A theory of economic development and dynamics of Chinese economy

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ABSTRACT

This paper constructs a theoretical model which captures the recent slowing-down of Chinese economy. In contrast with the previous literature which largely confines its focus on the resource misallocation between inefficient state-owned enterprises (SOEs) and more efficient private firms under a closed economy setting, this paper re-examines the dynamics of the growth of Chinese economy from the perspective of an open economy. In particular, this paper incorporates heterogeneous outputs and relative prices into the model, where private firms are assumed to be the major exporters and the remaining large SOEs create increasing import demand from the home country. By adding downward sloping world demand curve, our paper predicts a turning point during the transition process, as the falling relative price for exports starts to constrain and eventually slow down the growth; SOEs begin to co-exist with private firms in the economy before it is fully transformed. Our paper provides a theoretical foundation in terms of understanding the current dynamics and institutional change of Chinese economy. Additionally, this paper also provides quantitative evidence on the effects of financial development during the China's economic transition process.

1. Introduction

It is an undeniable fact Chinese economy has been slowing down in the recent years. The growth of Chinese economy has been persistently biased toward investment and exports. (Lardy, 2007; Kuijs, 2005; Aziz, 2006). Despite of the shrinkage of SOE sectors in Chinese economy, the remaining large SOEs in China still obtain much more privileged financial treatment when compared with the private sectors. To what extent the biased economic growth pattern of Chinese economy is inherently linked with the current slowing down of the economy still remains to be a big puzzle in the literature. This paper fills this gap and re-examines the interaction among the three major economic components in Chinese economy: the financial development, economic growth and international trade. Constructing a theoretical model, we argue that there exists a turning point during the transition of Chinese economy, as the falling relative price for exports starts to constrain and eventually slow down the growth and SOEs begin to co-exist with private firms in the economy before it is fully transformed. The contribution of our model is two-fold. First, the model adds heterogeneous outputs (two different products), with the financially constrained private firms which specialize in exporting its outputs (x good) and the outputs produced by SOEs (f good) are consumed and invested domestically. Second, the current model adds more realistic intratemporal decisions so that the domestic consumption/investment now consists of two different goods. In both extensions, the relative price of the exports in terms of f good is determined by the downward sloping demand curve at world market. Our model allows us to conceptualise the growth story for the Chinese economy: During the transition, the expansion of domestic private firms will unambiguously lower the relative price of the exports from home country, because of the downward sloping world demand curve, which will affect the profitability (and later stage investment) of private firms and leads to an unfinished transition after the takeoff. More importantly, such unfinished transition will lead to the situation under which both SOEs and private firms co-exist in the economy, which contributes to the

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Further slowing-down of Chinese economy.

Our paper is related to several studies in the previous literature. The closest work to our paper is done by Song et al. (2011) who also constructs a growth model to capture the dynamics of the transition of Chinese economy. The model developed in this paper differs from the one by Song et al. (2011) in the following aspects: First, instead of assuming the homogeneous output in the baseline model, our model incorporates heterogeneous outputs and relative prices into the analysis, with private firms assumed to be the major exporters and the remaining large SOEs create increasing import demand from the home country. Second, we add more realistic intratemporal decisions so the domestic consumption/investment now consists of two different goods. (SOE and private firm good) These two extensions allow us to illustrate the relevance of the potential occurrence of a turning point within Chinese economy, after which the economy would slow down caused by the co-existence between SOE sectors and private firms. This is drastically contrasted from Song et al. (2011)'s model in which they predict the remaining SOE sectors would be crowded out by high-productivity private firms and the whole economic transition process would be completed smoothly. Lin et al. (1994) argues that the China's economic miracle is due to the state's appropriate adoption of comparative advantage following development strategies such that the labour-abundance factor endowment structure of Chinese economy is fully utilized. Our paper partially agrees with his views; however, it also goes one step further to ask whether such comparative-following advantage development strategies are sustainable in the long run. This is because according to the argument in our paper, comparative advantage following development strategies would inevitably make the exporting sectors become the priority within the economy and the over-focus on the biased growth pattern toward exporting would lower the relative price of the home country due to the more intense competition; this could finally lower the profitability of most of private firms which are largely concentrated within the exporting sectors. The decline in profitability of private firms could make the economic growth of Chinese economy in the long run become unsustainable.

Papers by Lardy (2007), Kuijs (2005) and Aziz (2006) have rationalized various of reasons of why Chinese economy has failed to translated itself into the consumption-driven economic growth pattern and been heavily cling to the investment and exporting biased growth mode. For instance, both Kuijs (2005) and Aziz (2006) illustrate the relevance of the role of income disparity in determining current growth pattern of Chinese economy. Other scholars include Riedel et al. (2007) and Boyer-Debray and Wei (2005) who further argue the underdeveloped financial sector in China might be one of the fundamental causes of the failure of transformation for Chinese economy to step toward the consumption-driven economic growth pattern. What sets our paper apart from their work is that we consider the resource allocation between high-productivity private firms and low productivity SOEs as the main factor in explaining the long-run economic performance of Chinese economy and we also incorporate the role of financial sectors in affecting the growth of Chinese economy into the proposed framework.

Hsieh and Peter (2009) demonstrate slow growth of total factor productivity (TFP) of Chinese economy since the 2008 is largely caused by the resource misallocation across private and state sectors, which in turn resulted into the lower aggregate total factor productivity of Chinese economy. We partially agree with their views in the sense the damping effect of state-sectors on private counterparts would certainly lead to the resource misallocation among productive sectors, which will lead to the resource misallocation within Chinese economy. Nevertheless, what makes our paper distinctive from their work is we demonstrate in a growth model to show that resource misallocation would not only lower the aggregate TFP of Chinese economy, but also directly triggered the inferior performance of exports as well as the lower productivity of private firms, which both factors contribute to the slowing-down of Chinese economy. Paper by Hsieh and Song (2015) further confirm the aforementioned points that, arguing restructuring of large SOEs and shrinkage of state sectors since the late 1990s to 2008 has been responsible for the dramatic growth of Chinese economy during the period including 20 percent of aggregate TFP growth.

Paper by Lin et al. (2016) presents a rather optimistic outlook regarding the future growth prospects of Chinese economy. They argue the current slowing-down of Chinese economy is more caused by the structural factors external to the Chinese economy, such as the decline of growth of the rest of the world economy. Although it is true the sluggish growth of other countries with particular reference to Western economies has been persistently responsible for the lower growth of Chinese economy, they seem to ignore the structural factors stemming from the internal issues of Chinese economy such as the expansion of state-sectors and its ensuing crowding out effect on private sectors. Our paper argues that the internal and external factors which contribute to the slowing-down of Chinese economy are inherently intertwined. This is because according to the model developed in our paper, once the private sectors are crowded out by state sectors, the external export would be also negatively affected as most of private sectors concentrate within the exporting sectors.

The rest of the paper will be organized as follows: The second section offers the empirical motivation for our theoretical model. Sections 3 and 4 describe the theoretical model and model simulation results in greater detail.

2. Empirical motivation

2.1. Reverse trend between GDP growth and large SOEs

Regarding the empirical motivation of this study, the slowing-down of Chinese economic growth in the recent years is one of the first observations from the data which triggers the interests of this study. The following Fig. 1 shows the decline in China's annual GDP growth rate (in constant prices) over the past decade.

From Fig. 1, it is apparent China's annual GDP Growth Rate (in constant prices) has declined from 11.4 percent in 2005 to 6.6 percent in 2018. One of the argument proposed in this paper is that the resource misallocation caused by the co-existence between private sectors and state sectors is crucial for us to understand the current slowing-down of Chinese economy. Therefore, it is important to look at the evolution of the state-sector in Chinese economy. With respect to the proportions of state sector within the Chinese economy, the data also exhibits some interesting patterns: Fig. 2 has a adverse trend to Fig. 1. From 2005 to 2007, the number of SOEs is decreasing while the GDP growth rate increases in this period. From 2011 to 2015, number of SOEs increase and GDP growth rate decreases in this period. This implies that state sector in China is represented by large SOEs which have co-existed with private sectors in the past decade, but which might potentially contribute to the resource misallocation within Chinese economy. One of the most important features of such resource misallocation is embodied by the huge liabilities against large SOEs. Fig. 3 shows the increasing tendency of the amount of both liabilities and assets of large SOEs in China since 2005.

Note: Prior to 2007, this number includes all the industrial SOEs. From 2007 to 2011, large SOEs are defined as SOEs whose operating incomes are above 5 million RMB. After 2011, large SOEs are those whose operating incomes are above 20 million RMB.

Note: All the number has been transferred to the price level of 1999. The dramatic increase in the amount of liabilities of large SOEs in China since the past decade signifies the fact the financial sector including banking system is biased towards large SOEs. This gives large SOEs the priority in of bank loan lending as banks are also stated owned.

2.2. Impact of co-existence on GDP growth

In this section, the paper explores the effect of co-existence between SOEs and privately owned enterprises (POEs) on the GDP growth using
Fig. 1. China’s Annual GDP Growth Rate (constant price).

Fig. 2. Total number of SOEs in China, 2005–2017.
empirical analysis. This paper assumes the co-existence of SOEs impedes POEs’ performance, reduces the export, and decreases GDP growth.

2.2.1. Data and model construction

This paper uses the economic data of 31 provinces in mainland China\(^1\) between 2005 and 2017. All the variables in this paper are collected from the regional economic database within the Chinese Stock Market and Accounting Research Database (CSMAR). The industrial data about private firms begin in 2005 and ends at 2017 in the database so that we choose the data from 2005 to 2017. Besides, most of variables are converted to the price level of 1999 to reduce the impact of inflation. To alleviate the impact of extreme value, all the variables are winsorized at the 1% level.

To measure the co-existence between SOEs and POEs, this paper employs the ratio of operating sales in state-owned industrial firms to that in big-and-medium-sized industrial firms. A higher value of co-existence represents SOEs occupy a large proportion in the economy.

