immediately from (27). To derive (36), observe that

$$\begin{aligned} Y_t^l &= \left(\kappa_F^l\right)^\alpha \left(\frac{\psi}{1-\psi}\frac{N_{Et}}{N}+1\right) A_F N \\ &= \left(\frac{P_t^l\alpha}{R}\right)^{\frac{\alpha}{1-\alpha}} \left(\psi\chi^{\frac{1}{\alpha}}\left(1-\psi\right)^{\frac{1-\alpha}{\alpha}}\left(\frac{P_t^l\alpha}{R}\right)^{-\frac{1}{1-\alpha}}\frac{K_{Et}^l}{A_E}+N\right) A_F \\ &= \frac{R}{P_t^l\alpha}\left(\psi\chi^{\frac{1}{\alpha}}\left(1-\psi\right)^{\frac{1-\alpha}{\alpha}}\frac{K_{Et}^l}{A_E}+N\left(\frac{P_t^l\alpha}{R}\right)^{\frac{1}{1-\alpha}}\right) A_F \\ &= \left(\frac{P_t^l\alpha}{R}\right)^{-1}\psi\left(\chi\left(1-\psi\right)\right)^{\frac{1-\alpha}{\alpha}} K_{Et}^l + \left(\frac{P_t^l\alpha}{R}\right)^{\frac{\alpha}{1-\alpha}} A_F N. \end{aligned}$$

Finally, (32) ensures that $K_{Ft}^l > 0$, according to (27). The rest is immediate. ■

Proposition 4 *Stage 2 is defined as*

$$\left(\left(1-\psi\right)\chi\right)^{-\frac{1}{\alpha}}\left(\frac{P_t^l\alpha}{R}\right)^{\frac{1}{1-\alpha}} \leq \frac{K_{Et}}{A_E N} < \frac{1}{\chi}\left(\frac{P_t^l\alpha}{R}\right)^{\frac{1}{1-\alpha}}. \tag{40}$$

In the second stage, F firms disappear in the labor-intensive industry. Specifically, prices of labor- and capital-intensive goods are determined by (33) and (34). $N_{Ft}^l = 0$, $N_{Et}^l = N$, *capital and output in the labor-intensive industries are such that*

$$K_{Ft}^l = 0,\ K_{Et}^l = K_{Et},\ Y_t^l = \left(K_{Et}^l\right)^\alpha \left(A_E N\right)^{1-\alpha},$$

capital and output in the capital-intensive industry is identical to (37) in Stage 1. Moreover, capital in E firms also evolves according to (38) as in Stage 1.

Proof. The first inequality of (40) implies that $K_{Ft}^l = 0$. Now the wage rate is determined by the marginal product of labor in E firms.

$$w_t = P_t^l\left(1-\alpha\right)\left(1-\psi\right)A_E\left(\frac{K_{Et}^l}{A_E N}\right)^\alpha.$$

It is then easy to show that

$$\rho_{Et}^l = P_t^l\alpha\left(1-\psi\right)\left(\frac{K_{Et}^l}{A_E N}\right)^{\alpha-1}.$$

Suppose that E firms are active in the capital-intensive industry. We have

$$\rho_{Et}^{k} = (1-\psi)\,\chi^{1-\alpha}R.$$

However, the second inequality of (40) implies that $\rho_{Et}^{l} > \rho_{Et}^{k}$. Therefore, $K_{Et}^{k} = 0$ in the second stage. Finally, (40) is non-empty by Assumption 1. ■

Corollary 1 *If*

$$\chi^{1-\alpha} < \frac{\alpha\,(1+\beta)}{\beta\psi R}, \tag{41}$$

then there are only two stages in the economy (E firms never produce capital-intensive goods).

