

# Household Saving, Financial Constraint, and the Current Account in China\*

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## Abstract

In this paper, we present a model economy that can account for the changes in the current account balance in China since the early 2000s. Our results suggest that the increase in the household saving rate played a key role in the increase in the current account surplus between 2004 and 2008. We argue that inadequate insurance through government programs for the elderly and the decline in family insurance due to the one-child policy led to the increase in the household saving rate especially after 2000 as more and more families with only one child entered the economy. Furthermore, our results suggest that the decline in the current account surplus since 2008 was likely to be due to the relaxation of financial constraints facing domestic firms, which was a result of the large-scale fiscal stimulus plan launched by the Chinese government after 2008. These findings imply that the planned increases in China's public pension coverage are likely to reduce the future current account balances. On the other hand, if financial constraints are tightened back to the pre-stimulus levels; the current account surplus may rise again.

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# 1 Introduction

In 2007, the current account surplus in China reached 10% of GDP, sparking debate about its impact on global imbalances in the world economy. Such a high current account surplus was particularly puzzling since this was a period of high growth rates, high return to capital, and high investment rates in China, all of which would point to a current account deficit in a standard model. While China's current account surplus was blamed for a variety of problems ranging from job losses to the housing bubble in its trading partners (the U.S. in particular), there is still substantial debate about the real determinants of China's current account.<sup>1</sup> For example, Song, Storesletten, and Zilibotti (2011, thereafter SSZ), argue that the rise in the corporate savings was the leading cause of the current account surplus in the 2000s. They show that a period of transition where traditional firms (those mimicking the state-owned enterprises) shrink and entrepreneurial firms expand could lead to a current account surplus if financial constraints limit the amount of external funds allocated to entrepreneurial firms. Coeurdacier, Guibaud, and Jin (2015), on the other hand, focus on the divergence of the household saving rates between the U.S and China to explain the global capital flows. In their framework, heterogeneity in the levels of household credit constraints give rise to differences in household saving rates across developed versus emerging economies. They argue that it is the divergence of saving rates and not the investment rates that give rise to global imbalances. Gourinchas and Jeanne (2013) make a similar point.

In this paper, we argue that in order to capture the time series behavior of China's current account balance accurately, it is important to understand the changes in both components, the saving and investment rates, of the current account. We develop a dynamic general equilibrium model consisting of firms that face borrowing constraints similar to those in SSZ (2011) and altruistic households as in İmrohoroğlu and Zhao (2017). Households in this economy live at most up to 90 years. They face labor income risk during their working years, receive social security when retired, and face health related shocks in old age. Parents and children pool their resources and maximize a joint objective function. Through inter vivos transfers, parents insure their children against the labor income risk, and children support their parents during retirement and insure them against health related shocks. Households in this economy save because of concerns about old-age risks and the decline in family insurance due to the one-child policy. The corporate sector is composed of firms that are owned by a fraction of households who have entrepreneurial skills. They are highly productive but face borrowing constraints.<sup>2</sup> We calibrate the borrowing constraints to match the external funding the Chinese firms use. Owners of these firms enjoy high returns due to high productivity while most of the household savings earn the bank deposit rate that is determined in a competitive banking sector that equals the rate of return on foreign bonds. Banks collect savings from households and invest in loans to domestic firms and foreign bonds. Financial fractions restrict the amount of funds that can be allocated to the

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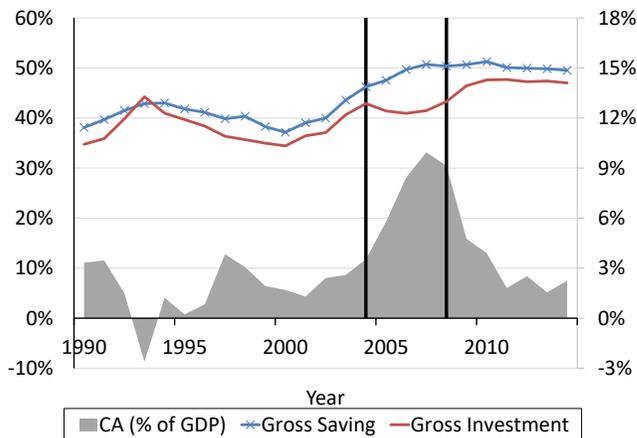
<sup>1</sup>See Song, Storesletten, and Zilibotti (2011); Wen (2011); Song, Storesletten, and Zilibotti (2014); Bacchetta and Benhima (2015); Coeurdacier, Guibaud, and Jin (2015); and Bai, Hsieh and Song (2016) among others.

<sup>2</sup>As discussed in SSZ (2011), even the state owned enterprises in China finance about half of their investment through internal savings. In our framework, changes in the saving rate are not driven by the differences between conventional versus entrepreneurial firms. Therefore, it is sufficient to characterize the average firm in China as facing borrowing constraints.

domestic firms. In addition, the government saves the excess tax revenues, leading to government savings. Banks simply invest the difference between domestic savings and loans to domestic firms in foreign bonds, resulting in a current account surplus for the country. It is important to note that China has strict capital account regulations on the private sector. Households cannot directly invest outside of China throughout most of the period we study, and capital flows can only go through the public sector.<sup>3</sup> Our model is consistent with this institutional feature of the Chinese economy where we assume that households can only allocate their savings into the domestic banking sector, and it is the banking sector that invests the saving deposits (not used by domestic firms) in foreign bonds (via the central bank).

Our model is motivated by the current data which indicates that in addition to the saving rate patterns, the behavior of investment rate, especially since 2008, is important to consider in order to fully capture the behavior of the current account in China. Figure 1, displays the gross saving and investment rates and the current account in China since 1990. From this data, we can observe that the rise in the current account surplus from around 3% to 9% between 2004 and 2008 (as highlighted by the two vertical lines) is the result of an increasing saving rate together with the relatively stable investment rate. On the contrary, the decline in the current account surplus since 2008 is a result of the rising investment rate and a flat saving rate. This first set of facts motivate us to construct an economy that models not only the saving but also the investment behavior in China.

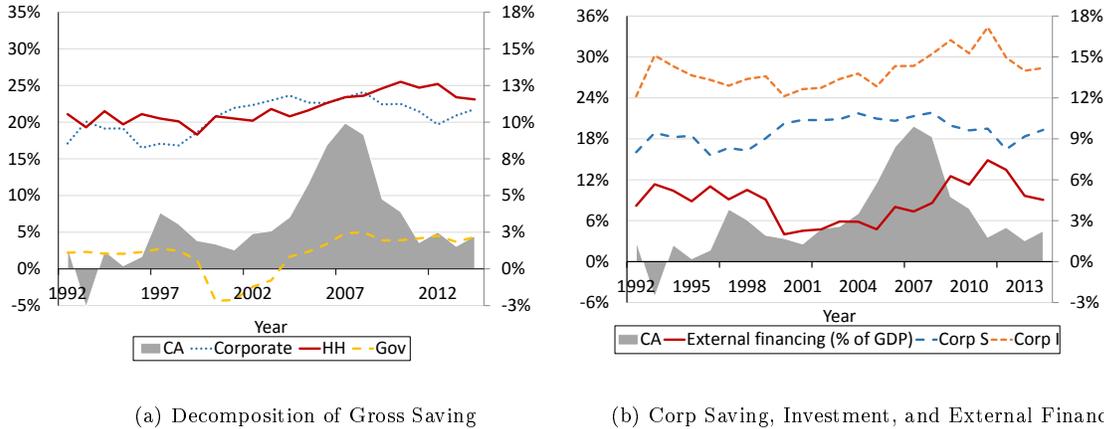
Figure 1: Motivating Facts I: Saving, Investment, and the CA in China



*Note:* the left vertical axis represents the gross saving and investment rates, and the right vertical axis represents the current account (% of GDP). *Data source:* the World Bank data.

<sup>3</sup>Bacchetta, Benhima, and Kalantzis (2013) and Jin (2016) refer to this as the semi-open economy.

Figure 2: Motivating Facts II



*Note:* The left vertical axis in panel (a) represents the decomposed saving rates. In panel (b), the left axis represents the investment and saving of non-financial corporations (labeled as “Corp I” and “Corp S”), and the external funds (as % of GDP) used by these corporations. The right vertical axis is the current account (% of GDP) in both panels. *Data source:* different years of the Chinese Statistical Yearbook, the Flow of Funds data from the National Bureau of Statistics (NBS) of China, and the World Bank data.

In addition, we model the differences in the saving behavior of the three sectors of the economy: corporate, household, and the government.<sup>4</sup> Panel (a) of Figure 2, displays household, corporate, and government saving rates from the flow of funds data in China. While household and corporate saving rates have both been high, the corporate sector is not very likely to be a major driver of the rise in China’s current account surplus between 2004 and 2008. This is a period where Chinese corporate saving remained stable while the household saving increased from 20.8% of GDP to 23.6% of GDP, and the government saving as a share of GDP increased from 2.6% to 6.0%.<sup>5</sup> Moreover, all throughout this period, the Chinese corporations invested more than they saved, suggesting that they have been net borrowers. Panel (b) of Figure 2 presents the aggregate savings of non-financial Chinese corporations together with their investments. While the corporations demand for external funds declined substantially around 1999, their usage of external funds (i.e., the difference between investment and saving) has been rather stable if not increasing during the period

<sup>4</sup>See Chen, Karabarbounis, and Neiman (2017) for the rise in corporate savings in the world.

<sup>5</sup>Most of the research dealing with saving rates in China relies on flow of funds data to decompose gross saving between corporate, household, and government. However, flow of funds data is subject to large revisions. Our findings, which is based on the most recent data, are different from what Chamon and Prasad (2010) have documented using the earlier versions of the flow of funds data. Previously, household savings as a percentage of GDP between 1993 and 2005 did not appear to have increased. In the 2012 data, however, household savings as a percentage of GDP is reported to have increased from about 20% in the 1990s to 25.5% in 2010. It is important to add that household savings as a share of GDP increased despite the fact that the household income as a share of GDP has been declining in this time period. Consequently, household saving rate (household savings as a percentage of household income) has been increasing even faster.

of high and rising current account surpluses from 2004 to 2008.<sup>6</sup>

We find that modeling the behavior of both the corporate and the household sector helps capture the rich dynamics across both saving and investment rates. Our quantitative results indicate that inadequate insurance through government programs during old age and the decline in family insurance due to the one-child policy play important roles in the increase in the household saving rate especially after 2000 as more and more families with only one child enter the economy. This feature leads to the increase in the national saving rate in the 2000s, which contributes to the rising current account surplus during the same period. We also find that the changes in financial constraints facing the firms is capable of generating the increase and the fluctuations observed in investment in China. In particular, we find that the relaxation of financial constraints facing the Chinese firms since 2008, likely due to the large-scale fiscal stimulus plan launched by the Chinese government, substantially increases domestic investment and thus is responsible for the decline of the current account surplus after 2008.

Using this framework, we examine the consequences of pension reforms, and the rollback of the financial stimulus plan on the future current account balance in China. Our results indicate that while doubling the social security benefits would lead to a permanent 3% decline in the current account surplus, rolling back the stimulus plan will double the current account surplus immediately.