To explore the impact of co-existence on economic performance of private firms, this paper designs the regression model as Eq. (1). Return on Assets (ROA) and operating sales of private industrial firms are the proxies of economic performance of private firms; it controls for the impact of GDP, FDI, turnover, financial leverage, firm size and year fixed effects.

\[
\text{ROA} = \alpha + \beta \text{Co-existence} + \gamma_1 \text{GDP} + \gamma_2 \text{FDI} + \gamma_3 \text{Turnover} + \gamma_4 \text{Leverage} + \gamma_5 \text{Size} + \sum \text{Year} + \epsilon
\]

(1)

The empirical model examines the effect of co-existence on exportation performance as shown in the equation below. This paper utilizes the total exportation, and total exportation and importation as the measurement for export performance. In this equation, GDP, FDI, total consumption, labor investment, capital investment, science & technology investment, and year fixed effects are controlled.

\[
\text{Export} = \alpha + \beta \text{Co-existence} + \gamma_1 \text{GDP} + \gamma_2 \text{FDI} + \gamma_3 \text{Consumption} + \gamma_4 \text{Labor} + \gamma_5 \text{Capital} + \gamma_6 \text{ST} + \sum \text{Year} + \epsilon
\]

(2)

Finally, this paper constructs the model to test the impact of co-existence on GDP. GDP and GDP per capita are utilized to proxy economic development. This paper controls for the impact of FDI, total consumption, labor investment, capital investment, science & technology investment, and year fixed effects are controlled.

\[
\text{GDP} = \alpha + \beta \text{Co-existence} + \gamma_1 \text{FDI} + \gamma_2 \text{Consumption} + \gamma_3 \text{Labor} + \gamma_4 \text{Capital} + \gamma_5 \text{ST} + \sum \text{Year} + \epsilon
\]

(3)

All the variables definitions are summarized in Table 1 and the summary statistics are shown in Table 2.

According to the summary statistics of Table 2, private industrial firms have average 9.6% return on total assets and 54.7% leverage in the sample.

2.2.2. Crowding out effect of co-existence on POEs’ performance

This paper employs ROA of private firms as the first proxy of economic performance of POEs and shows the result in Table 3. Model 1 only controls year fixed effect and model 2 include the remaining control variables. Coefficients of co-existence are negative and significant at the 1% level, indicating a negative effect of co-existence on earnings capacity of POEs. In other words, POEs in the provinces with high co-existence have lower earnings capacity.

The regression result for the second proxy for economic performance of POEs is the operating sales of private industrial firm is presented in

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\(^1\) This paper excluded samples of Hong Kong, Macau, and Taiwan.
Table 1

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROA</td>
<td>Return on assets of private industrial firms</td>
</tr>
<tr>
<td>Sales</td>
<td>Natural logarithm of total operating sales of private industrial firms</td>
</tr>
<tr>
<td>Export</td>
<td>Natural logarithm of total exportation</td>
</tr>
<tr>
<td>Export2</td>
<td>Natural logarithm of total exportation and importation</td>
</tr>
<tr>
<td>Per GDP</td>
<td>Natural logarithm of gross domestic productivity per capita</td>
</tr>
<tr>
<td>GDP</td>
<td>Natural logarithm of gross domestic productivity</td>
</tr>
<tr>
<td>Co-existence</td>
<td>Ratio of operating sales of state-owned industrial firms to total gross productivity of big-and-medium-sized industrial firms</td>
</tr>
<tr>
<td>FDI</td>
<td>Ratio of foreign investment to gross domestic productivity</td>
</tr>
<tr>
<td>Turnover</td>
<td>Ratio of operating sales to liquidity asset in private industrial firms</td>
</tr>
<tr>
<td>Leverage</td>
<td>Ratio of total debt to total assets of private industrial firms</td>
</tr>
<tr>
<td>Size</td>
<td>Natural logarithm of total assets of private industrial firms</td>
</tr>
<tr>
<td>Labor</td>
<td>Natural logarithm of total population</td>
</tr>
<tr>
<td>Consumption</td>
<td>Natural logarithm of total consumption expenditure</td>
</tr>
<tr>
<td>Capital</td>
<td>Natural logarithm of total fixed assets investment</td>
</tr>
<tr>
<td>ST</td>
<td>Natural logarithm of science and technology investment</td>
</tr>
</tbody>
</table>

Table 2

Summary statistics.

<table>
<thead>
<tr>
<th>variable</th>
<th>N</th>
<th>mean</th>
<th>sd</th>
<th>min</th>
<th>p25</th>
<th>p50</th>
<th>p75</th>
<th>max</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROA</td>
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<td>0.096</td>
<td>0.056</td>
<td>0.010</td>
<td>0.052</td>
<td>0.090</td>
<td>0.127</td>
<td>0.304</td>
</tr>
<tr>
<td>Export</td>
<td>403</td>
<td>0.581</td>
<td>0.231</td>
<td>0.175</td>
<td>0.391</td>
<td>0.615</td>
<td>0.753</td>
<td>1.075</td>
</tr>
<tr>
<td>GDP</td>
<td>403</td>
<td>8.309</td>
<td>0.972</td>
<td>5.544</td>
<td>8.449</td>
<td>8.950</td>
<td>10.171</td>
<td>11.480</td>
</tr>
<tr>
<td>FDI</td>
<td>403</td>
<td>8.094</td>
<td>0.853</td>
<td>5.670</td>
<td>8.241</td>
<td>8.704</td>
<td>9.273</td>
<td>10.704</td>
</tr>
<tr>
<td>Leverage</td>
<td>403</td>
<td>9.276</td>
<td>2.825</td>
<td>5.728</td>
<td>7.977</td>
<td>8.781</td>
<td>9.441</td>
<td>14.787</td>
</tr>
</tbody>
</table>

Table 3

Impact of co-existence on the earnings capacity of private firms.

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Co-existence</td>
<td>-0.073***</td>
<td>-0.043***</td>
</tr>
<tr>
<td>FDI</td>
<td>0.007**</td>
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<tr>
<td>Turnover</td>
<td>-0.060</td>
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<tr>
<td>Leverage</td>
<td>0.014***</td>
<td></td>
</tr>
<tr>
<td>Size</td>
<td>-0.245***</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>403</td>
<td>403</td>
</tr>
<tr>
<td>Adjusted R-squared</td>
<td>0.197</td>
<td>0.711</td>
</tr>
<tr>
<td>Year FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>F</td>
<td>39.14</td>
<td>88.15</td>
</tr>
</tbody>
</table>

(1) Heteroskedasticity-robust t-statistics are shown in parentheses.
(2) ***p < 0.01, **p < 0.05, *p < 0.1.

Table 4

Impact of co-existence on the gross productivity of private firms.

<table>
<thead>
<tr>
<th>VARIABLES</th>
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</tr>
</thead>
<tbody>
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<td>ROA</td>
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</tr>
<tr>
<td>Co-existence</td>
<td>-5.357***</td>
<td>-0.284***</td>
</tr>
<tr>
<td>FDI</td>
<td>0.299***</td>
<td></td>
</tr>
<tr>
<td>Turnover</td>
<td>0.052</td>
<td></td>
</tr>
<tr>
<td>Leverage</td>
<td>0.233***</td>
<td></td>
</tr>
<tr>
<td>Size</td>
<td>0.548***</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>403</td>
<td>403</td>
</tr>
<tr>
<td>Adjusted R-squared</td>
<td>0.501</td>
<td>0.994</td>
</tr>
<tr>
<td>Year FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>F</td>
<td>241.2</td>
<td>9064</td>
</tr>
</tbody>
</table>

(1) Heteroskedasticity-robust t-statistics are shown in parentheses.
(2) ***p < 0.01, **p < 0.05, *p < 0.1.

2.2.3. Impeding effect of co-existence on export

In this section, the paper explores the impact of co-existence on exportation performance, which is a key driver for economic growth. In Table 5, co-existence has negative and significant coefficients with export, illustrating that co-existence has a negative relationship with exportation. In other words, a higher level of co-existence reduces the total exportation.

In the next section, this paper examines the impact of co-existence on total exportation and importation. Results are presented in Table 6. Coefficients of co-existence are negative and significant at 1% level, similar to the results of Table 5. This result demonstrates that high co-existence would damage the exportation.

2.2.4. Impeding effect of co-existence on GDP

In the prior analysis, the empirical results show high levels of co-existence is detrimental to the development of POEs and exportation, implying co-existence might damage the economic development. To examine this expectation, this paper carries out further empirical analysis and presents the result in Table 7 and Table 8.

Table 7 harnesses GDP as the dependent variable and shows negative and significant coefficients of co-existence. This result indicates high co-existence impedes the GDP.

We employ GDP per capita as the alternative measure for economic development and shows the result in Table 8 still has negative and significant coefficients, in line with prior analysis. These results prove the
detrimental effect of co-existence on economic development.

Our empirical results find a higher level of co-existence impedes POEs’ performance, export performance, and economic growth.

3. The model

Developing a theoretical framework which is suitable for transition economies like China would be the key for our analysis. Song et al. (2011) considers a small-open economy model (SSZ model), which provides a good explanation for the Chinese growth story over the past 20 years. The micro-foundations of their model relies on the OLG model, but they extend the simple OLG structure with heterogeneous agents (workers and entrepreneurs) and divide the industrial sector into two types of producers: F firms and E firms. F firms are the less efficient, financially integrated, and state owned enterprises, while the E firms are more productive, credit-constrained, private firms. After economic transition takes off, resources are reallocated from less efficient firms to more efficient ones within the industrial sector. During the transition periods (i.e. resources are reallocated from F firms to E firms), the economy keeps accumulating foreign assets, as the aggregate domestic investment shrinks overtime. The financial development can be reflected by the falling iceberg costs, or alternatively, an increase in the financial access for E firms.