Proof. Define $\tilde{P}^{l} \equiv \left(1-\varphi^{\sigma}\left(\frac{R}{(A_F)^{1-\alpha}}\right)^{1-\sigma}\right)^{\frac{1}{1-\sigma}}$ as the constant price of labor-intensive goods in Stage 2. The law of motion (38) implies a upperbound of capital stock during the second stage of transition:

$$\frac{K_{Et}}{A_E N} \leq \left(\frac{\beta\psi\tilde{P}^{l}}{1+\beta}\right)^{\frac{1}{1-\alpha}}.$$

This gives the lowerbound of the rate of return:

$$\rho_{Et}^{l} > \tilde{P}^{l}\alpha\,(1-\psi)\left(\frac{\beta\psi\tilde{P}^{l}}{1+\beta}\right)^{-1} = \frac{\alpha\,(1-\psi)\,(1+\beta)}{\beta\psi}.$$

Recall that $\rho_{Et}^{k} = (1-\psi)\,\chi^{1-\alpha}R$. Therefore, $\rho_{Et}^{l} > \rho_{Et}^{k}$ always holds under the assumption of (41). ■

Proposition 5 *Stage 3 is defined as*

$$\frac{1}{\chi}\left(\frac{P_t^l\alpha}{R}\right)^{\frac{1}{1-\alpha}} \leq \frac{K_{Et}}{A_E N} < \frac{1}{\chi}\left(\frac{P_t^l\alpha}{R}\right)^{\frac{1}{1-\alpha}} + \frac{1}{A_E^{1-\alpha}}\left(\varphi\frac{P_t^l}{P_t^k}\right)^{\sigma}\left(\frac{1}{\chi}\left(\frac{P_t^l\alpha}{R}\right)^{\frac{1}{1-\alpha}}\right)^{\alpha}. \tag{42}$$

In the third stage, the E firms start to produce capital-intensive goods. Specifically, prices of labor- and capital-intensive goods are determined by (33) and (34). $N_{Ft}^{l} = 0$, $N_{Et}^{l} = N$, capital and output in the labor- and capital-intensive industries are such that

$$K_{Ft}^{l} = 0,\ K_{Et}^{l} = \frac{1}{\chi}\left(\frac{P_t^l\alpha}{R}\right)^{\frac{1}{1-\alpha}} A_E N,\ Y_t^l = \left(K_{Et}^{l}\right)^{\alpha}(A_E N)^{1-\alpha}, \tag{43}$$

$$Y_t^k = \left(\varphi P_t^l/P_t^k\right)^{\sigma} Y_t^l,\ K_{Ft}^{k} = \frac{Y_t^k - A_E^{1-\alpha}K_{Et}^{k}}{A_F^{1-\alpha}},\ K_{Et}^{k} = K_{Et} - K_{Et}^{l}, \tag{44}$$

respectively. Moreover, the total capital of E firms evolves according to the law of motion

$$\frac{K_{Et+1}}{A_E N} = \frac{\beta\psi}{1+\beta}\left(P_t^l\left(\frac{K_{Et}^l}{A_E N}\right)^{\alpha} + P_t^k A_E^{1-\alpha}\left(\frac{K_{Et}}{A_E N} - \frac{K_{Et}^l}{A_E N}\right)\right). \tag{45}$$

Proof. Lemma 4 implies that $K_{Ft}^l = 0$.[37] $K_{Et}^k > 0$ implies equalized rates of return across two industries.

$$\rho_{Et}^k = \rho_{Et}^l \Rightarrow (1-\psi)\chi^{1-\alpha}R = P_t^l(1-\psi)\alpha\left(\frac{K_{Et}^l}{A_E N}\right)^{\alpha-1} \Rightarrow$$

$$K_{Et}^l = \frac{1}{\chi}\left(\frac{P_t^l\alpha}{R}\right)^{\frac{1}{1-\alpha}} A_E N.$$

Given total capital of E firms K_{Et}, $K_{Et} - K_{Et}^l$ will be allocated to the capital-intensive industry. Enterpreneurs' total income is equal to $\psi\left(P_t^l\left(K_{Et}^l\right)^{\alpha}(A_E N)^{1-\alpha} + P_t^k A_E^{1-\alpha} K_{Et}^k\right)$, which gives the law of motion of capital (45). Finally, we need $Y_t^k > A_E^{1-\alpha}K_{Et}^k$ to ensure $K_{Ft}^k > 0$. This is given by the second inequality of (42). ■