Our paper is related to the global imbalances literature that emphasizes differences in financial or institutional characteristics between emerging economies and developed countries in shaping global capital flows. For example, in Mendoza, Quadrini, and Rios-Rull (2009), financial imbalances happen due to differences in the degree of financial development across countries. In their framework, financial integration between different regions results in a decline in savings and an increase in net foreign assets in developed countries since they have deep financial institutions. In Caballero, Farhi, and Gourinchas (2008), differences in countries' ability to produce financial assets for global savers leads to global imbalances.<sup>7</sup>

We contribute to this literature by examining the current account balance of the largest emerging economy and perhaps the most important contributor to the global imbalance in detail. When China's current account surplus peaked at 10% in 2007, it was 5% in Thailand, 1% in Korea, 2% in Indonesia, and -1% in India (see the World Bank data). Our results indicate that, in addition to financial constraints that the Chinese firms face, high household saving rates in China played an important role in the rise of their current account surplus during this period. Indeed, the gross saving rate in China was also substantially higher than most other emerging economies during this time. According to the World Bank, the gross saving rate in China reached above 50% in 2010 when it was 29% in Thailand, 38% in India, 34% in Korea, and 33% in Indonesia. Our findings show that the increase in the household saving rate in particular was critical in the increase in the current account surplus until 2008.

Our model differs from the growing literature studying China's current account by quantitatively ac-

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<sup>6</sup>After studying the Chinese corporate savings using firm-level data, Bayoumi, Tong, and Wei (2010) make a similar point. Note that as also shown in Figure 3aa, while the government saving has been relatively low, it has gone through significant changes since the late 1990s. Thus, we also incorporate government saving in our analysis.

<sup>7</sup>See also Gourinchas and Jeanne (2013); Bacchetta, Benhima, and Kalantzis (2013); and Ju and Wei (2010) among others.

counting for both saving and investment behaviors that lead to changes in the current account balance as well as the changes in the components of the saving rate. For example, SSZ (2011) focus on the rise in the corporate savings in accounting for the increase in the current account surplus and abstract from the increase in the household saving rates. Coeurdacier, Guibaud, and Jin (2015) focus on the household saving rate but abstract from changes in investment since the “investment wedge” was shown to be small before 2008, the period that is analyzed by most of the literature.<sup>8</sup> Our model is able to account not only for the increase in the current account balance until 2008 but also its subsequent decline. Our results indicate that the investment behavior becomes rather important after 2008 leading to the decline in the current account surplus back to less than 3% by 2014.

The remainder of the paper is organized as follows. Section 2 presents the model used in the paper and Section 3 its calibration. The main quantitative findings are presented in Section 4. Section 5 presents the results of some policy experiments and Section 6 presents the sensitivity analysis. Section 7 provides the concluding remarks.

## 2 The Model

In this section, we present the benchmark model for our analysis of China’s saving, investment and the current account. The model consists of altruistic households as in İmrohorođlu and Zhao (2017) and financially constrained firms that share similar features to the entrepreneurial firms in SSZ (2011). Due to the altruistic links present in our model, parents do not have to combat an incentive problem regarding their children as in SSZ (2011). This framework allows us simplify the firm’s problem considerably where children invest the bequests they receive from their parents in the family firm.

The economy is populated with altruistic agents who derive utility from their own lifetime consumption and from the felicity of their predecessors and descendants.<sup>9</sup> The decision-making unit is the household consisting of a parent and children. Each period  $t$ , a generation of individuals is born. All children become parents at age  $T+1$  and face mandatory retirement at age  $R$ . After retirement, individuals face random lives and can live up to  $2T$  periods. Depending on survival, an individual’s life overlaps with his parent’s life in the first  $T$  periods and with the life of his children in the last  $T$  periods. A household lasts  $T$  periods. A dynasty is a sequence of households that belong to the same family line. At age  $T+1$ , each child becomes a parent in the next-generation household of the dynasty. The size of the population evolves over time exogenously at the rate  $g_{t-1}$ . At the steady state, the population growth rate satisfies  $g = n^{1/T}$ , where  $n$  is the fertility rate (that is the average number of children each household has).

Working age individuals supply labor exogenously. Labor income is comprised of a deterministic component  $\varepsilon_j$  representing the age-efficiency profile and a stochastic component,  $\mu_j$ , faced by individuals up to age  $T$ . Parents face a health risk,  $h$ , that necessitates long-term care (LTC) where  $h = 0$  represents a healthy

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<sup>8</sup>See also, Jin (2016); Kuijs (2005); Wang, Wen and Xu (2017); and Wen (2011).

<sup>9</sup>As in Laitner (1992) and Fuster, İmrohorođlu, and İmrohorođlu (2003, 2007)

parent without LTC needs. When  $h = 1$ , the family needs to provide LTC services to the parent. We assume that the cost of LTC services consists of two parts: a goods cost  $m$  and a time cost  $\xi$ . Here,  $\xi$  represents the informal care that requires children's time. For working individuals, the LTC cost also includes their own forgone earnings.

Labor income of a family is composed of the income of the children and the income of the father. Once retired, the father faces an uncertain lifespan where  $d = 1$  indicates a father who is alive and  $d = 0$  indicates a deceased father. If alive, a retired father receives social security income,  $SS_j$ . All children in the household split the remaining assets (bequests) equally when they form new households at time  $T + 1$ .

After-tax labor earnings,  $e_j$ , of all household with age- $j$  children is given by:

$$e_j = \begin{cases} [w\varepsilon_j\mu_j(n - \xi h) + w\varepsilon_{j+T}(1 - h)](1 - \tau_{ss}) & \text{if } j + T < R \\ w\varepsilon_j\mu_j(n - \xi h)(1 - \tau_{ss}) + dSS & \text{if } j + T > R, \end{cases} \quad (1)$$

where  $\tau_{ss}$  is the payroll tax rate to finance the social security program.

Families are assumed to have heterogeneous skills, denoted by  $z$ . In each cohort, a  $\omega$  fraction of the population are with entrepreneurial skills and own the firms ( $z = 1$ ), and the rest are workers ( $z = 0$ ). Firm ownership is inherited from parents. These families operate the firms, supply their own labor in the firm, and employ workers that belong to the other families.<sup>10</sup> For the sake of simplicity, we also assume that the entrepreneurial skills of a household do not change over generations so there are two types of households: one in which both the parents and the children are entrepreneurs and another in which both the parent and the children are workers.

In this framework, since parents care about the utility of their descendants, they save to insure them against the labor income risk, and since children are altruistic toward their parents, they support them during retirement and insure them against health-related risks. In addition, parents leave voluntary bequests to their children. In families who own the firms, children invest the bequests back in the firm.<sup>11</sup> A key difference between the two types of households is that worker households put their saving in a bank and entrepreneurial households invest all their saving in their firm.

The state of a household consists of age  $j$ , assets  $a$ , the realizations of the labor productivity shock  $\mu$ , and the health  $h$  and mortality  $d$  states faced by the elderly, and the entrepreneurial skill  $z$ .<sup>12</sup>

## 2.1 Entrepreneurial Families (Firms)

Entrepreneurial Families ( $z = 1$ ) own the firm and earn profits from it. However, the firm (or these families) faces a credit constraint and can finance investment only by its own capital together with a limited amount

<sup>10</sup>All workers earn the same effective wage rate.

<sup>11</sup>In this framework, we do not have to be concerned about opportunistic behavior of the children as in the SSZ model.

<sup>12</sup>All children are born at the same time and face identical labor income shocks.

of external funds from the banking sector. We model the credit constraint in the fashion of SSZ. That is, we assume that the firm can only pledge to repay a share  $\eta$  of the value of the firm in the next period, which results in the borrowing limit faced by the firm. We assume that the firm produces a single good using a Cobb-Douglas production function  $Y = AK^\alpha N^{1-\alpha}$  where  $\alpha$  is the output share of capital,  $K$  and  $N$  are the capital and labor input at time  $t$ , and  $A$  is the total factor productivity. The growth rate of the TFP factor is  $\gamma - 1$ , where  $\gamma = (\frac{A'}{A})^{1/(1-\alpha)}$ . Capital depreciates at a constant rate  $\delta \in (0, 1)$ .

The optimization problem of a firm (an entrepreneurial family) with own capital  $a$ , is simply to choose labor,  $N$ , and loans,  $l$ , to maximize profits subject to the credit constraint where  $r^l$  as the bank's lending interest rate. Thus, the problem of the firm is given by:

$$\max_{N,l} AK^\alpha N^{1-\alpha} - \delta K - wN - r^l l \quad (2)$$

subject to the incentive-compatibility constraint (or the credit constraint):

$$(1 + r^l)l \leq \eta[AK^\alpha N^{1-\alpha} + (1 - \delta)K - wN] \quad (3)$$

and

$$K = a + l. \quad (4)$$

Note that the right-hand side of the credit constraint is simply the  $\eta$  share of the value of the firm (before repaying the loan and its interest). The firm's optimization implies that the wage rate  $w$ , and the net return to capital,  $\rho$ , are given by:

$$w = (1 - \alpha)A(K/N)^\alpha \quad (5)$$

and

$$\rho = \alpha A(K/N)^{\alpha-1} - \delta. \quad (6)$$

Note that after substituting in equations 5 and 6, the credit constraint (i.e., equation 3) can be simplified to  $(1 + r^l)l \leq \eta(1 + \rho)(a + l)$ .

In this paper, we follow SSZ (2011) and assume that the firm's credit constraint is always binding, that is,  $(1 + r^l)l = \eta(1 + \rho)(a + l)$ . This assumption determines the level of loan for any given own capital, which is,

$$l = \frac{\eta(1 + \rho)}{1 + r^l - \eta(1 + \rho)} a \quad (7)$$

Given the optimal behavior of the firm, an entrepreneurial family of age  $j$  with own capital  $a_j$  faces the following budget constraint:

$$a_{j+1} + nc_{sj} + dc_{fj} + mh = e_j + a_j + (1 - \tau_k)\pi^f(a_j) + \kappa \quad (8)$$

where  $c_{sj}$  and  $c_{fj}$  are consumption of each child and consumption of the parent,  $\tau_k$  is the capital income tax rate, and  $\pi^f(a)$  is the maximized profit from the firm's problem which is a function of firm's own capital  $a$ . The goods cost of taking care of a parent with LTC needs ( $h = 1$ ) is given by  $m$ . Here,  $\kappa$  is the government transfer, which guarantees a consumption floor for the most destitute. Following the literature, the value of  $\kappa$  is determined as follows:<sup>13</sup>

$$\kappa = \max \{0, (n + d)\underline{c} + mh - [e_j + a_j + (1 - \tau_k)\pi^f(a_j)]\} \quad (9)$$

We assume that when the household is at the consumption floor ( $\kappa > 0$ ),  $a_{j+1} = 0$  and  $c_{sj} = c_{fj} = \underline{c}$ .

The utility-maximization problem of households is to choose a sequence of consumption and asset holdings given the set of prices and policy parameters. Let  $V_j(x)$  denote the maximized value of expected, discounted utility of an age- $j$  household with the state vector  $x = (a, \mu, z, h, d)$ . The maximization problem facing entrepreneurial households is given by:

$$V_j(x) = \max_{c_s, c_f, a'} [nu((1 - \tau_c)c_s) + du((1 - \tau_c)c_f)] + \beta E[\tilde{V}_{j+1}(x')] \quad (10)$$

subject to the budget constraint 8, and  $a_j \geq 0, c_s \geq 0$  and  $c_f \geq 0$ , where

$$\tilde{V}_{j+1}(x') = \begin{cases} V_{j+1}(x') & \text{for } j = 1, 2, \dots, T - 1 \\ nV_1(x') & \text{for } j = T. \end{cases}$$

Here  $\tau_c$  is the consumption tax rate, which is set to balance the government budget in the stationary equilibrium and is calibrated to match the total tax revenues along the transition path.

## 2.2 Worker Families

It has been argued that most workers in China can only deposit their savings in the banking sector and do not have access to the high returns to capital.<sup>14</sup> In our benchmark model we assume that while the owners of the firms (entrepreneurial families) enjoy high returns due to high productivity, the worker families can only allocate their savings into the domestic banking sector and earn  $r^d$ , the deposit interest rate which is determined in a competitive banking sector that equals the rate of return on foreign bonds. The maximization

<sup>13</sup>For instance, see Hubbard, Skinner, and Zeldes (1995), De Nardi, French, and Jones (2010), Zhao (2017), and among others.