Our model introduces an extension by having two different kinds of goods in the economy: x and f so there will be relative prices in our model as well. In the baseline, we assume the domestic consumers only consume x goods, the relative price level is determined at the world market, as x goods are all exported; this occurs instead of seeing private financial development can be re-

### Table 5
Impact of co-existence on total exportation.

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>(1)</th>
<th>(2)</th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>Model 1</td>
<td>Model 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Export</td>
<td>Export</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Co-existence</td>
<td>-5.680***</td>
<td>-1.731***</td>
<td>(-21.568)</td>
<td>(-9.653)</td>
<td></td>
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<tr>
<td>GDP</td>
<td>1.145***</td>
<td>0.408</td>
<td>(4.048)</td>
<td></td>
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</tr>
<tr>
<td>FDI</td>
<td>2.993***</td>
<td>2.942</td>
<td>(2.942)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumption</td>
<td>0.057</td>
<td>(0.193)</td>
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<td>Labor</td>
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<td>Capital</td>
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<td>(-1.739)</td>
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<tr>
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<td>(6.675)</td>
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<tr>
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<td>F</td>
<td>465.2</td>
<td>365.4</td>
<td></td>
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</tbody>
</table>

(1) Heteroskedasticity-robust t-statistics are shown in parentheses.
(2) ***p < 0.01, **p < 0.05, *p < 0.1.

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<th>VARIABLES</th>
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<td>Model 2</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Export</td>
<td>Export</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Co-existence</td>
<td>-5.509***</td>
<td>-1.101***</td>
<td>(-21.289)</td>
<td>(-7.805)</td>
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</tr>
<tr>
<td>GDP</td>
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<td>(7.281)</td>
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<td>FDI</td>
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<td>(8.781)</td>
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<td>Consumption</td>
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<tr>
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<tr>
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(1) Heteroskedasticity-robust t-statistics are shown in parentheses.
(2) ***p < 0.01, **p < 0.05, *p < 0.1.

### Table 6
Impact of co-existence on total exportation and importation.

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</tbody>
</table>

(1) Heteroskedasticity-robust t-statistics are shown in parentheses.
(2) ***p < 0.01, **p < 0.05, *p < 0.1.
pattern of economic growth, as E firms will no longer be profitable if production passes a certain threshold level. This leads to a co-existence of both E firms and F firms in the home economy.

Secondly, we further improve the micro-level assumptions in the second extension by adding intratemporal decisions into the model so that domestic consumers and firms are allowed to consume and invest both $x$ and $f$. Standard economic theory suggests relative demand between two goods will also depend on the relative prices between two goods. A fall in relative price-level in the second extension will raise the domestic demand and reduce the amount of exports from the home country, which in turn will be reflected in the next period’s relative price level. This endogenous setting will limit the price effects and delay the transitional failure.

3.1. Microfoundations

In our model, economic agents work in the first period and live off their savings in the second period. The utility function are in the CRRA form:

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

(4)

where $\beta$ is the discount factor and $\theta$ is the inter-temporal elasticity of substitution in consumption $c$. In this model, we assume that $\theta \geq 1$.

Total population, $N_t$, consists of two types of economic agents: workers and entrepreneurs. Both agents grow at a constant rate, $\alpha$. Each worker supplies one unit of labour at each time period, therefore, the total number of workers are assumed to be $L_t = N_t$ and the number of entrepreneurs is $\mu N_t$, where $\mu \in (0, 1)$.

3.1.1. Workers

Each young worker earns a wage $w_t$ and consume $c^w_t$ during the first period at time $t$, the rest is saved with financial intermediaries (banks) under perfect competition, since their second period consumption solely rely on their savings. Agents die without leaving positive bequests or debts to the next generations. The worker’s maximisation problem is subject to the intertemporal budget constraint:

$$c^w_t + c^w_{t+1} / R^d = w_t$$

(5)

where $R^d$ is the deposit interest rate. Solving the consumer’s maximisation problem yields the optimal savings $s^w_t = \tilde{s}^w w_t$, where $\tilde{s}^w = [1 + \rho \cdot \psi (R^d)^{-1}].$ Therefore, the worker’s consumption functions at each period are:

$$c^w_t = (1 - \tilde{s}^w) w_t$$

(6)

$$c^w_{t+1} = R^d s^w_t = R^d \tilde{s}^w w_t$$

(7)

3.1.2. Firms

On the production side, there are two types of firms: Financially integrated (F) firms representing SOEs which have preferential access to the financial intermediaries and Entrepreneurial (E) firms are owned by entrepreneurs. E firms can operate with more productive technologies than F firms, but they are restricted to the access to loans from the financial intermediaries due to financial frictions. Therefore, an E firm finance only part of their investment through the financial system, with the rest of the investment financed by accumulated savings. We assume normal Cobb-Douglas production functions for both F firms and E firms:

$$y_{yt} = k_{yt}^\alpha \left(x, n_{yt}\right)^{1-\alpha}$$

(8)

$\beta$ This implies that agent’s savings are non-decreasing in the rate of return. Under the special case, when $\theta = 1$, we have a logarithmic utility function.

$$y_{yt} = k_{yt}^\alpha \left(x, n_{yt}\right)^{1-\alpha}$$

where $y_t$ is output, $k$ and $n$ represent capital and labour respectively. Technology grows at a constant exogenous rate $\alpha$. Due to the weakness in corporate governance and the fear over severe agency problem, F firms prefer direct control. In contrast, E firms prefer delegation, agency problem is effectively limited so that only a share of, $\psi \in (0, 1)$, the total output will be lost. Delegation approach leads to higher total factor productivity (TFP) and is reflected by parameter $\alpha > 1$ in E firm’s production function. Therefore, the managers in F firms are paid the same wage ($w_t$) as the workers, whereas the managers in E firm are paid $n_t > w_t$. The presence of F firms heavily rely on the preferential access to financial intermediaries, otherwise, E firms will outgrow F firms immediately.

Financial intermediaries receive savings from workers and invest in domestic firms and foreign bonds ($B$). The bonds yield a gross return $R$, which is exogenously fixed by the world market. However, the lending within this economy is subject to financial frictions and it is reflected by the iceberg cost, $\psi$, which captures operational costs, verification costs, red tape, etc. Under the competitive environment, such costs are covered by setting the effective lending rate, $R^e$.

$$R^e = \frac{R^d \left(1 - \psi\right)}{1-\theta}$$

(10)

Free capital movement and arbitrage ensures that the rate of return from domestic savings equals the rate of return from foreign bonds (i.e. $R^d = R$). F firms behave just like the neo-classical firms, where profit maximisation implies that marginal revenue of capital equals lending rate (i.e. borrowing cost per capital unit) and marginal revenue of labour equals labour wage; after some rearrangement, we have

$$w_t = (1 - \alpha) \left(1 - \psi\right) R^d \frac{\tilde{s}^w}{\alpha}$$

(11)

The price of $f$ good (produced by F firms) is assumed to be the numerie in this economy. Workers can freely migrate between two types of firms with no extra skill training required, so E firms need to pay a competitive wage ($w_t$) to attract the workers to work at E firms.

E firms face an additional market friction, a verification cost, when borrowing from the financial intermediaries. Financial intermediaries are only willing to finance part of the E firms investment (i.e. $\eta$ share of the expected total profits of E firms). In our model, we also consider the changes in the relative price between $x$ (produced by E firms) and $f$, which is denoted by $p_t = \frac{R}{R^d}$ at time $t$, so that $p_t$ now denotes the total revenue of each E firm in terms of $f$ good and its profit can be expressed as a function of capital $k_{et}$:

$$\Pi(k_{et}) = \max_{m_{et}} \{ p_t (k_{et})^\alpha (x, n_{et})^{1-\alpha} - m_t - w_t n_{et} \}$$

(12)

The entrepreneurs have to pay a minimum managerial wage $p_t \psi (k_{et})^\alpha (x, n_{et})^{1-\alpha}$ for the managers to perform effectively. Optimal contract ensures the incentive constraint for managers is binding,

$$m_t = p_t \psi (k_{et})^\alpha (x, n_{et})^{1-\alpha}$$

(13)

Solving the profit maximisation problem for the entrepreneurs, we have the first order condition with respect to $n_{et}$, after some arrangement, we have

$$\Pi(k_{et}) = \max_{m_{et}} \{ p_t (1 - \psi) \left(1 + \rho \cdot \psi (R^d)^{-1}\right) - m_t - w_t n_{et} \}$$

(14)

where $R^d$ is the rate of return to capital for E firms at time $t$.

3.1.3. Entrepreneurs

The stock capital of E firm at $t + 1$ is formed by either savings or loans
from financial intermediaries at time \( t \), i.e., \( k_{2t+1} = \delta^* + \delta t \). As the rate of return to capital depend on \( p_t \), there would be an equilibrium level of debt share \( \delta t = \delta^* + \delta t \) at each time period. With perfect foresight about the next period profits and the optimal debt contract at time \( t \), we have a binding incentive compatibility constraint: 
\[
R_t^E = \eta_t k_{2t+1} \kappa_{t+1},
\]
which implies that \( E \) firms can borrow \( \delta t = \delta^* + \delta t \) from the financial intermediaries and invest in its production at time \( t \). The maximisation problem for the entrepreneurs is subjected to the budget constraints at time \( t \) and variables at time \( t + 1 \),
\[
c^t = m_t - \delta^* t
\]
(15)
\[
c^{t+1} = p_t \left( \delta^* t + \delta^* t \right) - R_t^E
\]
(16)
solving it, we have
\[
s^t = \left\{ 1 + \beta^* \left( \frac{(1 - \eta)p_{2t+1} R}{R - \eta p_{2t+1}} \right) \right\}^{-1} m_t
\]
(17)
where \( s^t = \left\{ 1 + \beta^* \left( \frac{(1 - \eta)p_{2t+1} R}{R - \eta p_{2t+1}} \right) \right\}^{-1} \). The entrepreneur’s consumption and savings decisions are now changing over time and are subject to the changes from the rate of turn to capital. On the other hand, the managerial wage, \( m_t \), also depends on the current level of relative price and production growth of \( E \) firms. Given the complexity of this dynamic, it is unlikely for us to reach clear analytical predictions, hence the dynamic process will be examined through simulation in more details.