Proposition 6 *Stage 4 is defined as*

$$\frac{K_{Et}}{A_E N} \geq \frac{1}{\chi}\left(\frac{P_t^l\alpha}{R}\right)^{\frac{1}{1-\alpha}} + \frac{1}{A_E^{1-\alpha}}\left(\varphi\frac{P_t^l}{P_t^k}\right)^{\sigma}\left(\frac{1}{\chi}\left(\frac{P_t^l\alpha}{R}\right)^{\frac{1}{1-\alpha}}\right)^{\alpha}.$$

In the fourth stage, economic transition is complete in the sense that F firms vanish even in the capital-intensive industry. Specifically, prices of labor- and capital-intensive goods are determined by (33) and (46).

$$P_t^k = \frac{R}{(1-\psi)A_E^{1-\alpha}}. \tag{46}$$

$N_{Ft}^l = 0$, $N_{Et}^l = N$, *capital and output in the labor- and capital-intensive industries are identical to (43) and (44), except that* $K_{Ft}^k = 0$. *The law of motion of capital in E firms also follows (45) in the third stage.*

The proof is immediate and is omitted.

Finally, we revisit the foreign balance. The balance sheets of the banks must take into account the investments of F firms in both industries:

$$K_{Ft+1}^k + K_{Ft+1}^l + B_t = \frac{\beta}{1+\beta}w_t N_t.$$

[37] Alternatively, $K_{Ft}^l = 0$ can be ensured by the first inequality of (42).

Proposition 7 *In the first stage, the country's asset position in the international bond market increases if*

$$\frac{\alpha\left(1-\psi\right)}{\psi} > \varphi^{\sigma}\left(P^{l}/P^{k}\right)^{\sigma-1}, \tag{47}$$

where P^l and P^k follow (33) and (34), respectively.