<sup>14</sup>See, for example SSZ (2011). There is, however, flow of funds data from the NBS of China providing information on household investment ranging from 5-12 % of GDP. These household investments include agricultural production in the rural areas, small businesses operated by the self-employed, and so on. In Section 6.1, we examine a case where we assume that a fixed share  $\theta_{hi}$  of household assets is directly invested and earns the same return as the return to capital implied in the production sector, and the rest is deposited in the bank account.

problem facing worker households is then given by:<sup>15</sup>

$$V_j(x) = \max_{c_s, c_f, a'} [nu((1 - \tau_c)c_s) + du((1 - \tau_c)c_f)] + \beta E[\tilde{V}_{j+1}(x')] \quad (11)$$

subject to

$$a_{j+1} + nc_{sj} + dc_{fj} + mh = e_j + a_j(1 + r^d) + \kappa \quad (12)$$

and  $a_j \geq 0$ ,  $c_s \geq 0$  and  $c_f \geq 0$ , where

$$\tilde{V}_{j+1}(x') = \begin{cases} V_{j+1}(x') & \text{for } j = 1, 2, \dots, T - 1 \\ nV_1(x') & \text{for } j = T \end{cases}.$$

### 2.3 Banks

Banks collect savings from worker families and invest in loans to domestic firms and in foreign bonds. The bonds yield a net return  $r$ . In a competitive equilibrium of the open economy, the deposit rate is equal to the lending rate and the rate of return on foreign bonds, that is,  $r = r^d = r^l$ .<sup>16</sup> However, there are financial frictions that restrict the amount of funds allocated to domestic firms. This drives a wedge between bond yields and the marginal product of capital in this economy.

### 2.4 Government

In our benchmark economy, the government taxes corporate income and consumption at rates  $\tau_k$  and  $\tau_c$ , respectively, and uses the revenues to finance an exogenously given stream of government consumption  $G_t$ . This way of modeling the government significantly simplifies the tax system. It is important to note that the Chinese government has been investing in financial and physical assets during the past several decades.<sup>17</sup> To capture them, instead of using a transfer to balance the budget, we assume that the fiscal surpluses (or deficits) are saved in a bank account and earn the bank deposit rate along the transition path.<sup>18</sup>

In addition, the government runs a pay-as-you-go social security program that is financed by a payroll tax  $\tau_{ss}$ .

<sup>15</sup>Here the government transfer for worker families is given by:

$$\kappa = \max \left\{ 0, (n + d)\underline{e} + mh - [e_j + a_j(1 + r^d)] \right\}$$

<sup>16</sup>Potentially the interest rate on bank loans can be higher than the deposit rate, reflecting the administrative cost of the banking sector or the inefficiency of the system. We leave this for future research.

<sup>17</sup>See, for example, Ma and Yi (2010).

<sup>18</sup>To guarantee the convergence, this bank account is assumed to be closed after 2050, and any saving at that time is redistributed back to households proportional to their labor income.

## 2.5 Aggregation and the Current Account Surplus

Let  $\{X_j(x)\}_{j=1}^T$  represent time-invariant measures of households. The aggregate capital and labor can be specified as:

$$K = \sum_{j,x} [(a_j(x) + l_j(x))I_{z=1}]X_j(x) \quad (13)$$

and

$$N = \sum_{j,x} [\varepsilon_j \mu (n - \xi h) + \varepsilon_{j+T} (1 - h)] X_j(x). \quad (14)$$

In the competitive equilibrium of the open economy setting, the bank deposit rate is equal to the rate of return on foreign bonds, and the current position of the net foreign assets is simply equal to the difference between household savings deposited in the bank account and bank loans borrowed by the domestic firms. That is:

$$NFA_t = \sum_{j,x} a_j(x) I_{z=0} X_j(x) - \sum_{j,x} l_j(x) I_{z=1} X_j(x). \quad (15)$$

The current account is simply measuring the change in net foreign assets over time. That is:

$$CA_t = NFA_{t+1} - NFA_t$$

When the economy is closed, the net foreign assets and the current account balance are both zero, and the bank interest rate is determined endogenously by the market-clearing condition in the credit market, that is, the household savings equal the bank loans demanded by the firms.

## 2.6 Equilibrium

The definition of stationary recursive competitive equilibrium (steady state) in the benchmark model is standard and similar to that in İmrohoroğlu and Zhao (2017).

When the economy is open, a stationary recursive competitive equilibrium is defined as follows: Given a fiscal policy  $(G, \tau_c, \tau_k, \tau_{ss}, SS)$  and a fertility rate  $n$ , a stationary recursive competitive equilibrium is a set of value functions  $\{V_j(x)\}_{j=1}^T$ , households' decision rules  $\{c_{j,s}(x), c_{j,f}(x), a_{j+1}(x), l_j(x)\}_{j=1}^T$ , time-invariant measures of households  $\{X_j(x)\}_{j=1}^T$  with the state vector  $x = (a, z, \mu, h, d)$ , and relative prices  $\{w, \rho, r, r^d, r^l\}$ , such that:

1. Given the fiscal policy and prices, households' decision rules solve households' decision problem in equation 10.
2. Factor prices solve the firm's profit maximization policy by satisfying equations 5 and 6.
3. Individual and aggregate behavior are consistent, that is, equation 13 and equation 14 are satisfied.
4. The net foreign assets position satisfies equation 15.
5. The measures of households satisfy:

$$X_{j+1}(a', z, \mu', h', d') = \frac{1}{n^{1/T}} \sum_{\{a, \mu, h, d: a'\}} \Omega(\mu, \mu') \Gamma(h, h') \Lambda(d, d') X_j(a, z, \mu, h, d), \text{ for } j < T,$$

$$X_1(a', z, \mu', 1, 1) = n \sum_{\{a, \mu, h, d: a'\}} \bar{\Omega}(\mu') X_T(a, z, \mu, h, d)$$

where  $a' = a_{j+1}(x)$  is the optimal assets in the next period.

6. The government's budget holds.<sup>19</sup> That is,

$$G = \sum_{j,x} \tau_c [nc_{j,s}(x) + dc_{j,f}(x)] X_j(x) + \sum \tau_k \{[\rho(a_j(x) + l_j(x)) - rl_j(x)] I_{z=1}\} X_j(x).$$

7. The social security system is self-financing, and the expenditures for the consumption floor are financed from the same budget:

$$\sum_{j=R-T+1}^T \sum_x d(SS_j + \kappa) X_j(x) = \tau_{ss} \left[ \sum_{j=1}^{R-T} \sum_x w \varepsilon_{j+T} (1-h) X_j(x) + \sum_{j=1}^T \sum_x w \varepsilon_j \mu_j (n - \xi h) X_j(x) \right].$$

When the economy is closed, the definition of the stationary equilibrium is the same as in the open economy setting except that the net foreign assets position is always zero, and the bank interest rate is now endogenously determined by the market-clearing condition:

$$K = \sum_{j,x} a_j(x) X_j(x). \tag{16}$$

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<sup>19</sup>Note that this is the government's budget constraint at steady state. Along the transition path, we assume that the fiscal surpluses (or deficits) are saved in a bank account and earn the bank deposit rate.

Our computational strategy is to start from an initial steady state that represents the Chinese economy before 1980 and then to numerically compute the equilibrium transition path of the macroeconomic aggregates generated by the model as it converges to a final steady state. Gross saving rate along the transition path for this economy is measured as  $\left(\frac{Y_t - C_t - G_t}{Y_t}\right)$ , and gross investment rate along the transition path for this economy is measured as  $\left(\frac{K_{t+1} - (1-\delta)K_t}{Y_t}\right)$ .

### 3 Calibration

Our calibration of the TFP growth rate, the individual income risk, the fertility rate, government expenditures, tax rates, and health-related risks in China (both for the steady-state calculations and for the transition path) largely follows İmrohorođlu and Zhao (2017). Compared to the economy in İmrohorođlu and Zhao (2017), there are only three additional parameters that need to be calibrated. These are the parameters that correspond to the borrowing constraints faced by the firms, the share of household savings that is directly invested in production, and the share of the families that own the firms.

#### 3.1 Demographics and Labor Income

A newborn in this economy is 20 years old and lives to be at most 90 years old. An individual becomes a parent at age 55 to  $n$  children (who are 20 years old) and forms a household. Retirement is mandatory at age 60 after which individuals face mortality risk. Table 1 summarizes the mortality risk at five-year age intervals over the life cycle, which are used to calibrate the transition matrix for  $d$ .<sup>20</sup>

Table 1: Survival Probabilities:

Age	<60	60	65	70	75	80	85
Surv.	1	.9815	.9696	.9479	.9153	.8642	.7611

The average number of children per couple at the initial steady state is set to its value of 4 in the 1970s. In the model economy, this implies a fertility rate (number of children per parent) at the initial steady state of 2 ( $n = 2.0$ ). The corresponding annual population growth rate is 2.0% (i.e.,  $n^{1/35} - 1 = 2.0\%$ ). The one-child policy implemented around the year 1980 restricts the urban population to having one child per couple and the rural population to having two children only if the first child is a girl. However, despite the strong penalties imposed in the implementation of the one-child policy, the “above-quota” children are not unusual and the estimates of the realized fertility rate after the one-child policy are approximately 1.6 per couple. This is the fertility rate we use for the model economy with the one-child policy along the transition path (the implied population growth rate at the final steady state is -0.6% (i.e.,  $n^{1/35} - 1 = -0.6\%$ )). With

<sup>20</sup>Data are taken from the 1999 World Health Organization data (Lopez et al., 2001). The survival probability is assumed to be the same within each five-year period and along the transition.

this calibration, the population shares of each age group (i.e., ages 20-40, 40-65, and 65+) generated by the model along the transition path mimic the data reasonably well (see İmrohorođlu and Zhao (2017)).

We assume that a  $\omega$  fraction of the population are entrepreneurs. The value of  $\omega$  is chosen so that the capital-output ratio in the initial steady state matches the data. All workers, including those who own the firms face the same labor income process that is composed of a deterministic age-efficiency profile  $\varepsilon_j$  and a stochastic component (faced up to age 55) given by  $\log(\mu_j) = \theta \log(\mu_{j-1}) + \nu_j$ . We take the age-specific labor efficiencies,  $\varepsilon_j$ , from He, Ning, and Zhu (2015) who use the data in CHNS to estimate them and set  $\theta = 0.86$  and the variance  $\sigma_\nu^2$  as 0.06 based on the findings in Yu and Zhu (2013). We discretize this process into a 3-state Markov chain by using the Tauchen (1986) method. The resulting values for  $\mu$  are  $\{0.36; 1.0; 2.7\}$  and the transition matrix is given in Table 2.

Table 2: Income Shock

$\Gamma_{\mu\mu'}$	$\mu' = 1$	$\mu' = 2$	$\mu' = 3$
$\mu = 1$	0.9259	0.0741	0
$\mu = 2$	0.0235	0.953	0.0235
$\mu = 3$	0	0.0741	0.9259

### 3.2 Preferences and Technology

The utility function is assumed to take the following form:  $u(c) = \frac{c^{1-\sigma}}{1-\sigma}$  where  $\sigma$  is set to 3.0. The subjective time discount factor  $\beta$  is set to 0.99 to match the gross saving rate in the initial steady state. The capital depreciation rate  $\delta$  is set to 10% and the capital share  $\alpha$  is set to 0.5 based on the estimates in Bai, Hsieh, and Qian (2006)<sup>21</sup>. The total factor productivity  $A$  is chosen so that output per household is normalized to one. The growth rate of the TFP factor  $\gamma - 1$  in the initial steady state is set to 6.2%, which is the average growth rate of the TFP factor in China between 1976 and 1985. We assume that the growth rate of the TFP factor in the final steady state is 2%, which is commonly considered to be the growth rate at which a developed economy eventually stabilizes. Between 1980 and 2014, we use the observed growth rates of TFP.<sup>22</sup> For the period after 2014, we use the GDP long-term forecasts provided by OECD.<sup>23</sup>

### 3.3 The Banking Sector

Our model implies that in a competitive equilibrium of the open economy, the deposit rate is equal to the lending rate and the rate of return on foreign bonds, that is,  $r_t = r_t^d = r_t^l$ . We set the rate of return on foreign bonds to the interest rate implied by the long-term U.S. Treasury bills in our benchmark calibration

<sup>21</sup>It is also the same as those values used in SSZ (2011).