### 3.2. Transition dynamics

**Proposition 1.** A successful transition requires the TFP gap to satisfy both \( \chi > \chi^* \) and \( \chi > \beta \). The former ensures the existence of \( E \) firms in equilibrium. The latter complements the process by ensuring \( E \) firms to outgrow the \( F \) firms. In our model, thresholds are changing over time with the price dynamics, which raises the possibility of different transition experiences. When the home country’s export production expands during transition, \( p_t \) continues to fall. The productivity and the profitability of the exporting firms (\( E \) firms) will fall, which unambiguously decelerates the transition and eventually ceases the transition at an equilibrium level (with \( E \) firms and \( F \) firms coexisting in the economy).

**Proof of Proposition 1.** This section provides the proof for Proposition 1 and specifies the economic transition process at the macroeconomic level. The derivation of the existence threshold is straightforward. In order to ensure that \( E \) firms borrow from the financial intermediaries and its existence in the transition equilibrium, we need the following assumption which satisfies \( \rho_{2t} > R^* \):
\[
\chi > \chi^* \equiv \left[ \frac{1}{p_t (1 - \psi)} \right]^{\pi}
\]
(18)

It also guarantees that \( E \) firms prefer delegation to direct control and young entrepreneurs are motivated to invest their savings in the production of \( E \) firms rather than deposit them in the financial intermediaries. The threshold productivity level is negatively related to the current relative price. Therefore, when the relative price falls, the speed of transition gradually slows down and the transition will eventually be ceased at a certain point.

First we denote \( k_{2t} \equiv k_t / (\kappa_A n_t) \) and \( k_{2t} \equiv k_t / (\kappa_A n_t) \) as the capital per effective unit of labour for \( F \) firms and \( E \) firms respectively. Similar to the neo-classical growth models, the Cobb-Douglas production functions can be rewritten as a function of \( \kappa \):

\[
\frac{y_{kt}}{A_p n_t} = \kappa_t^\phi
\]
(19)
\[
\frac{y_{kt}}{A_p n_t} = \kappa_t^\phi \left( \psi \right) \left( \eta_t \right)
\]
(20)

where \( \kappa_t \) is inversely related to \( p_t \). For simplicity, without losing important insights, we first assume all of \( x \) good produced by \( E \) firms are exported, while all the domestic consumers consume \( f \) good only. This implies total exports from this economy is equal to the total outputs from \( E \) firms, \( \chi^t = \chi_t \). These exports face a downward sloping world demand curve, given below:
\[
\chi^t = \varphi (\psi_t) - \phi
\]
(21)

where \( \varphi \) is the weight parameter and \( \phi \) is the export elasticity. Equally, we have the relative price function given by,
\[
\psi_t = \left( \frac{\varphi}{\chi^t} \right)^{1/\phi}
\]
(22)

As the exports continue to increase, then the relative price will fall due to the downward sloping world demand curve. The economic transition reflects the effects of resource reallocation between less efficient \( F \) firms to more productive \( E \) firms, so \( \gamma_t \) keeps growing overtime and it will lower its price in the world market. The falling price implies increasing level of capital per effective unit of labour in \( E \) firms overtime. Moreover, the optimal level of labour inputs in \( E \) firms will also decrease, which further raises the capital per effective unit of labour for \( E \) firms during the transition.

Now we move on to the transition dynamics. In our model, \( K_{2t} \) and \( A_t \) are state variables, but \( K_{2t} \) is now endogenous to \( p_t \) so it varies over time. Moreover, since the entrepreneurial saving decisions are endogenous, the growth rates of employment, capital, and output of \( E \) firms also change during the whole transition process. We will now examine the transition process for each factor.

By assuming constant return to scale, we can easily get the aggregate levels for all variables (upper case) by replacing all the individual variables (lower case) in all the equations discussed above. The total employment of \( E \) firms and \( F \) firms are expressed as
\[
N_t = K_{2t} / \chi A_{t+1}
\]
(23)
\[
N_t = N_t - K_{2t} / \chi A_{t+1}
\]
(24)

where \( N_t \) is the total employment which is shared by both firms. \( k_{2t} \) will directly affect the total employment in both firms. With lower \( k_{2t} \) (an increase in \( p_t \) will increase the profitability of \( E \) firms), the total employment of \( E \) firms will rise and the total employment of \( F \) firms will fall.

Regarding the capital growth, we have capital stock of \( E \) firm at \( t + 1 \) as
\[
k_{2t+1} = k_t + \delta s^t + \delta t = \left[ R^t / (R^t - \eta k_{2t+1}) \right] s^t
\]
(25)
It clearly shows less savings at time \( t \) will lead to lower the capital stock of \( E \) firms at time \( t + 1 \). We know the managerial wage is \( \psi \) share of the total revenues in \( E \) firms, so the aggregate capital of all \( E \) firms at time \( t+1 \) is:
\[
k_{2t+1} = R^t / (R^t - \eta k_{2t+1}) \kappa_t^\phi p_t \psi \kappa_t^\phi A_{t+1}
\]
Divide both sides by \( K_t \) and substitute \( \delta^* t \) and \( \delta^* t \), we have

\[
\kappa_{2t+1} = k_t / (A_A n_t)
\]

\[\]
where $\rho_{E} = \left[p_{1}(1 - \psi)\right]^{1/\beta}R^{\beta}$. The capital growth dynamics are more difficult to predict analytically, as $\rho_{E}$, $\psi$, and current levels of savings and borrowings are all influenced by the relative price levels and the latter two also depend on the expected future value of $\rho_{E}$. E firm's employment growth is given by:

$$\frac{N_{E_{t+1}}}{N_{E_{t}}} = \frac{K_{E_{t+1}}}{K_{E_{t}}} \left[ \begin{array}{c} A_{1} \kappa_{E_{t}} \kappa_{E_{t}} = \left( 1 + Z_{K_{E_{t}}} \right) \left( \frac{p_{E_{t+1}}}{p_{E_{t}}} \right) \right]^{1/\alpha} \equiv 1 + \epsilon_{E_{t}} \tag{27}$$

In addition to the capital growth in E firms, employment growth is also positively related to the growth of price levels. Given the complexity of the dynamics, quantitative simulation is required to examine the both capital and employment growth in E firms.

The key feature of the economic transition is reflected by the shift of labour from F firms to E firms, which implies that employment of F firms to grow faster than the population growth rate (i.e. $E_{F} > L$). Bring the full expression of ([Eq. (27)]) into ([Eq. (28)]), we have

$$\frac{R^{\beta}}{\left[ R^{\beta} - \eta p_{E_{t+1}} \right]} \left( 1 + \beta \frac{\left( 1 - \eta p_{E_{t+1}}^{1/\beta} \right)^{1-\beta}}{\left( 1 - \psi \alpha \left( \frac{p_{E_{t+1}}}{p_{E_{t}}} \right) \right)^{1-1/\alpha}} \right) \frac{\psi}{1 - \psi \alpha (1 + \psi)(1 + g)} > (1 + \psi)(1 + g)$$

Rearranging the inequality, we have,

$$\psi \frac{1}{1 - \psi \alpha (1 + \psi)(1 + g)} > \left( \frac{p_{E_{t+1}}(1 - \psi)^{1/\beta} \chi^{1/\beta}}{p_{E_{t}}^{1/\beta}} \right) \left( \frac{p_{E_{t+1}}}{p_{E_{t}}} \right) \right) \right) ^{1/\beta}$$

Given any positive levels of $p_{E}$ and $p_{E_{t+1}}$, there must exist a value of $\chi$, that equates both sides of the inequality. Because the left hand side is a constant, whereas the right hand side is monotonically decreasing in $\chi$. The level of relative prices here will affect the speed of convergence/divergence when $\chi$ changes, which is why we have the time subscript for the threshold level. For $\epsilon_{E_{t}} > \chi$, we assume another requirement that satisfies $\chi > \chi_{E_{t}}$ at time t, otherwise, the reverse process will happen. This is indeed the case, as it is shown in our simulation.

Proof Completes

The right-hand side is decreasing in $\beta$, $\eta$ and $R^{\beta}$ so they need to be sufficiently large to ensure the inequality. An increase in $p_{E_{t+1}}$ will have both positive effects and negative effects on the right hand side, which depends on the values assigned to other parameters. The left-hand side is decreasing in $\alpha$, $\psi$, and $g$, but increasing in $\psi$. Thus, the inequality requires small $\alpha$, $\psi$, $g$ and a reasonably large $\psi$.

The equilibrium dynamics of F firms is captured by the condition that $K_{F_{t}} = \kappa_{F_{t}}A_{1}(N_{E_{t}} - N_{F_{t}})$. Hence, as long as the employment share of E firm grows, the growth rate of $K_{E}$ declines, following similar steps, we get

$$\frac{K_{E_{t+1}}}{K_{E_{t}}} = \frac{A_{1} \kappa_{E_{t}} N_{E_{t+1}}}{A_{1} \kappa_{E_{t}} N_{E_{t}}} = \left( 1 + g \right) \left( \frac{N_{E_{t+1}} - N_{E_{t}}}{N_{E_{t}} - N_{F_{t}}} \right) \equiv 1 + Z_{K_{E_{t}}} \tag{30}$$

and

$$\frac{N_{E_{t+1}}}{N_{E_{t}}} = \frac{N_{E_{t}}(1 + \psi) - N_{E_{t}}(1 + \psi)}{N_{E_{t}} - N_{F_{t}}} = 1 + \psi \frac{N_{E_{t}} - N_{F_{t}}}{N_{F_{t}} - N_{E_{t}}} \tag{31}$$

denote $u_{E} = \epsilon_{E}$, bring back to the ([Eq. (31)]), and after differentiating with respect to $\epsilon_{E}$, we have,

$$\frac{d}{dt} \left( 1 + Z_{K_{E}} \right) = \left( 1 + g \right) \left( \frac{v - \epsilon_{E}}{1 - \epsilon_{E}} \right) \tag{32}$$

Proposition 2. This implies that the capital growth rate of F firms relies on the employment shares of E firms in this economy. If the employment share of E firms grows faster than the population growth rate (i.e. during the economic transition), the capital growth in F firms declines, and vice versa.