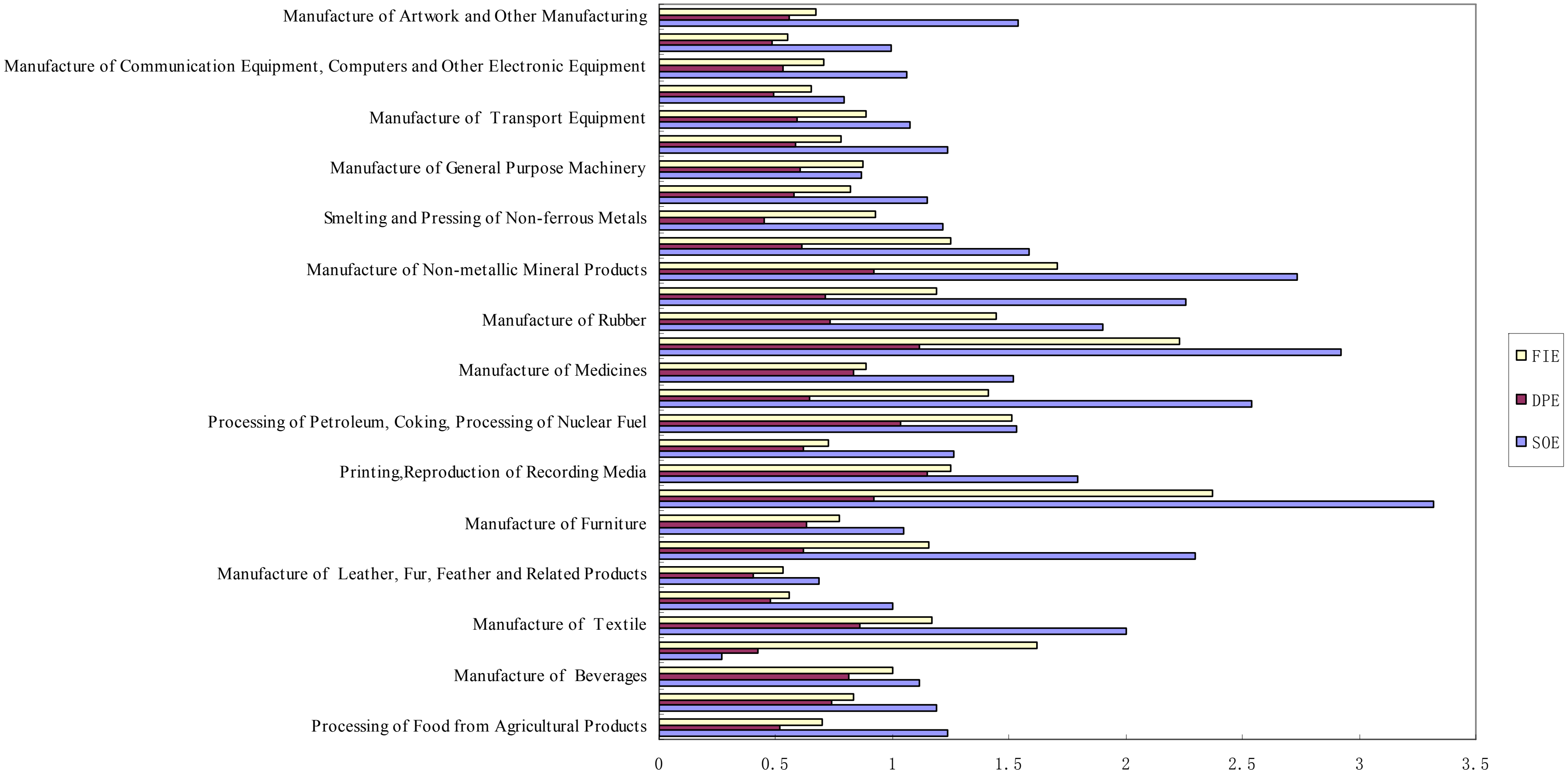
Proof. Using (19) and (20), standard algebra shows that:

$$\begin{aligned}
\frac{B_{t+1}}{A_F N} &= \frac{\beta}{1+\beta}w_t - \frac{K^l_{Ft+1}}{A_F N} - \frac{K^k_{Ft+1}}{A_F N} \\
&= \frac{\beta}{1+\beta}P^l\left(1-\alpha\right)A_F\left(\frac{P^l\alpha}{R}\right)^{\frac{\alpha}{1-\alpha}} \\
&\quad -\left(\frac{P^l\alpha}{R}\right)^{\frac{1}{1-\alpha}}\left(1-\frac{\left(\left(1-\psi\right)\chi\right)^{\frac{1}{\alpha}}\left(\frac{P^l\alpha}{R}\right)^{-\frac{1}{1-\alpha}}K^l_{Et+1}}{A_E N}\right) \\
&\quad -\frac{\left(\varphi P^l/P^k\right)^{\sigma}}{A_F^{1-\alpha}}\left(\left(\frac{P^l\alpha}{R}\right)^{-1}\psi\left(\chi\left(1-\psi\right)\right)^{\frac{1-\alpha}{\alpha}}\frac{K^l_{Et+1}}{A_F N}+\left(\frac{P^l\alpha}{R}\right)^{\frac{\alpha}{1-\alpha}}\right).
\end{aligned}$$

Since K^l_{Et+1} is increasing, B_{t+1} is an increasing sequence if (47) holds. ■

The main results of Proposition 1 therefore carry over to this extended model economy.

Figure A1 (Panel 2) Capital-Output Ratios by Ownership and Sector in Manufacturing in 2006



Note: We use net value of fixed assets as a proxy for capital. Data source: CSY 2007

Figure A1 (Panel 1) Capital-Labor Ratios (thousand yuan per worker) by Ownership and Sector in Manufacturing in 2006