<sup>22</sup>We construct the TFP series using  $A_t = \frac{Y_t}{K_t^\alpha N_t^{1-\alpha}}$ . The detailed information about how the TFP series is constructed can be found in İmrohorođlu and Zhao (2017).

<sup>23</sup>The GDP growth data from 2015-2050 can be found at the following webpage: <https://data.oecd.org/gdp/gdp-long-term-forecast.htm>. As for the forecasts after 2050, we simply fix the growth rate of the TFP factor at 2%.

given that a major fraction of China’s foreign reserves are invested in the U.S. T-bills. When the economy is closed, the bank deposit rate is endogenously determined to clear the credit market. Based on China’s experience in the past several decades, we assume that the economy is closed at the initial steady state, and it opens up along the transition path.

As firms can only pledge to repay a share  $\eta$  of the firm value in the next period, the bank is willing to lend them up to a limit that their incentive-compatibility constraint holds. We set the value of  $\eta$  to 0.43 in the initial steady state to match the average external funds (as % of GDP) used by the Chinese firms during this period, that is around 8 according to the flow of funds data. This value of  $\eta$  implies 47% loan to assets ratio for firms at the initial steady state. As documented in SSZ (2011), the Chinese firms on average have about 50% loan to assets ratio.

Several existing studies have argued that the financial constraints facing the Chinese firms have been changing over time, due to a variety of reasons such as the privatization of state-owned enterprises occurred in late 1990s, and the large-scale fiscal stimulus plan the Chinese government has implemented since 2009. This point can be clearly seen in panel (b) of Figure 2 that displays the amount of external funds used by the Chinese firms as a share of GDP (measured by the difference between aggregate corporate investment and aggregate corporate saving) over time. To capture the changing financial constraints, we allow the value of  $\eta$  to vary over time and calibrate its value along the transition path to match the data on the amount of external funds used by the Chinese firms presented in panel (b) of Figure 2.

### 3.4 Health Risk

Government provided health care programs in China do not provide full coverage for many health shocks that the elderly face. İmrohoroglu and Zhao (2017) use data from the Chinese Longitudinal Healthy Longevity Survey (CLHLS) to document the expenditures associated with one of these, the Long Term Care costs. According to their findings, the average expenditures of individuals in LTC status range from RMB 4466 to RMB 9124 during 2005 - 2011, that is, 26 – 37% of GDP per capita in the year.<sup>24</sup> In addition, according to the CLHLS data, individuals receive a significant number of hours of informal care from their children and grandchildren. For those in LTC status, the average amount of informal care from children and grandchildren is approximately 40 hours per week during 2005 to 2011. Based on this information, we set the goods cost of LTC services  $m$  as 33% of GDP per capita in a given year in the model. As the total number of available hours (net of sleeping) is approximately 100 hours per week, we set the time cost of LTC,  $\xi$ , to 0.42. We also assume that the probabilities of receiving the LTC shock,  $\Gamma_j(0, 1)$ , are age-specific and calibrate their values to match the fractions of individuals in LTC by age and the probability of exiting from the LTC status,  $\Gamma_j(1, 0)$ , is assumed to be constant across the age groups and is calibrated so that the probability of staying

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<sup>24</sup>While these costs are high for individuals in LTC status, average expenditures per person (including those not in LTC status) for individuals aged 65+ range from approximately RMB 253 in 2005 to RMB 1490 in 2011.

in LTC for more than three years in the model matches the data.<sup>25</sup>

### 3.5 Government Policies

Government expenditures,  $G$ , is set to be 14% of output at the steady states, which is China’s average level of government expenditures since 1980. Along the transition path, the actual data on government expenditures is used for values of  $G_t$ . The capital income tax rate is set at 15.3 according to Liu and Cao (2007) along the transition path and at the steady states. The consumption tax rates are then chosen to balance the government budget at both steady states. As for the period from 1980 to 2014, the consumption tax rates are determined to match the actual data on aggregate tax revenues in China. For the period after 2014, we assume that both government expenditures and the consumption tax rate gradually converge to their final steady state values in 10 years. We set the average social security replacement rate at 15 for the whole population, which represents the average coverage between the urban and the rural households. We assume that the social security program is self-financing and that the social security payroll tax rate  $\tau_{ss}$  is endogenously determined to balance the budget in each period. The consumption floor,  $\underline{c}$ , is set to 0.1% of output per household as in İmrohorođlu and Zhao (2017).

Table 3: Calibration

Parameter	Description	Value
$\alpha$	capital income share	0.5
$\delta$	capital depreciation rate	0.1
$\sigma$	risk aversion parameter	3.0
$A$	TFP factor	0.37
$\beta$	time discount factor	0.99
$m$	goods cost of LTC services	33% of GDP per capita
$\xi$	time cost of LTC services	0.42
$G$	government expenditures	14% of GDP
$SS$	social security replacement rate	15%
$\gamma_{initial}^{1-\alpha} - 1$	initial steady state TFP growth rate	3.1%
$\gamma_{final}^{1-\alpha} - 1$	final steady state TFP growth rate	1%
$n_{initial}$	initial steady state total fertility rate	2.0
$n_{ocp}$	fertility rate under one-child policy	0.8
$n_{final}$	final steady state total fertility rate	1.0
$\omega$	popu. share with entrepreneurial skills	10%
$\eta$	fraction of profits can be pledged at initial SS	0.43

Table 3 summarizes the main results of our calibration exercise.

<sup>25</sup>Please see İmrohorođlu and Zhao (2017) for the detailed description of the relevant empirical moments calculated from the CLHLS data and the details of the calibration of LTC risks facing Chinese households.

## 4 Quantitative Results

We start this section by examining the key aggregate statistics of the calibrated economy at both the initial and the final steady states. The initial steady state is assumed to be a closed economy, and it is calibrated to mimic the economic and demographic conditions in China in 1980, while the final steady state is an open economy, representing the one that the Chinese economy will eventually converge to. Next, we examine the time series path of the saving rate, investment rate, and the current account along the transition path.

### 4.1 Initial and Final Steady States

The results presented in Table 4 show that the initial steady state of the calibrated model matches several key aspects of the Chinese economy in 1980, including the gross and net saving rates, the return to capital, and the demographic structure. The gross saving rate is 37% at the initial steady state, while the Chinese gross national saving rate was, on average, 36% around the year of 1980.<sup>26</sup> The return to capital generated by the model at the initial steady state is 15%, which is mostly due to the relatively high TFP growth rate to which the initial steady state is calibrated. Bai, Hsieh, and Qian (2006) argue that the return to capital was, indeed, quite high in China in the 1980s, about 14% on average. However, most of the Chinese households did not get full access to the high returns to capital due to the financial frictions. The bank deposit rate generated in the initial steady state is 5%. The demographic structure at the initial steady state is also consistent with the Chinese data. For instance, the share of the population aged 65+ at the initial steady state is 13%, while the share of the Chinese population aged 65+ was about 11% in 1980.

The final steady state of the economy is generated by exogenously changing the fertility rate from 2.0 to 1.0 and the growth rate of TFP factor from 6.2% to 2.0% while keeping the rest of the parameters the same as at the initial steady state.<sup>27</sup> That is, we assume that the Chinese economy will eventually slow down and its growth rate will stabilize around 2%, the average growth rate among the current developed economies. In addition, as a fertility rate lower than the replacement rate is not sustainable permanently, we assume that the Chinese government will eventually abandon the one-child policy and the demographic structure will stabilize at the replacement rate.

As also shown in Table 4, the decline of the fertility rate has a large impact on the demographic structure at steady state. The elderly population share increases from 13% at the initial steady state to 22% at the final steady state. The gross saving rate at the final steady state is also higher (i.e., 44%) than that at the initial steady state, while the net saving rate at the final steady state is 16%, lower than that at the initial steady state.<sup>28</sup> In addition, the changes in the bank deposit rate caused by the opening up of the economy

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<sup>26</sup>The net national saving rate is around 21% in both the initial steady state and in the data.

<sup>27</sup>The payroll tax rate is also different between the two steady states. In the initial steady state, the social security replacement rate is set at 15%, which results in a payroll tax rate of 2.6%. At the final steady state, a higher payroll tax rate (5.4%) is needed to balance the budget due to a much larger share of the elderly population.

<sup>28</sup>Note that in this model the decline of the fertility rate implies an increase in the capital-output ratio, i.e., from 2.0 to 3.3. This is why the gross and net saving rates respond differently to the declining fertility rate.

also contribute to the change in the saving rate, while the lower return to capital at the final steady state is largely due to the increased capital accumulation and the lower TFP growth rate.

Table 4: Properties of the Steady States

Statistic	Data	Initial steady state	Final steady state
Gross saving rate	36%	37%	44%
Net saving rate	21%	21%	16%
Elderly population share (65+)	11%	13%	22%
Share of the elderly (65+) in LTC	10%	10%	11%
Return to capital ( $\rho$ )	14%	15%	5%
Bank interest rate ( $r$ )		5%	2%
Capital-output ratio	2.0	2.0	3.3
Output per household	..	1.0	0.86
Social security payroll tax ( $\tau_{ss}$ )	..	2.6%	5.4%

## 4.2 Time Path of the Current Account

In this section, we present our benchmark results where we examine the time path of the saving rate, the investment rate, and the current account along the transition path. At the initial steady state, the Chinese economy is assumed to be closed to capital flows and international trade where household savings in the bank equals the bank loans demanded by the firms. We open the model economy to capital flows in 10 years after the transition path starts (i.e., 1990).<sup>29</sup> We shock the initial steady state by imposing the one-child policy, that is, the fertility rate is immediately reduced from 2.0 to 0.8. As the one-child policy is not sustainable permanently, we assume that it will be abolished eventually. In the benchmark model, we assume that the one-child policy lasts until 2050, and after that the fertility rate is set to the replacement rate.<sup>30</sup> We use the actual data on the TFP growth rate, government expenditures and tax revenues along the transition path and assume perfect foresight for all these components.<sup>31</sup> We compare the current account along the transition path generated by the model to the Chinese data to evaluate if the model is capable of accounting for the rise and the fall in China's current account surplus.

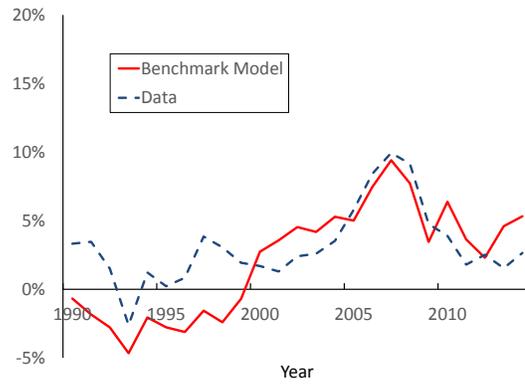
Panel (a) in Figure 3 displays the current account surplus generated by the benchmark economy together with the data starting in 1990. The time series path of the current account generated by the model, especially after the 2000s, tracks the data reasonably well. In the data the current account surplus increases from 1.7%

<sup>29</sup>The actual opening up of China's financial accounts started around the mid 1980s, and the process was gradual and lasted until the early 1990s. As a robustness check, we find that opening up the economy in 1985 does not significantly change our results.