We will examine the dynamics of the aggregate capital accumulation of F firms during the transition in the quantitative analysis. The GDP per capital, during the transition, is given by

$$\frac{Y_{F}}{N_{F}} = \frac{Y_{F}(1 - \psi) + Y_{E}}{N_{E}} = \frac{Y_{E}}{N_{E}} + \frac{Y_{F}}{N_{F}} \tag{33}$$

where,

$$\frac{Y_{F}}{N_{F}} = \kappa_{F}^{\beta} \left( \frac{A_{1}N_{E}}{N_{F}} \right)^{1-\alpha} \frac{\kappa_{F}^{\beta}A_{1}N_{E}}{N_{F}} \tag{34}$$

$$\frac{Y_{E}}{N_{E}} = \kappa_{F}^{\beta} \left( \frac{A_{1}N_{E}}{N_{F}} \right)^{1-\alpha} \frac{\kappa_{F}^{\beta}(1 - \psi)\psi}{p_{F}^{1 - \psi}} \frac{A_{1}N_{E}}{N_{F}} \tag{35}$$

After rearrangement, we have

$$\frac{Y_{F}}{N_{F}} = A_{1} \left( 1 + p_{F}(1 - \psi) \right) A_{F} \tag{36}$$

Once again, we are facing the trade-off between the production levels and price levels. The growth rate accelerates during the transition when $\chi > \chi_{E_{t}}$ and we observe a growing share of the E firms in the economy. As F firms are more productive than F firms, the reallocation of resources from F firms towards E firms will create more production and the average rate of return to capital increases as well. However, in our extension, all the products produced by E firms are now exported. These exports are subject to a downward sloping world demand curve, which lowers its price and diminishes $\rho_{E}$ and the total profits of E firms. If $\rho_{E}$ falls below to a certain level, E firms are no longer profitable then a reverse labour migration from E firm back to E firms will be observed, which hinders the economic transition process.

3.3. Trade and external balance

Having discussed the transition dynamics in this economy, we now focus on its impacts on the external balance of the economy. The aim of this section is to examine the interactions between the consumption/saving decisions, economic growth, and international trade. We first keep the simple assumption that all $x$ goods (produced by E firms) are exported and domestic consumption/investment only uses $f$ goods (produced by F firms) in this economy. This assumption will be relaxed later in the next section by allowing intratemporal decisions.

The total GDP of this economy is given by,

$$p_{F}Y_{E} + Y_{F} = Y_{F} \tag{37}$$

Since all the products from E firms are exported, the aggregate amount of exports equals to the total production from E firms,

$$EX_{E} = Y_{E} \tag{38}$$

the aggregate demand of $f$ goods in this economy will likely to exceed (as domestic consumers and firms consume and investment only with $f$ goods) its aggregation production from the F firms, so the total imports can be shown as
IMt = DAt − YAt

where \( DAt \) is the domestic demand for \( f \) goods at time \( t \), \( EXt \) and \( IMt \) denote for current levels of exports and imports respectively. In this simple model, the final outputs are either consumed or invested or participated in the international trade, the trade balance of this economy can then be defined as,

\[
NXt = p_t EXt - IMt - Yt - Ct - It
\]

where \( p_t EXt \) is the export revenue measured in terms of \( f \) good. Equally, we see the account current should be consistent with the differences between the domestic savings and domestic investment at time \( t \):

\[
NXt = S_t - It
\]

where the external balance (B) also reflects the capital flows positions. In the micro-foundations, we assume all the savings within this economy are entirely coming from the workers. Because the entrepreneurs are assumed (when \( x > x^* \)) to invest all their savings in their own production, which earns higher returns than saving with financial intermediaries. This is also because of the financial constraints which are imposed on \( E \) firms, as entrepreneurs can only finance part of the investment by borrowing from the financial intermediaries. The investments made by financial intermediaries are divided between the \( F \) firms and \( E \) firms: since the \( F \) firms are financially integrated, the entire investment in \( F \) firms are financed through loans, while the latter can only finance part of their investments (\( t_{t-1} = \frac{w_{t-1}}{R_{E}} \)) from the financial intermediaries.

\[
B_t = c^*(w_{t-1} - K_{t-1} - \frac{\eta p_t}{R} K_{E})
\]

where \( c^*(w_{t-1} - K_{t-1} - \frac{\eta p_t}{R} K_{E}) \) represents the total savings from workers at time \( t - 1 \) and last two terms on the right are the domestic investment made by the financial intermediaries. Substituting both \( K_{t-1} \) and \( K_{E} \) with \( \kappa_E \) and \( \kappa_B \), respectively, we have:

\[
B_t = \left( \frac{c^*(1-\alpha)}{(1+\gamma)(1+\nu)} \right) - \kappa_E \frac{\eta p_t}{R} \frac{\eta p_t}{R} \frac{\kappa_B}{K_{E}} A_Nt
\]

where \( w_{t-1} = (1-\alpha)A_{t-1} \) and \( \frac{\kappa_B}{K_{E}} = 1 - \frac{\kappa_B}{K_{E}} \). Substituting into (40), we have

\[
B_t = \left( \frac{c^*(1-\alpha)}{(1+\gamma)(1+\nu)} \right) - \kappa_E \frac{\eta p_t}{R} \frac{\kappa_B}{K_{E}} A_Nt
\]

The growing share of employment in \( E \) firms contributes to the accumulation of foreign bonds during the economic transition, as the growing foreign surplus is reflected by employment reallocation within the economy. The financially integrated \( F \) firms shirk and release more and more labour to the more productive \( E \) firms. Therefore, should the financial friction remain, the domestic borrowings will fall and the financial intermediaries gradually shift their investment portfolio towards foreign bonds. The transition will eventually come to an end with all the labour employed by the \( E \) firms (i.e. \( N_{E} / N_t = 1 \)). However, having the price effects, such predictions will no longer hold.

**Proposition 3.** as \( E \) firms continue to grow, the increasing supply of \( f \) goods in the world market will lower \( p_t \). This price adjustment effect will affect \( E \) firm’s rate of return to capital (\( \rho_{E} \)) and result a lower level of profits for \( E \) firms (i.e. lower consumption from the firm owners during the second period). Additionally, the total revenues will also fall, if the expansion of production is not big enough to cover the fall in price. This leads to lower managerial wage (a fixed share of firm’s total revenues) and less savings for later investment. The transition is then trapped in a vicious cycle and the levels of net capital out-flows are also reduced. Given the complexity in these dynamics, we can only verify Proposition 3 through model simulation.

### 3.4. Adding intratemporal decisions

In this section, we relax the assumption on the domestic demand decisions and allow domestic consumption/investment demand to choose between two goods: \( f \) goods are produced by \( F \) firms and \( x \) goods are produced by \( E \) firms. This requires adding intratemporal decisions about the composition of the consumption bundle for both workers and entrepreneurs as well as intratemporal decisions about the investment demand from \( E \) firms and \( F \) firms in this economy. For simplicity, we will examine Cobb-Douglas aggregator in this section.

We first consider the intratemporal Cobb-Douglas consumption aggregator for both workers and entrepreneurs, which captures the essential ideas that we intend to show. We assume that the Cobb-Douglas consumption aggregators are the same across two periods. On the consumption side, we have seen the optimal consumption decisions are made by the worker’s maximisation problem and the entrepreneur’s maximisation problem, but we have not discussed how much \( x \) goods and \( f \) goods are consumed by each worker/entrepreneur. In order to do so, we first maximise the Cobb-Douglas consumption aggregators for both workers and entrepreneurs,

\[
\max_{x_t^W, f_t^W} \frac{(x_t^W)^{1-\sigma}}{(f_t^W)^{\sigma}}
\]

where \( J \in \{1, 2\} \), \( c^W_J \) and \( c^E_J \) denote the consumption for workers and entrepreneurs respectively at period \( J \) and time \( t \), subject to the budget constraints measured in \( f \) goods,

\[
c^W_J = p^x_{J} x^W_t + f^W_t
\]

\[
c^E_J = p^x_{J} x^E_t + f^E_t
\]

This maximisation problem implies that, at period \( J \) and time \( t \), the workers will spend the share \( q \) of the consumption budget on \( f \) goods and the share \( 1 - q \) on \( x \) goods. Similarly, each entrepreneur will spend \( \sigma \) share of his/her consumption budget on \( f \) good and the rest on \( x \) goods. The demand functions for both workers and entrepreneurs at life period \( J \) are shown below:

\[
x^W_t = \frac{(1 - q) x^W_t}{p_t} \quad x^E_t = \frac{(1 - \sigma) c^E_t}{p_t}
\]

\[
f^W_t = q c^W_t \quad f^E_t = \sigma c^E_t
\]

Following this, using the quantity demand function we can show how the relative demand between two goods reacts to price changes over time. We illustrate the first period worker’s consumption as an example, using the same steps can also be applied to entrepreneurs. From Eqs. (51) and (52), we have

\[
x_{1t}^W = \frac{(1 - q) x_{1t}^W}{p_t}
\]

\[
f_{1t}^W = q c_{1t}^W
\]
the relative demand between $x$ and $f$ for workers who are in their first period of life at time $t$ is given by

$$x^W_t = \frac{(1 - \varphi) f^W_t}{q \cdot P_t}$$

(53)

Similar steps apply to time $t + 1$, we have

$$x^W_{t+1} = \frac{(1 - \varphi) f^W_{t+1}}{q \cdot P_{t+1}}$$

(54)

This implies that if $P_{t+1} < P_t$, i.e. if price falls between $t$ and $t + 1$, the relative quantity demand between $x$ and $f$ for period 1 workers increases accordingly. The same results are also suitable for entrepreneurs. Rearranging (64) and apply the same procedure to time $t + 1$, we have

$$x^W_t = \frac{(1 - \varphi) f^W_t}{q \cdot P_t}$$

(55)

$$x^W_{t+1} = \frac{(1 - \varphi) f^W_{t+1}}{q \cdot P_{t+1}}$$

(56)

bring them back to the budget constraint,

$$c^W_t = P_t x^W_t + f^W_t = \frac{(1 - \varphi) f^W_t}{P_t} + f_t = \frac{1}{q} f_t$$

(57)

$$c^W_{t+1} = P_{t+1} x^W_{t+1} + f^W_{t+1} = P_{t+1} \frac{(1 - \varphi) f^W_{t+1}}{P_{t+1}} + f_{t+1} = \frac{1}{q} f_{t+1}$$

(58)

Although the fall in price increases the relative quantity demand of $x$ over $f$, the consumption share of each good within the same time period does not change, since the price effects cancel out. This is the special property of the Cobb-Douglas aggregator. In the Appendix-A, we use a more general setting for the aggregator (CES aggregator) and allow the property of the Cobb-Douglas aggregator. In the Appendix-A, we use a more general setting for the aggregator (CES aggregator) and allow the share of investment demand for each good at time $t$ with the Cobb-Douglas aggregator, the investment demand from E firms and F firms on each good can also be expressed by,

$$I^E_t = \frac{(1 - \lambda) f^E_t}{P_t}$$

(63)

$$I^F_t = \lambda f^F_t$$

(64)

where $\lambda$ is the share of investment demand of $f$ good in E firms and $\lambda$ denotes the share of investment demand of $f$ good in F firms. Similarly, the share of investment demand for $x$ good in E firms and F firms are given by $(1 - \lambda)$ and $(1 - \lambda)$ respectively. Therefore, same as the consumption demand, the investment demand on $x$ good is also inversely related to the relative price levels. To combine both domestic consumption demand and investment demand, we have the aggregate domestic demand for both $x$ and $f$ at time $t$:

$$D_x = C_x + I_x$$

(65)

$$D_f = C_f + I_f$$

(66)

where $C$ and $I$ are aggregate consumption demand and aggregate investment demand within the economy. So in this extension, both $x$ goods and $f$ goods are consumed/invested domestically at first. Therefore, at time $t$, if the domestic demand exceeds its domestic supply, the home country needs to cover this unmet demand by imports. Similarly, if the domestic production exceeds its demand, all the extra products will be exported. In our model, we assume the country has none or small amount of foreign assets prior to economic transition. F firms dominate the market at the beginning, with a small amount of E firms exist in the home country. As soon as the transition takes off, E firms grow rapidly and gradually outgrow the F firms. The theory suggests the boom of E firms at home country is accompanied by shrinking the number of F firms at the same time, where the resources of F firms are gradually transferred to E firms. This is one of major sources of the growing TFP at home country. Hence, the home country will be exporting $x$ goods and importing $f$ goods. The net capital flows should be equal to the net export revenues at home country, which indicates that:

$$EX_t = Y_{Et} - D_x$$

(67)

$$IM_t = D_f - Y_{Et}$$

(68)

$$B_t = p_t EX_t - IM_t$$

(69)

This is different from our first extension, as now the domestic consumer will consume both goods. From the transition dynamics, we notice that, once the transition takes off, $Y_{Et}$ increases and $Y_{Et}$ declines over time. This implies growing import demand of $f$ good and increasing export supply of $x$ good from home country. However, this is not the whole story. A rise of $EX_t$ will lower the $p_t = \left( \frac{1}{EX_t} \right)^{1/\varphi}$ in the world market and the domestic demand of $x$ good will also react to the falling relative price level. This falling relative price level is explained in details in the previous section, as the growing exports of $x$ good from home country is subject to the downward sloping world demand curve, the increasing world supply of $x$ lowers its price level at the world market. Arbitrage ensures that the domestic price level is same as the international level. Hence the falling relative price further increases the domestic demand for $x$ and it will reduce the level of $EX_t$ at time $t + 1$. Given the increase in domestic demand is unlikely to exhaust all the production surplus from E firms, which will decelerate the process of falling price so that it will be less dramatic than our previous extension. The turning point of the transition is expected to be delayed to later periods, when adding intratemporal decisions.

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This is a simple demographic assumption, in future research we can relax this assumption and conduct country specific research.
4. Model simulation

The simulation section is used to verify our qualitative predictions about the model and examine the economic transition process under different scenarios of financial development. The baseline simulation replicates Song et al. (2011)\(^\text{10}\). The main purpose of the baseline model is to capture the empirical facts about the economic growth in China between year 1998 and 2005, however, should the baseline scenario continue, E firms shall completely drive F firms out of the market, which we find is not true. The empirical observation clearly shows coexistence of both firms. In fact, the SSZ is only a special case of our theory\(^\text{11}\). In this simulation we further explore the possibilities of different transition experiences and provide quantitative evidence for our propositions. Simulation 1 is based on assumptions that there are two different products x and f. All products (x) from E firms are exported and subject to the downward sloping world demand curve, while the f goods are consumed and invested domestically only. Simulation 2 is a generalised form of the first extension. It relaxes the assumptions on the consumption/investment behaviour and introduces the intratemporal decisions, which allows to consume and invest two goods domestically.

4.1. Scenario 1 - adding heterogeneous outputs and relative price

In scenario 1 all the E firms outputs are exported and subject to a downward sloping world demand curve\(^\text{12}\), which is given by \(p_t = \left( \frac{\phi}{\phi - \nabla} \right)^\frac{1}{\phi} \); hence, we need to add two more parameters into the calibration of our first extension: \(\phi\) is the weight parameter\(^\text{13}\) and \(- \phi\) is the export elasticity. The rest of the parameter values are consistent with the SSZ model.

The calibrated parameters are given in Table 9. Imbs and Mejean (2010) provides cross-country evidence on the export price elasticity, with the estimates for most of the country lie between –3 and –4. We choose the upper bound, –3, in the simulation which provides reasonable dynamics for most of the variables. Furthermore, it seems natural for us to assume the initial relative price to be 1 in both extensions so they can be consistent with the baseline model at the initial position. This assumption is also important for the initialisation of all the other economic variables in all our simulations.

In order to avoid sharp price falls, we take the log form of the total exports in our price simulation and set an upper limit for the relative price at 1 which further smooths the price movement during the simulation\(^\text{14}\). In this simulation, the growing production from E firms will shift the world supply curve to the right and lower the relative price after the transition takeoff. This further decreases the rate of return to capital in E firms and lessens their profitability and entrepreneurial savings. Therefore, the transition process is slowed down.

4.2. Scenario 2 - adding intratemporal decisions

Our second scenario is based on more realistic micro-level assumptions, which allow the domestic consumption and investment consist both x good and f good. Without losing generality, we assume Cobb-Douglas aggregator for both consumption and investment. We have simplified the model by assuming both workers and entrepreneurs spend \(\sigma\) share of their consumption budget on f good and the rest on x good. Similarly, there are \(\nu\) share of the domestic investment (combining investment demand from both E firms and F firms) goes to f good and the remaining goes to x good. Additional calibrated values are presented in Table 10. We assign 0.7 for both consumption shares and investment shares of f good to produce representative results from our model. With more detailed study on specific countries, we can adopt more realistic values for both consumption and investment demand. Our theory also allows the shares to be different between the entrepreneurs and workers and between the E firms and F firms.

We have the calibrated demand function of x and f are given by,

\[
D_x = \frac{(1 - 0.7)(C_t + I_t)}{p_t} \\
D_f = 0.7(C_t + I_t)
\]

The quantity demanded function for x good is inversely related to the relative price \(p_t\), but the budget share (i.e. \(p_tD_x\)) spent on each good is invariant to price variations\(^\text{15}\). Therefore, in our second scenario, the domestic demand of x also reacts to the changes of relative price levels at the world market. When the transition takes off, E firms expand their production and gradually meet the domestic demand and start exporting the additional outputs. The story is similar to the first scenario, however, now a fall in the relative price of x will encourage the domestic agents to consume more x good and invest more with x good, which lead to a rise in the domestic demand. The increase in domestic demand is unlikely to exhaust all the exports from home country, since the market size of the home country is relatively small comparing it with the world market. With a reduction in the amount of exports from home country, the relative price of exports falls less dramatically than our first scenario.

Again, we assume the initial relative price and the upper limit to be 1, since our focus lies on the effects of falling relative prices on economic transition. This assumption stays when the domestic demand from home country exceeds its production of x good. Both conditions ensure initial levels of the other economic variables are also consistent with the baseline model and first scenario. We would expect all the results from our second scenario to be closer to the baseline predictions than our first extension, as the relative price movements are stickier.

4.3. Results

In all our results, f good serves as the numerie and the time frame is limited to the transition period between 1992 and 2012 which is consistent with the SSZ model. The aim of our simulations is to focus on the possibilities of other transitional paths for the home economy, which will provide a more complete picture about the economic development process. In fact, we believe this model better describe the economic slow

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\(^{10}\) All the baseline results are generated from the MATLAB files provided by the authors.

\(^{11}\) When the relative price of two goods always remain at 1.

\(^{12}\) This also implicitly assumes that the world will fully absorb the exports from home country.

\(^{13}\) The model solves with a weight parameter ranging between 2.5 and 4, we choose some values in the middle to avoid extreme movements.