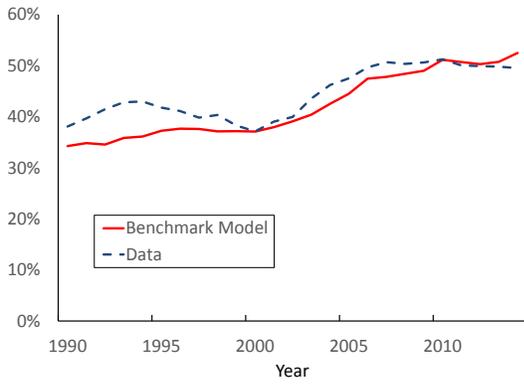
<sup>30</sup>China's one-child policy was partially relaxed in 2016 allowing the Chinese households to have up to two children. We leave the implications of such a policy shock for future research. In addition, we assume that the entrepreneurial households are not affected by the one-child policy and their fertility rate is set to the replacement rate along the entire transition path. We make this assumption to avoid the investment behavior of corporations to be directly affected by the family structure of owners, which is empirically less likely.

<sup>31</sup>İmrohoroğlu and Zhao (2017) and Chen, İmrohoroğlu and İmrohoroğlu (2006) show that the perfect foresight assumption does not have a large impact on the quantitative implications of this type of a model.

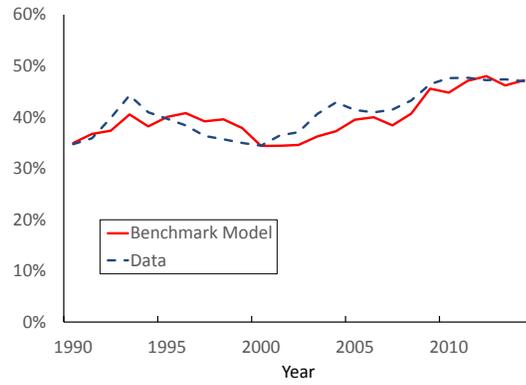
Figure 3: Benchmark: Key Statistics Along the Transition Path



(a) Current Account (as % of GDP)



(b) Gross Saving Rate: Data and Model



(c) Gross Investment Rate: Data and Model

of GDP in 2000 to 9.9% in 2007 and 9.1% in 2008, after which it starts to decline reaching 2.5% in 2012 (see Table 5). In the benchmark economy, the current account surplus increases from 2.7% of GDP in 2000 to 9.4% in 2007 and 7.7% in 2008. After 2008, it starts declining and reaches 2.3% of GDP in 2012. While our model matches the dramatic rise and the decline in the current account in the 2000s well, it under-predicts the current account surpluses in 1990s.

In panels (b) and (c) of Figure 3 gross saving and investment rates generated by the model are displayed together with their data counterparts. The model tracks the time path of China’s gross saving and investment rates reasonably well.<sup>32</sup> In particular it captures the substantially different trends in the two rates in the 2000s. In the data, the gross saving rate increases from 37% to 50% between 2000 and 2008. During the same period, the investment rate increases from 34% to 43%. Similar results are generated in the benchmark model where the gross saving rate increases faster than the investment rate during this period resulting in an increase in the current account balance.

The decline in China’s current account surplus after 2008, on the other hand, stems from an increasing investment rate together with a relatively stable saving rate. Specifically, China’s gross investment rate increases from 43% in 2008 to 47% in 2012 while its gross saving rate remains rather flat around 50%. The benchmark model generates similar trends. As shown in Table 5, the investment rate along the transition path generated in the model increases from 41% in 2008 to 48% in 2012, while the saving rate remains relatively stable during this period (increasing from 48% in 2008 to 50% in 2012). Thus, in the model as in the data, the decline in the current account balance stems from an increase in the investment rate together with a stable saving rate.

In the next section, we investigate the reasons behind these diverging trends in saving and investment rates before and after 2008 in more detail.

Table 5: Key Statistics Along the Transition Path

Economy	1990	2000	2007	2008	2012
Current Account (% of GDP)					
Data	3.3	1.7	9.9	9.1	2.5
Benchmark	-0.7	2.7	9.4	7.7	2.3
Gross Saving Rate					
Data	38	37	51	50	50
Benchmark	34	37	48	48	50
Gross Investment Rate					
Data	35	34	42	43	47
Benchmark	35	34	38	41	48

<sup>32</sup>In section 8.1, we present additional properties of the transition path generated in the benchmark model, and we show that our benchmark model is capable of matching the Chinese data in other relevant dimensions, such as the population dynamics, the return to capital, and the wage rate. In addition, in Section 6 we examine the decomposition of the saving rate across households and corporations.

### 4.3 Understanding the Time Path of Saving and Investment Rates

In this section, we present the two main reasons behind the rise and the subsequent decline in the current account balance in China. We find that the rise in the national saving rate until 2008 is mainly driven by the increase in the household saving rate. As we will explain in more detail in the next section, the main reason behind this increase was the implementation of the one-child policy in China in the 1980s. In the recent decades, Chinese families have had to rely predominantly on private savings to insure against old-age risks as the role of family insurance declined due to the small number of children per family. The increase in the saving rate coupled with the financial frictions preventing the increased household saving from being invested in domestic firms resulted in large current account surpluses until 2008. We also find that the decline in the current account surplus since 2008 is mainly driven by the relaxation of financial constraints faced by the Chinese firms in the following years. According to the findings in Bai, Hsieh, and Song (2016), this relaxation of financial constraints was most likely due to the large-scale fiscal stimulus plan implemented by the Chinese government in 2009 and 2010. In our benchmark analysis, this relaxation of financial constraints faced by the Chinese firms is simply captured by the varying value of  $\eta$  over time, which is calibrated to match the amount of external funds (as % of GDP) used by Chinese firms. In the model, the relaxation of financial constraints encourages domestic investment and thus reduces the current account surplus in the years following 2008.

In the rest of the section, we present the results from two counterfactual experiments that lead us to the above-described findings. In the first experiment, we document the relationship between the national saving rate and the one-child policy. In the second experiment, we examine the role of the financial constraints by examining a counterfactual case in which the value of  $\eta$  remains constant along the transition path.<sup>33</sup>

#### One-Child Policy and the Current Account

İmrohoroğlu and Zhao (2017) show in a closed economy model the rise in the Chinese saving rate would have been much smaller if there were no one-child policy. To consider the impact of the one-child policy on the current account, we examine a counterfactual case in which the one-child policy is never implemented. Here, we follow İmrohoroğlu and Zhao (2017) and consider two possible counterfactual scenarios without the one-child policy: (1) the fertility rate is fixed at the initial steady state level throughout the entire transition path and (2) the fertility rate gradually declines at a constant rate along the transition path and gets to the replacement rate in 2050.<sup>34</sup> We find that the implications for saving are very similar for the two scenarios and choose to present the results from the second one.

The results from this experiment are displayed in Figure 4. Consistent with our theory, the current account balance is substantially lower during the entire period and the rise in the current account surplus

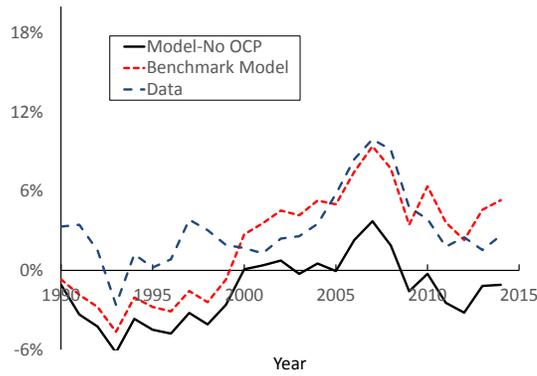
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<sup>33</sup>In Section 8.2, using a simplified version of the model we derive some analytical results to illustrate the intuition behind the key mechanisms we emphasize.

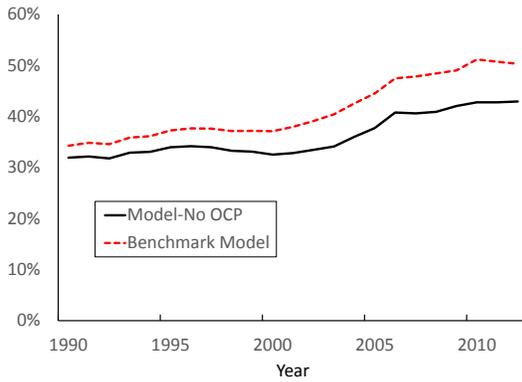
<sup>34</sup>The second scenario is motivated by the empirical observation that the fertility rate is negatively correlated with the income level of the country and tends to decline as the economy grows over time.

after 2000 is much smaller in this counterfactual economy. This is largely due to the decline in the saving rate as a result of the increase in family insurance (via having more children) against old-age risks (panel (b) of Figure 4). Of course this channel does not have the same impact on the investment behavior of the firms, consequently giving rise to similar investment rates in the “Benchmark Model” and the “No-OCP Model” as shown in panel (c) of Figure 4.

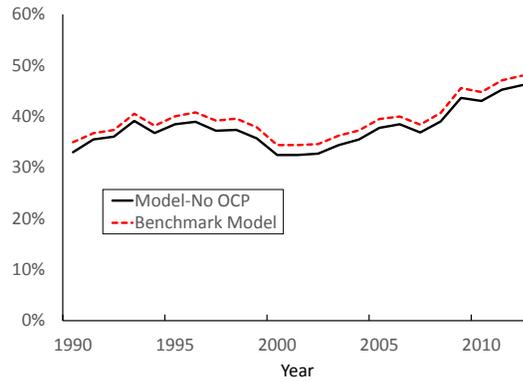
Figure 4: One-Child Policy and the Current Account



(a) Current Account (as % of GDP)



(b) Gross Saving Rate: Benchmark vs. No OCP

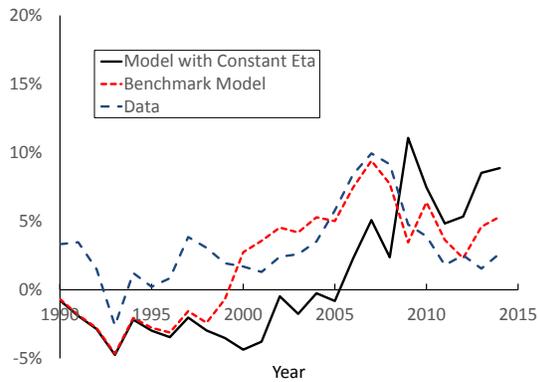


(c) Gross Investment Rate: Benchmark vs. No OCP

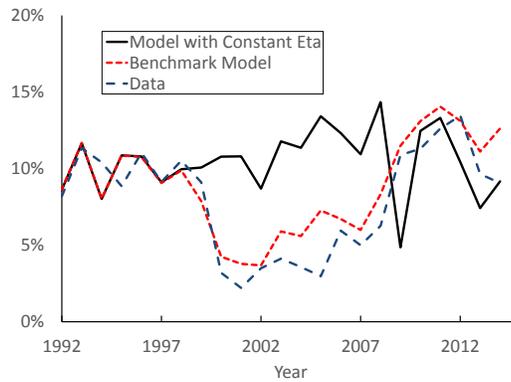
## Financial Constraint and the Current Account

In our benchmark analysis, the variation in the financial constraints faced by Chinese firms are simply captured by the changes in the value of  $\eta$  along the transition path (which is calibrated to match the amount of external funds (as % of GDP) used by Chinese firms). Therefore, to assess the role of the variation in financial constraint in shaping the current account, we consider a counterfactual economy in which the value of  $\eta$  is assumed to be constant along the transition path. In Figure 5, we summarize the results of this experiment.