\(^{14}\) We are mainly interested in the general trend of economic transitions, so this upper limit of relative price does not affect our general conclusion.

\(^{15}\) Under a more general form, i.e. CES aggregator, the consumption budget share spent on each good also varies.
down observed in China after 2010.

In the baseline model, the transition process is primarily reflected by the growth of the employment levels in E firms. During economic transition, we expect the efficient E firms to gradually outgrow the inefficient F firms. This is directly reflected by the baseline simulation in Panel E and Panel F (Fig. 4). On the contrary, our model experiences economic growth slow down, the transition slows down after year 1997 in first extension and, for the second extension, this slowdown comes after year 2000. The slow down in economic growth and trade activities are indeed observed in China in recent years. Hence our model better fits the growth experience post 2008 financial crisis.

On the other hand, the employment of F firms are more persistent in our model. E firms face difficulties to carry on the transition after certain point and F firms keep the dominant position on employment levels. According to the assumption there is no unemployment in this economy16 and the amount of working-age workers is fixed, the employment shares of E firms and F firms always add up to the full employment level. This verifies our claims in the propositions.

Another important input in the production function is capital. We find the aggregate capital levels of E firms in both scenarios increase by much less than the baseline, while the aggregate capital levels of F firms are much higher than the baseline prediction. Why? The capital levels in E firms and F firms are directly linked with the labour employment in each firm (having the capital-labour ratios $k_E$ and $k_F$ constant). In the baseline, the employment of E firms outgrow the F firms during the transition. Hence, the capital levels of E firms and F firms are following the same trend as employment levels. In our model, $k_E$ stays constant, but $k_F$ is inversely associated with the relative price ($k_F = \frac{k_E}{1 - \psi} (1 - \psi)$). Hence, when transition starts, the growing employment and the production of E firms will be accompanied by falling relative prices (due to the downward sloping world demand curve, see Panel A in Fig. 4), which increases the capital-labour ratio in E firms. However, the overall trend of capital growth is dominated by the total employment of E firms. This is verified by Panel A and D (Fig. 4). The capital growth of F firms is still following the same trend of the employment in F firms. The capital growth intensifies after 2000, because the falling iceberg cost encourages capital deepening in all firms (financially integrated F firms benefit more from this financial development). The aggregate output of the economy increases by less in our model, as the efficient E firms grow much slower and the inefficient F firms remain dominant in the economy.

Next, we further investigate the causes of the economic slowdown in our model. The most important feature is the falling relative price levels. In Panel A (Fig. 5), the relative price stays constant at 1.7 between year 1992 and 1995 in the first scenario, while the fall is delayed to year 2000 in the second scenario. While the relative price is at 1, both scenarios follow exactly the baseline simulation. The economic transition starts off as in the SSZ model, with E firms gradually expand their production and hire more labour over time. Scenario 1 assumes all the production from E firms are exported, therefore, the relative price is determined at the world market. The more $x$ goods are exported, the further the relative price will fall. The relative price is stickier in the second scenario18, as the fall of the relative price of $x$ also increases its domestic demand (for both consumption and investment) and reduces the amount of $x$ exports. This prevents its relative price from falling as quickly as in the first extension.

In Panel B, we observe a falling trend of the rate of return in both firms after year 2000; this is because of the financial development effects: the iceberg cost, $z_t$, gradually falls to 0 from 2000 to 2019 following the setup of the SSZ.

However, this falling trend starts early in our model, due to the additional effects from falling price: $\rho_{k_F} = \left[\beta(1 - \psi)\frac{\eta}{1 - \psi}\right]^{1 - \delta}$. In the baseline, the rate of return in E firms always remain 9% higher than the rate of return in F firms. Now adding the falling price effects, the rate of returns to capital in E firms drops more quickly and fosters the productivity gap between two firms to converge. The falling rate of return will affect the total profits of E firms ($II(k_{EB}) = \rho_{k_B} k_{EB}$), the savings from managers ($s_t = \left[1 + \beta^t \left(\frac{(1 - \psi)k_{EB}}{k_{EB} + \omega_{t+1}}\right)^{1 - \delta} - 1\right] m_t$), and the amount of loans that can be borrowed from financial intermediaries ($l_t = \omega_{t+1} - k_{EB}$). To combine all these effects at time $t$, we observe a fall in the investment of E firms and less outputs of E firms at time $t+1$ than the baseline. Both falling relative price levels and less outputs at time $t+1$ contribute to a lower revenue at time $t+1$ and result a lower managerial wage at time $t+1$.

In our model, the full transition equilibrium is not reached, which means that life-time earnings of workers are permanently lower than the baseline simulation at new equilibrium, due to the existence of less efficient F firms. This provides answers to the puzzling differences between the aggregate consumption/saving of workers in Figs. 6 and 7. The wage differential and entrepreneurial savings are the main drivers to trigger the economic transition in the SSZ model; now both factors increase by much less in our model, which inevitably slows down the transition process.

Panel E and Panel F in Fig. 5 present staggering differences on the capital account positions among three simulations. The capital flows in the model are determined by the differences between the domestic savings and domestic investment. There are drivers behind this: 1. F firms are financially integrated and its production technology requires higher levels of investment than E firms. More importantly, the F firms remain dominant; 2. The increasing savings from the entrepreneurs (managers) are the major sources for the future investment in E firm, as they are financially constrained, but now the falling relative price discourages the savings from entrepreneurs by lowering the rate of return in E firms and managerial wage. Therefore, our model predicts the possibility of capital inflow rather than outflow19 after certain tipping point. This suggests a possibility to rebalance the position of foreign reserves in a country20. To understand the causes, we need to analyse in more detail the aggregate saving and investment dynamics in the model.

The investment in both firms covers the change in capital stocks and the depreciation ($I_t = K_{t+1} - (1 - \delta)K_t$). The transition process is slowed down in our model, which leads to a higher aggregate capital stock in F firms and lower aggregate capital stock in E firms than the baseline simulation.

As the aggregate investment levels are driven by changes of aggregate capital levels, the trend of aggregate investment in both firms should be consistent with the trend of the aggregate capital levels in both firms. This is confirmed by Panel D and Panel E (Fig. 6). The pattern of aggregate investment is dominated by the pattern of the aggregate investment of F firms in our extensions, while in the baseline, this was dominated by the aggregate investment of E firms.

On the other hand, as we have explained earlier, the savings of entrepreneurs grow much slower than the baseline model because of the

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16 This assumption can be further released and adding the labour market frictions into the model.

17 This is due to the upper limit assumption, which smooths out the undesirable price movements.

18 The price remains at 1 in the second extension when the home country does not export $x$ or when the price movement hit the upper limit.

19 The capital inflows only last for a short period of time. In the long run, our model also predicts capital outflows, but less than the predicted levels from SSZ model.

20 Unfortunately, this is not the long equilibrium of the model, the transition will speed up again in later periods (when the relative price approaches its equilibrium level) and reaches an equilibrium levels with both E firms and F firms existing in the economy.
falling rate of return to capital and managerial wage. This is indeed observed in Panel A (Fig. 6), and the savings of workers increase by much more in our model. Given the large number of workers within the economy, the trend of aggregate savings is inevitably dominated by their savings.

However, the growth of entrepreneurial savings surges in the baseline simulation, which dwarfs the savings of workers and dominates the trend of aggregate savings. The reasons for these changes are less intuitive, since the theoretical part suggests that the workers save at a constant rate. To solve our puzzles, we need to analyse Fig. 7. In the simulation, the total savings of entrepreneurs are given by the changes in aggregate asset of entrepreneurs between time $t$ and time $t + 1$ and the depreciated capital stocks in E firms ($S_E = A_{E_{t+1}} - A_E + \delta K_E$). Similarly, the aggregate savings of workers are determined by the changes of aggregate asset (wealth) levels of workers and depreciated capital stocks in F firms ($S_F = A_{F_{t+1}} - A_F + \delta K_F$).

The changes in asset levels follow the law of motion. The difference in aggregate asset positions between our model and the baseline simulation is entirely due to the lower life-time earnings of workers, as in our model, the transition process reaches an equilibrium level with the existence of
both E firms and inefficient F firms. With less lifetime earnings, the workers need to accumulate more wealth than the baseline to smooth their consumption across time. The aggregate asset positions of workers coincide between two extensions is a direct consequence of the identical long run labour wage. The differences in the saving levels of workers are due to the different capital stock levels in E firms and F firms. We noticed that the savings of workers are higher in the extensions, but they rise less dramatically than the aggregate investment in F firms, which explains the predictions of net capital inflow in our extensions.

The divergence between the consumption of workers in our extensions and the baseline (Panel B in Fig. 7) is also caused by the differences of lifetime earnings between the simulation of our extensions and the baseline simulation. With less earnings, the workers consume less in our model. The lower consumption levels for entrepreneurs follow a similar logic, as we have seen in Fig. 5, the managerial wage grows by much less, which results lower consumption. With lower consumption, the asset accumulation for entrepreneurs appears to grow faster in our model at the beginning. However, the baseline soon surpasses both scenarios, as E firms grow much faster and offer increasingly higher managerial wages over time, which enable the wealth accumulation process to speed up after a certain point.

**Fig. 5.** Transition dynamics of relative price, rate of return, wages and capital account positions.
5. Conclusion

The economic growth in China has been heavily reliant on investment and exports for quite some time. The failure to translate the benefits of economic growth into domestic consumption calls for urgent action to rebalance the Chinese economy\(^{21}\). Our model explores the theoretical possibilities of the Chinese growth experiences with the coexistence of both SOEs and private firms. Our work also enriches the understanding about the interactions and interdependence between economic transition and international trade.