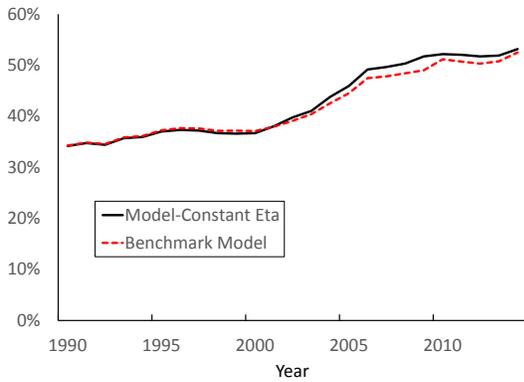
Figure 5: Changing Financial Constraints and the Current Account



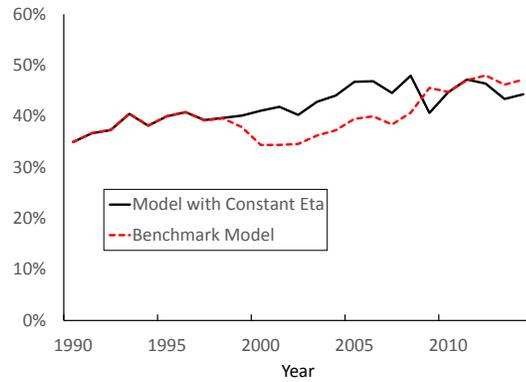
(a) Current Account (as % of GDP)



(b) External Funds Used by the Firms (as % of GDP)



(c) Gross Saving Rate



(d) Gross Investment Rate

When the value of  $\eta$  is kept constant, the amount of external funds used by domestic firms (as % of GDP) becomes relatively stable during the transition path (panel (b) of Figure 5).<sup>35</sup> At the same time, the current account surplus of China, as shown in panel (a) of Figure 5 becomes substantially larger after 2008 with a constant  $\eta$ . The tightening of the financial constraint in the late 1990s also has an impact on the current account surplus before 2008. When the value of  $\eta$  is constant, there is a level shift down in the current account from 1999 to 2008. Figure 5 also displays the gross saving and investment rates generated in this experiment (in panels c and d). As expected, the impact of changing financial constraints on the current account is mostly coming from the investment side.<sup>36</sup>

Why have the financial constraints been changing? SSZ argue that as the economy experienced the transition from financially integrated firms (i.e., state-owned firms) to financially constrained firms (i.e., private firms), the Chinese corporate sector on average became more financially constrained over time. This might have been particularly true in the late 1990s when the large-scale privatization of state-owned enterprises occurred (for instance, see He et al, 2014). Bai, Hsieh, and Song (2016) argue that the large-scale fiscal stimulus plan implemented by the Chinese government in 2009 was implicitly a financial liberalization process for the Chinese firms. That is, the large fiscal stimulus plan, largely financed by off-balance sheet companies, relaxed the financial constraints of local governments, which in turn increased the amount of financial resources channeled toward private firms. For tractability, our model captures both of these policy changes in a fairly reduced-form way by simply varying the value of  $\eta$  over time. It would be interesting to incorporate the details of these policy changes, in particular the fiscal stimulus plan, and examine their macro implications in a more realistic model, something we leave for future research.

The counterfactual analyses we have conducted so far suggest that both the one-child policy and the variation in financial constraint are important for understanding the current account surpluses in China since 1990. Table 6 summarizes the key statistics along the transition path in all three counterfactual experiments. As can be seen, our counterfactual results suggest that while the decline of the current account surplus after 2008 was mainly driven by the relaxation of financial constraint facing domestic firms, the rise in the current account surplus until 2008 was due to both the one-child policy and the tightening of financial constraint for firms since the late 1990s. In addition, we find that the one-child policy was a relatively more important driver, accounting for over half of the current account surplus in 2008.

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<sup>35</sup>The remaining changes in the external funds are simply due to the changes in government taxes and expenditures and the rate of return on foreign bonds. In particular, the large drop in the current account surplus in 2009 is simply due to the jump in the real US T-bill rate in that year. We check the sensitivity of our results to the assumed world interest rate in Section 6.2.

<sup>36</sup>In Section 8.3, we examine the relationship between the tightness of the financial constraints and the current account balance at the provincial level using data from National Bureau of Statistics of China (NBS) and the Urban Household Survey (UHS) during 2004-2013.

Table 6: CA Along the Transition Path: The Counterfactuals

Economy	1990	2000	2007	2008	2012
Current Account (% of GDP)					
Data	3.3	1.7	9.9	9.1	2.5
Benchmark	-0.7	2.7	9.4	7.7	2.3
CF1-No one-child policy	-1.1	-0.1	3.7	1.9	-3.2
CF2-Constant Financial Frictions	-0.8	-4.4	5.1	2.4	5.3

## 5 Policy Experiments

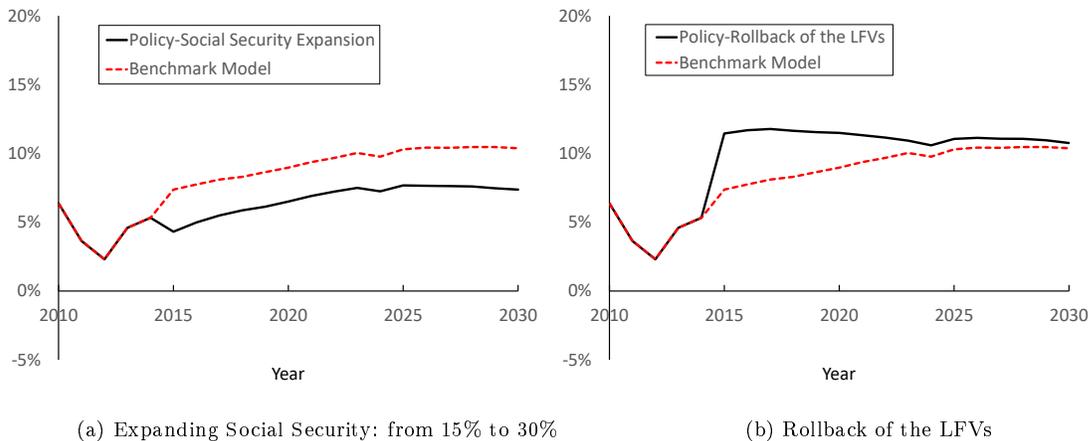
Given that our benchmark model captures the time path of the saving and investment rates and the current account reasonably well, we now use it to analyze the impact of potential policy reforms that have been frequently debated in China’s policy circles and in academia. In particular, we examine the consequences of pension reforms and the rollback of off-balance sheet companies (local financing vehicles (LFVs)) on the future current account balance in China.

### 5.1 Expanding Public Pension Coverage

Recognizing the inadequacy of publicly provided old-age insurance across a large fraction of the population, the Chinese government has announced plans to expand public pension coverage in recent years. As documented in Bairoliya, Canning, Miller and Saxena (2016), two new pension programs were recently introduced aiming to improve the old-age insurance benefits among the residents who are not covered by the standard public pension program. The New Rural Social Pension Scheme was introduced in 2009 for rural residents, and the Urban Social Pension Scheme was introduced in 2011 to help the originally uncovered urban residents. While the benefits these programs currently provide are still very low (Vilela, 2013), it is reasonable to expect that China’s public pension coverage will improve further in near future. To understand the impact of the potential expansion of China’s public pension program on the current account, we consider a policy experiment in which the benchmark economy along the transition path gets shocked in 2015 by an increase in social security replacement rate from 15% to 30%.

In this policy experiment, we change the social security replacement rate (and the corresponding payroll tax rate) in 2015 and onward while keeping the rest of the model the same as in the benchmark case. Panel (a) of Figure 6 plots the current account balance along the transition path since 2010 in this policy experiment together with the one from the benchmark case. Note that since households in this experiment are not aware of the policy shock before 2015, the transition path until 2015 is the same as in the benchmark case. In the benchmark exercise, the current account surplus is around 7% of GDP in 2015. In the policy experiment where social security replacement rate is raised from 15% to 30%, the current account surplus drops immediately to 4% of GDP in 2015 and is always 2-3% lower than that in the benchmark case in the following decade. This result is largely due to that the pay-as-you-go social security program crowds out

Figure 6: Current Account with Potential Policy Reforms



household savings and thus reduces the amount of extra savings invested in foreign bonds leading to the decline in the current account surplus.

## 5.2 Rollback of the Off-Balance Sheet Companies

According to the findings in Bai, Hsieh, and Song (2016), the relaxation of financial constraints facing the Chinese firms after 2008 was most likely due to the large-scale fiscal stimulus plan implemented by the Chinese government in 2009 and 2010. They argue that this stimulus plan was implicitly a financial liberalization process for the Chinese firms. The large fiscal stimulus plan was largely financed by off-balance sheet companies (local financing vehicles (LFVs)), which relaxed the financial constraints of local governments who in turn increased the amount of financial resources channeled towards the private firms.

It is important to note that these LFVs did not stop growing after the end of the fiscal stimulus in 2010, and thus this “financial liberalization” process kept going on in the following years. On the other hand, as noted in Bai et al. (2016), the central government has made numerous attempts to roll back these off-balance sheet financial institutions in the past few years as they are concerned about the increasing amount of local government debt. While these attempts have not achieved their goals so far, it is possible that the central government may succeed in the future.

In the next policy experiment, we consider a case in which the central government eventually succeeds in rolling back the LFVs and thus the financial liberalization process since 2009 is partially reversed. Specifically, we conduct a counterfactual experiment in which the value of  $\eta$  (which controls the degree of financial constraints) drops to its pre-crisis level in 2015. The results from this counterfactual case are reported in panel (b) of Figure 6 together with plots from the benchmark results. As can be seen, the current account

surplus immediately doubles (from around 5% of GDP in 2014 to 11% in 2015) in this counterfactual case compared to a milder increase to around 7% of GDP in the benchmark case. The jump in the current account surplus after 2015 is mainly due to the response from the investment rate. The reversal of financial liberalization cuts the external funds available to firms and thus reduces domestic investment. As a result, more domestic savings are invested on foreign bonds which lead to the increase in the current account surplus. The difference between this counterfactual case and the benchmark case gradually shrank in the following years as firms respond to the tighter borrowing constraint by accumulating more of their own capital which in turn allows them to borrow more externally as well.

## 6 Further Discussion

### 6.1 The Extended Model with Household Investment

In the benchmark model, we follow SSZ (2011) and assume that households can only invest their assets in the bank account and earn the low deposit rate. There is, however, flow of funds data from the NBS of China providing information on household investment ranging from 5-12 % of GDP. These household investments include agricultural production in the rural areas, small businesses operated by the self-employed, and so on. To investigate the robustness of our main results to the availability of additional investment options, we now examine an extended version of the model in which we assume that a fixed share  $\theta_{hi}$  of household assets is directly invested and earns the same return as the return to capital implied in the production sector, and the rest is deposited in the bank account.