We first introduce heterogeneous outputs into the SSZ model by assuming SOEs (F firms) and private firms (E firms) produce two different products, with the latter specialises in exporting only. Another major difference is the inclusion of relative price between two goods and the downward sloping world demand curve. The relative price levels is endogenised into many key variables, such as the managerial wage, the

\(^{21}\) Bernanke (2005) even believes that the global imbalance was an underlying cause of the financial crisis.
rate of returns to capital in E firms, the saving rate of entrepreneurs, and E firm's capital per effective unit of labour. Therefore, the private firms cannot completely outgrow the SOEs during the transition due to the falling relative price. If the increasing exports from home country lowers the relative price to a threshold level the transition process could even come to a halt.

In addition, we develop a more realistic set of micro-level foundations by allowing intratemporal decisions for the consumption demand of workers and entrepreneurs and the investment demand of E firms and F firms. The essential idea is to allow domestic consumers and firms to consume and investment two different goods domestically so that a falling relative price will also raise its domestic demand. Hence the price movements are less dramatic than the first extension.

Another important result is related to China's accumulation of foreign reserves and net capital flows. In contrast to the popular argument that the growing foreign reserves in China are due to the manipulation of its exchange rates and export-led growth, the financial repression plays a key role in understanding the foreign reserve accumulation in China. Our model predicts a failure of full transition. Hence it is compatible with the recent empirical observation. China's foreign reserves have been falling
continuously from US$3.8 trillion in 2014 to US$3.1 trillion in 2017. Net capital outflow at the beginning of economic transition can be reversed if the transition hits the turning point.

Appendix. B Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.econmod.2019.06.003.

Appendix A. Intratemporal Decisions with CES Aggregator

In Section 3, we already examined the intratemporal decisions with a Cobb-Douglas aggregator. We can further examine the effects of intratemporal decisions with the constant-elasticity-of-substitution (CES) aggregator. This does not change the important conclusions in our extensions, but it also allow the budget shares to respond to price changes. Note that some notations are redefined in the appendix and we focus on the consumption aggregator only. The investment demand for E firms and F firms follow similar derivations. The following steps are derived by the aut hor.

In this case, each consumer (worker or entrepreneur) maximises a CES function:

$$\max_{x^*_h, J^*_t} \left[ \frac{1}{\gamma} \left( \frac{\gamma}{\gamma-1} \theta \left( \gamma f^{W}_{J_t} \right)^{\gamma-1} \right) \right]$$

$$\max_{x^*_h} \left[ \frac{1}{\gamma} \left( \frac{\gamma}{\gamma-1} \theta \left( \gamma f^{E}_{J_t} \right)^{\gamma-1} \right) \right]$$

where $J \in \{1, 2\}$ represents each period, $\lambda \in (0, 1)$, $q, o > 0$. If $q, \lambda = 0$, we choose only $f$ goods, and vice versa. $q$ and $o$ are elasticities of substitution between two goods for workers and entrepreneurs respectively. The expenditure constraints of workers and entrepreneurs measured in $f$ goods are given by,

$$c^W_j = p_jx^W_j + f^W$$

$$c^E_j = p_jx^E_j + f^E$$

solve the worker’s and entrepreneur’s maximisation problems separately and yields

$$\frac{(1-\gamma)x^W_j}{J^*_t} = p^*_j$$

$$\frac{(1-\gamma)x^E_j}{J^*_t} = p^*_j$$

The equations are showing that consumption preferences are homothetic so that relative demand between two goods depends only on relative price. This is the same with the Cobb-Douglas aggregator. In fact, if the elasticity of substitution between two goods approaches 1 (i.e. $q \rightarrow 1$ or $o \rightarrow 1$), the CES functions will become proportional, but not identical, to the Cobb-Douglas function: $(x^W_j)^\gamma (f^W_{J_t})^{(1-\gamma)}$ for workers and $(x^E_j)^\gamma (f^E_{J_t})^{(1-\gamma)}$ for entrepreneurs. Combining expenditure constraint functions with the relative demand functions for workers and entrepreneurs respectively, we obtain their demand functions for each good,

$$x^W_j = \frac{p^*_j x^W_j}{p_j} + (1-\gamma)$$

$$f^W_{J_t} = \frac{(1-\gamma)x^W_j}{J^*_t} + (1-\gamma)$$

$$x^E_j = \frac{p^*_j x^E_j}{p_j} + (1-\lambda)$$

$$f^E_{J_t} = \frac{(1-\lambda)x^E_j}{J^*_t} + (1-\lambda)$$

Given the demand functions, we can easily show how the worker’s intratemporal consumption decisions are affected by changes in relative price between $x$ and $f$:

$$\frac{p_{t+1} x^W_{t+1}}{p_t x^W_t} = \frac{p_{t+1}}{p_t} \frac{p_j^* x^W_{J_t}}{p_j^* x^{W}_{J_t}}$$

$$\frac{f^W_{J_t}}{f^{W}_{J_{t-1}}} = \frac{(1-\gamma)x^W_j}{J^*_t} + (1-\gamma) \frac{(1-\gamma)x^{W}_{J_{t-1}}}{J^*_{t-1}} + (1-\gamma)$$

The worker’s optimal consumption levels follow the classical OLG maximisation problems, with $c^*_{t+1} = (1-\gamma)w$, $c^*_t = \gamma w R$ and $w_t = (1-\alpha) \left( \frac{1}{\gamma} \right) A$. We have $\frac{\delta x^W_{t+1}}{\delta x^W_{t+1}} = \frac{\delta x^W_{t+1}}{\delta x^{W}_{J_{t+1}}} = \frac{\delta x^W_{t+1}}{\delta x^{W}_{J_{t+1}}} = A \left( \frac{1}{\gamma} \right)$, so the above equations now become,
Similarly, the entrepreneur’s intratemporal consumption decisions follow the same procedure. However, for entrepreneurs, the changes of consumptions in each period are less straightforward. The entrepreneur's consumption decisions are not exogenous, their variations are also subject to the changes in relative price between x and f, because the rate of return to capital, \( \rho_{f, t} \), responds to changes in prices and it further affects the profitability of E firms, the managerial wage and saving decisions.

\[
\frac{p_{i, t}}{p_{i, t+1}} \frac{x_{i, t}^w}{x_{i, t+1}^w} = \frac{1 - \sigma}{(1 + \gamma)} \frac{pp_{i, t}^{\lambda - \gamma} + (1 - \gamma)}{pp_{i, t}^{1 - \sigma} + (1 - \gamma)}
\]

\[
\frac{f_{i, t}^w}{f_{i, t+1}^w} = \frac{1}{(1 + \gamma)} \frac{pp_{i, t}^{\lambda - \gamma} + (1 - \gamma)}{pp_{i, t}^{1 - \sigma} + (1 - \gamma)}
\]

Given \( c_{f, t} = (1 - \sigma)m_t \) and \( c_{x, t+1} = \frac{\rho_{x, t+1}(1 - \sigma)}{\rho_{f, t+1}} m_{t+1} \), we need to discuss the changes in entrepreneur's demand equations at two life-periods separately.

When entrepreneur is still a manager of the firm, \( J = 1 \), we have

\[
\frac{p_{i, t}}{p_{i, t+1}} \frac{x_{i, t}^f}{x_{i, t+1}^f} = \left( \frac{p_{i, t}}{p_{i, t+1}} \right)^{1 - \sigma} \left( \frac{1 - \sigma}{\lambda} \right) m_{t+1} \frac{pp_{i, t}^{\lambda - \gamma} + (1 - \gamma)}{pp_{i, t}^{1 - \sigma} + (1 - \gamma)}
\]

\[
\frac{f_{i, t}^w}{f_{i, t+1}^w} = \frac{1}{(1 + \gamma)} \frac{pp_{i, t}^{\lambda - \gamma} + (1 - \gamma)}{pp_{i, t}^{1 - \sigma} + (1 - \gamma)}
\]

When entrepreneur becomes the owner of the firm, \( J = 2 \), we have

\[
\frac{p_{i, t}}{p_{i, t+1}} \frac{x_{i, t}^f}{x_{i, t+1}^f} = \left( \frac{p_{i, t}}{p_{i, t+1}} \right)^{1 - \sigma} \left( \frac{1 - \sigma}{\lambda} \right) m_{t+1} \frac{pp_{i, t}^{\lambda - \gamma} + (1 - \gamma)}{pp_{i, t}^{1 - \sigma} + (1 - \gamma)}
\]

\[
\frac{f_{i, t}^w}{f_{i, t+1}^w} = \frac{1}{(1 + \gamma)} \frac{pp_{i, t}^{\lambda - \gamma} + (1 - \gamma)}{pp_{i, t}^{1 - \sigma} + (1 - \gamma)}
\]

This is a key difference from the Cobb-Douglas aggregator. Since now, not only the quantity demand of each good will be affected by the price dynamics, the consumption share within the expenditure budget constraints also respond to the price changes over time. Unfortunately, we cannot see clear predictions about the dynamics across time from the analytical form, hence, more detailed discussion requires quantitative simulation.

Again, The aggregate consumption demand for each good at time \( t \) are shown as:

\[
C_x = C_{x, t}^w + C_{x, t}^f
\]

\[
C_f = C_{f, t}^w + C_{f, t}^f
\]

Let us be the share of workers who are in their first period of life-cycle and \( b \) be the proportion of entrepreneurs before they become firm owners, then we have \( C_{x, t}^w = aN^w(x_{t, t}) + (1 - a)N^w(x_{t, t}) \) and \( C_{f, t}^w = aNf_{t, t}^w + (1 - a)Nf_{t, t}^w \) as the aggregate consumption of \( x \) goods and \( f \) goods of workers at time \( t \) respectively. Similarly, \( C_{x, t}^f = bN^f(x_{t, t}) + (1 - b)N^f(x_{t, t}) \) and \( C_{f, t}^f = bNf_{t, t}^f + (1 - b)Nf_{t, t}^f \) are the total consumption of \( x \) goods and \( f \) goods of entrepreneurs at time \( t \). The analysis on the balance of payments from the previous section also applies here. But we would expect the price dynamics to be different and we also need to observe how consumption shares react to the changes of price.

References