That is, worker families in this extended model face the following budget constraint:

$$a_{j+1} + nc_{sj} + dc_{fj} + mh = e_j + \theta_{hi}a_j[1 + \rho] + (1 - \theta_{hi})a_j(1 + r^d) + \kappa \quad (17)$$

where  $r^d$  is the deposit interest rate and  $\rho$  is the return to capital. Here the household investments can be understood as being invested in family small businesses that are not allowed to have debt-financing but get access to the same production technology as entrepreneurial firms. That is, the household investment problem is simply the following profit-maximizing problem:

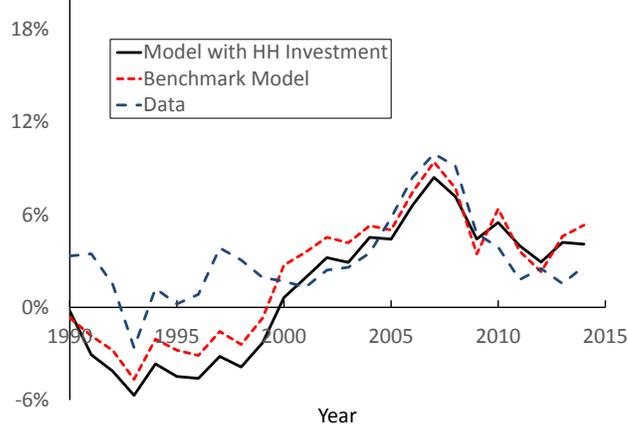
$$\max_{N_w} AK_w^\alpha N_w^{1-\alpha} - wN_w$$

$$\text{with } K_w = \theta_{hi}a.$$

Here  $K_w$  and  $N_w$  are the capital and labor used in the family-run business and  $a$  is the household assets.<sup>37</sup> Solving this simple maximization problem, we know that the capital-labor ratio in the household investment problem is equal to that in the firms and the return to household investments is same as the return to capital

<sup>37</sup>Note that to be consistent with the definitions used in the flow of funds data, here we categorize the family businesses into the household sector.

Figure 7: CA in the Extended Model with HH Investment



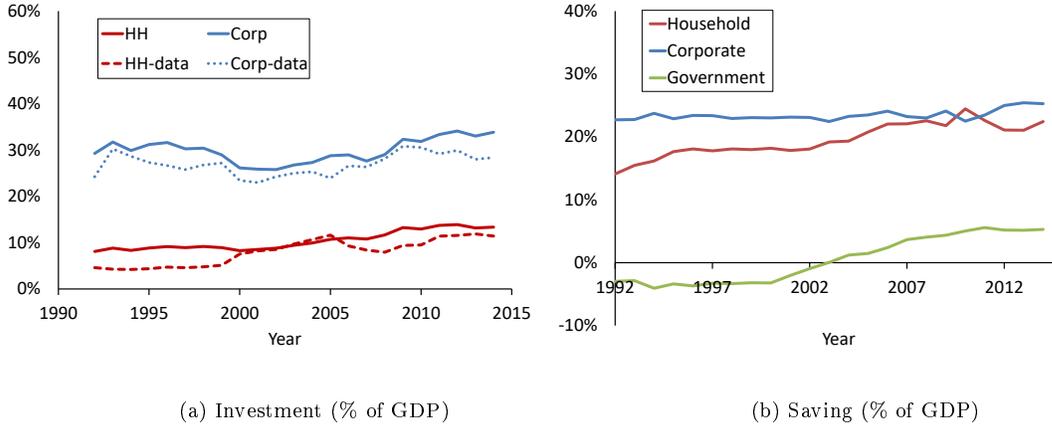
implied in the firm sector. To be consistent, we use  $K_e$  and  $N_e$  to represent the capital and labor used in the firm sector. Therefore, the aggregation conditions simply become  $K = K_e + K_w$ ,  $N = N_e + N_w$  and the net foreign assets position (NFA) is give by:

$$NFA = \sum_{j,x} \theta_{hi} a_j(x) I_{z=0} X_j(x) - \sum_{j,x} l_j(x) I_{z=1} X_j(x) \quad (18)$$

We calibrate the value of  $\theta_{hi}$  to match the ratio of household investments over corporate investments observed in the flow of fund data, and replicate the main computational exercise in the extended model with household investments. As displayed in Figure 7, the time series of the current account generated in this extended model tracks that in the benchmark model fairly well, with the current account balances in this case slightly lower than those in the benchmark model in most years. In addition, we find that with the option of household investment, the model matches better the decomposed savings and investments by each sector.

Figure 8 plots the decomposed saving and investment rates by each sector in the extended model with household investments. As displayed in Panel (a), the model is capable of matching the corporate and household investments from 1992 to 2014 fairly well. Panel (b) of Figure 8 plots the decomposed savings by each sector where the model can generate some of the key differences in the saving behavior of the three sectors as documented in the data. Household savings increases significantly during the period of rising current account surpluses (i.e., from 2004 to 2008) while corporate saving is rather stable during this period.

Figure 8: Households vs. Corporations



In addition, the model is capable of matching the increasing government saving in China in the 2000s. For instance, government saving generated in the model increases from 1% in 2004 to 4% of GDP in 2008, while in the data, government saving rises from 2% in 2004 to 5% in 2008.<sup>38</sup>

It is important to note that our model has several limitations in terms of matching the decomposition of three sectors using the flow of funds data. For instance, our model cannot capture the positive government saving in the 1990s, and in addition, our model is not able to generate the increase in corporate saving in the 1990s as observed in the flow of fund data. While these limitations are likely due to our rather simple ways of modeling the government and the corporate sectors, it is also possible that the quality of the flow of funds data is not without questions. As we pointed out earlier, the flow of funds data from the NBS of China are often subject to large revisions over the years.

## 6.2 Other Modeling Strategies and Assumptions

In this section, we evaluate the robustness of our main quantitative results with respect to several modeling strategies/assumptions made in the benchmark exercise.

We set the rates of return on foreign bonds  $r_t$  to the real rates of return on 10-year U.S. Treasury bills after the economy opens up along the transition path as a major portion of China's net foreign assets are invested in them. As shown in Table 8, the real rate of return on U.S. long-term treasury bills has declined gradually since 1990, from around 4% in the early 1990s to near zero after the global financial crisis. The

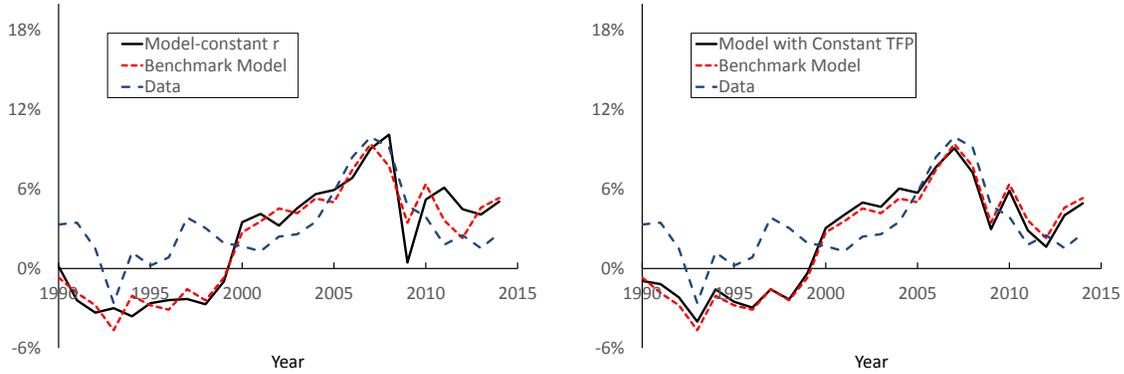
<sup>38</sup>The benchmark model is also capable of generating similar time series saving behavior in each sector. However, since the benchmark model does not capture the high-return household investment, the level of household saving compared to corporate saving is lower than in the data.

average rate of return during this period is around 2%. To assess the role of interest rates in shaping China's current account, we consider the first sensitivity case in which the rate of return on foreign bonds is set to 2% along the entire period. The results from this case are plotted in panel (a) of Figure 9. The time series of the current account generated in this counterfactual case is not significantly different from that in the benchmark except for a few years when the real rate of return on U.S. Treasury bills experienced substantial changes. In addition, we find that the impact of interest rates on the current account is mainly through the investment side (here we do not report the saving and investment rates from this case to save space).

Another factor that may play a role in our model is the TFP growth rates. Based on our estimation, China's TFP growth rates have experienced substantial changes and fluctuations throughout the entire period (see Table 8). To explore the implications of changing TFP growth, we conduct another sensitivity analysis in which TFP growth rate is assumed to be constant from 1980 to 2014 with its value set to the average of this period. The results from this counterfactual case are displayed in panel (b) of Figure 9, which shows that the TFP growth rates do not play a significant role in shaping the time series of the current account.

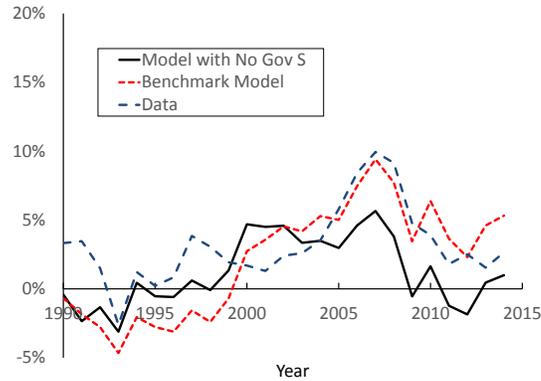
Lastly, we investigate the role of government saving in shaping the current account time series. As pointed out in the literature, the Chinese government has been investing in financial and physical assets during the past several decades (see, for example, Ma and Yi (2010)). To capture them, we assume that the fiscal surpluses (or deficits) are saved in a bank account and earn the interest rate of  $r^d$  along the transition path. As shown in Figure 9b, this rather simple way of modeling is capable of matching a key feature of the government saving data: that is, government saving has been increasing in the decade since the late 1990s. To assess the role of government saving, we now consider a counterfactual case in which the government does not save but instead redistributes the fiscal surpluses (or deficits) in each period back to households (proportional to their consumption). The current account time series generated from this case is plotted in panel (d) of Figure 9. As can be seen, government saving plays a significant role in shaping the current account time series. We find that the impact of government saving on the current account is mainly through its effect on the national saving rate.

Figure 9: Sensitivity Analysis



(a) Constant Rate of Return on Foreign Bonds

(b) Constant TFP Growth



(c) No Government Saving

## 7 Conclusion

In this paper, we develop a model economy that can account for the changes in the saving and investment rates as well the changes in the current account balance in China since the 2000s. Our quantitative analysis suggests that both investment and saving are important in shaping the time path of the current account in China. We develop a dynamic general equilibrium model consisting of firms that face borrowing constraints similar to those in SSZ (2011) and altruistic households as in Imrohorglu and Zhao (2017). We find that the rise in the current account surplus between 2004 and 2008 is largely driven by the increase in household

saving. We show that the decline in family insurance due to the one-child policy and inadequate insurance through government programs during old age play important roles in the increase in the household saving rate especially after 2000 as more and more families with only one child enter the economy. This feature leads to the increase in the national saving rate in the 2000s, which contributes to the rising current account surplus during the same period. We also find that the changes in financial constraints facing the firms is capable of generating the increase in investment in China after 2008. In particular, the relaxation of financial constraints facing the Chinese firms since 2008, likely due to the large-scale fiscal stimulus plan launched by the Chinese government, substantially increases domestic investment and thus is responsible for the decline of the current account surplus after 2008.

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## 8 Appendix

### 8.1 Additional Properties of the Economy

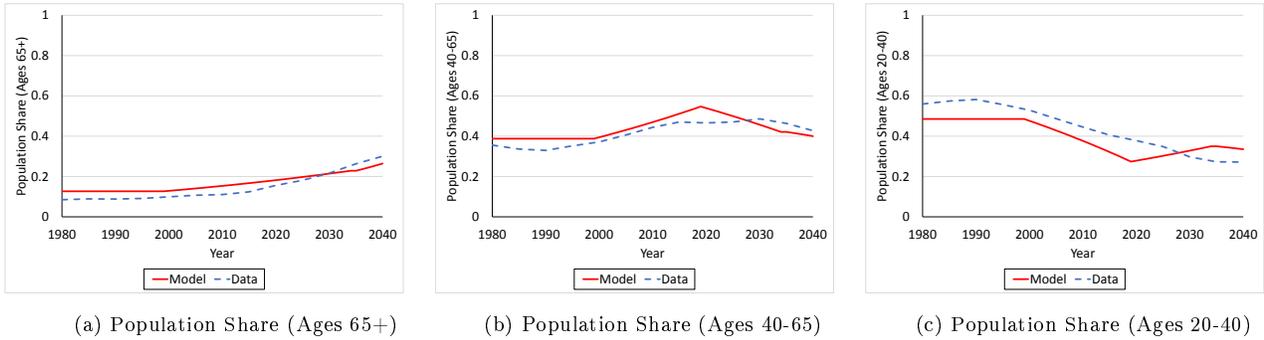
In this section, we investigate whether our model is capable of matching the Chinese data in other relevant dimensions, such as population dynamics, the return to capital, and the wage rate.

#### Population Dynamics

In Figure 10 we plot the population dynamics for three age groups. Panel (a) of Figure 10 plots the elderly population share along the transition path. The share of population aged 65+ in the model is constant before 2000. This is simply due to the fact that one-child households did not enter the economy until 2000. As more and more one-child households enter the economy after 2000, this share increases and is projected

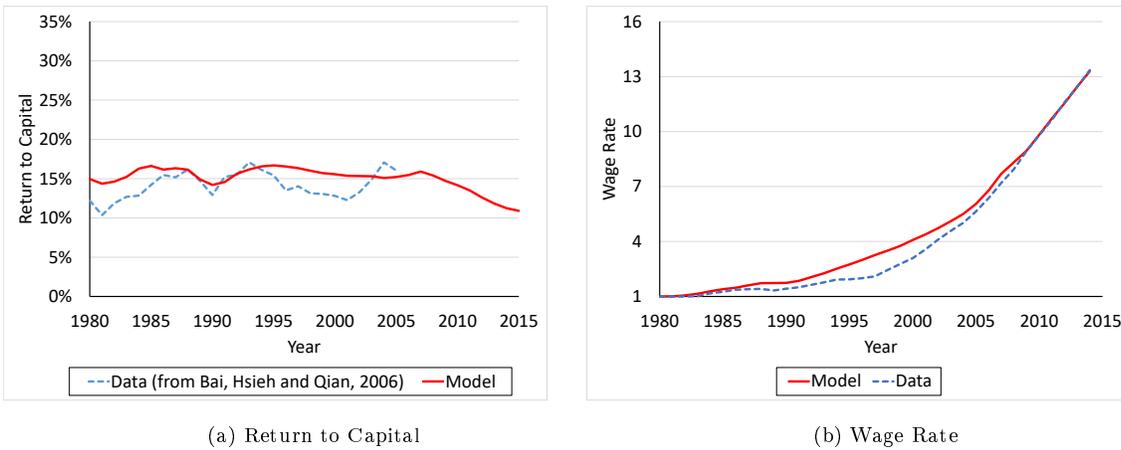
to rise to 30% by 2040. Panel (b) of Figure 10 shows the population shares of 40-65-year-olds, and panel (c) displays the share of 20-40-year-olds. The population dynamics along the transition path generated by the model is reasonably consistent with the data.

Figure 10: Demographics Along the Transition Path



### Dynamics of the Factor Prices

Figure 11: Return to Capital and the Wage Rate



Next, we check the model-generated return to capital and the wage rate against their counterparts in the data. Bai, Hsieh, and Qian (2006) carefully measure the net return to capital in China between 1978 and 2005 using data from China's national accounts. They address many of the potential measurement problems

and provide data on the return to capital under different assumptions such as removing residential housing, agriculture, and mining or including inventories in the definition of the capital stock. The model-generated net return to capital as well as the data obtained from Bai, Hsieh, and Qian (2006) are given in panel (a) of Figure 11.<sup>39</sup> Chang, Chen, Waggoner, and Zha (2015) provide long time-series data on nominal wages in China. Panel (b) in Figure 11 displays real wages constructed by using their wage and CPI data and the model-generated wage rates, all normalized to one in 1980. Both of these endogenous variables track their counterparts in the data reasonably well.

## 8.2 The Simplified Model

In this section, we present a simplified version of the model, and derive some analytical results to illustrate the intuition behind the key mechanisms we emphasize. To this end, we simplify the model along several dimensions: (1) agents only live for two periods, (2) instead of being motivated by altruism, intergenerational transfers are exogenously given, (3) some model elements are assumed away such as labor productivity heterogeneity, mortality risks, and health risks.

The economy is populated with two types of agents: working agents and entrepreneurial agents. The measure of each type of agents is normalized to one. Working agents live for 2 periods. In the first period, they receive income  $w$ , consume  $c_1$ , and save  $s'$ . In the second period, they live on their saving and the old-age support  $i'$  from their children. The lifetime utility maximization problem of the working agent can be defined as follows:

$$\max_{c_1, c_2, s'} u(c_1) + \beta u(c_2)$$

subject to

$$c_1 + s' = w$$

$$c_2 = (1 + r)s' + i'$$

$$\text{and } s' \geq 0, c_1 \geq 0 \text{ and } c_2 \geq 0.$$

The first-order condition (FOC) with respect to  $s$  is:

$$u'(w - s') = (1 + r)\beta u'(s'(1 + r) + i') \quad (19)$$

Assuming  $(1 + r)\beta = 1$ , the FOC implies,  $s' = \frac{w - i'}{2 + r}$ . It is easy to see that the impact of transfer on saving is negative, that is  $\frac{ds'}{di'} < 0$ .

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<sup>39</sup>Our definition of the capital stock includes inventories; therefore, the relevant comparison with the data is given in Figure 8 of Bai, Hsieh, and Qian (2006) who were kind enough to provide the data.

The firm faces financial constraint and is owned by entrepreneurial agents. The firms produce a single good using a Cobb-Douglas production function  $Y = AK^\alpha N^{1-\alpha}$  where  $\alpha$  is the output share of capital,  $K$  and  $N$  are the capital and labor input, and  $A$  is the total factor productivity. The growth rate of the TFP factor is  $\gamma - 1$ , where  $\gamma = (\frac{A'}{A})^{1/(1-\alpha)}$ . Capital depreciates at a constant rate  $\delta \in (0, 1)$ . The financial constraint is modeled in the fashion of SSZ. That is, we assume that the firm can only pledge to repay a share  $\eta$  of the value of the firm in the next period. This results in the borrowing limit faced by the firm.

Assuming that the entrepreneurial agent receives endowment  $e_e$  in the first period (which can be considered as transfers from his parents). He consumes part of it and invests the rest (denoted by  $a'$ ) in the firm.<sup>40</sup> The capital stock in the current period  $K$  is comprised of the firm's own capital  $a$  and the bank loans they obtain  $l$ . The firm maximizes profits by solving the following problem:

$$\pi^f(a') = \max_{l'} A'(a' + l')^\alpha 1^{1-\alpha} - \delta(a' + l') - w - rl'$$

subject to the incentive-compatibility constraint:  $(1+r)l \leq \eta(1+\rho')(a' + l')$ , where  $r$  is the interest rate on loans and  $w$  is the wage rate. Here,  $\rho'$  is the marginal return to capital, which is given by:

$$\rho' = \alpha A'(K'/1)^{\alpha-1} - \delta.$$

In this paper, we assume that the firm's credit constraint is always binding, that is,  $(1+r)l' = \eta(1+\rho')(a' + l')$ . This assumption determines the level of loan for any given own capital,  $l' = \frac{\eta(1+\rho')}{1+r-\eta(1+\rho')}a'$ . It is easy to see that the impact of financial development (measured by  $\eta$ ) on the amount of loan is positive, that is  $\frac{dl'}{d\eta} > 0$ .

As the measures of both types of agents are normalized to one, in the open economy setting, the net foreign assets holding, denoted by  $NFA$ , is simply equal to the difference between household saving and bank loans borrowed by the domestic firms. That is:

$$NFA' = s' - l' \tag{20}$$

The current account,  $CA$ , is then simply measuring the change in net foreign assets over time. That is:

$$CA = NFA' - NFA \tag{21}$$

When the economy is closed, the net foreign assets and the current account balance are both zero.

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<sup>40</sup>Here for simplicity, we assume entrepreneurial agents do not provide labor to the firm.

**Proposition 1** (1) As the family support for the old age declines, that is,  $i \downarrow$ , the net foreign assets position increases and thus the economy experiences a current account surplus, that is  $\frac{dNFA'}{di'} < 0$ , and  $\frac{dCA}{di'} < 0$ . (2) As the financial constraint looses, that is,  $\eta \uparrow$ , the net foreign assets position decreases and thus the economy experiences a current account deficit, that is  $\frac{dNFA'}{d\eta} < 0$ , and  $\frac{dCA}{d\eta} < 0$ .

**Proof:** The statement in part (1) is simply an implication of the negative saving effect of old-age transfers,  $\frac{ds'}{di'} < 0$ , together with equations (16) and (17). On the other hand, the statement in part (2) is resulting from the positive effect of  $\eta$  on loans,  $\frac{dl'}{d\eta} > 0$ , together with equations (16) and (17).

### 8.3 Micro-Level Implications

Our theory has sharp implications for the relationships between household saving, financial constraints, and the current account surplus. In the model, a higher household saving rate leads to a larger current account surplus (or a smaller deficit), as the extra household savings cannot be absorbed by the corporate sector and invested domestically due to the credit constraints facing domestic firms. On the other hand, tighter financial constraints on the corporate side can also lead to a larger current account surplus (or a smaller deficit) because domestic firms get less access to external financing and thus absorb less household savings.

Following SSZ (2011), we break down the net current account surplus (i.e. saving minus investment) into provinces and test the statistical relationships implied by our theory across provinces in China. We find the following statistical relationships at the provincial level:

1. Household saving rate is not significantly correlated with the investment rate.
2. The tightness of the financial constraint is positively correlated with the current account surplus, and it is significant at 10% level.
3. Household saving rate is positively correlated with the current account surplus, and it is significant at 5% level.

Table 7: Impact of Household Saving and Financial Constraint on CA

Independent Variables	Prov. Net Surplus (% of GDP)					
	(1)	(2)	(3)	(4)	(5)	(6)
Household Saving Rate			0.616*	0.711**	-0.311	-0.364
Self-Funds (% of investment)	0.384*	0.400*				
Controls (from SSZ)		X		X		X
Year Dummy	X	X	X	X	X	X
Province FE	X	X	X	X	X	X
Observations	310	310	310	310	310	310
R-squared	0.032	0.079	0.068	0.264	0.140	0.242

Specifically, we construct a provincial level panel during 2004-2013 using data from National Bureau of Statistics of China (NBS) and the Urban Household Survey (UHS) data. Our empirical strategy is similar to that adopted in SSZ (2011) who regress the provincial net surplus (as % of provincial GDP) on the annual change in the employment share of entrepreneurial firms and a set of control variables in a data set of similar structure (see Table 1 in their paper). We extend their empirical exercises by using more years of data and including additional independent variables of interest based on our specific theoretical implications. The data for the additional variables and the extra years are from the Chinese Statistical Yearbooks data, while the other data are from SSZ (2011). The regression results are reported in Table 7. Similar to SSZ (2011), we add time dummies so that the statistical correlations are not driven by a common trend in the two variables. The first two columns report the regressions of the provincial net surplus on the tightness of financial constraints in that province, measured by the self-funds as a share of total investment. As shown in column (2), including the control variables used in SSZ (2011) the estimated coefficient of interest is around 0.4 and significant at 10% confidence level. Columns (3)-(4) report the regressions of the net surplus on household saving rate, and the coefficients of interest are very significant and range from 0.6-0.7. On the other hand, as shown in Columns (5)-(6), the correlation between the investment rate and the household saving rate is insignificant at province level in all specifications. Note that the correlations between the tightness of financial constraint and the net surplus and the correlations between the net surplus/investment rate and the household saving rate are mainly from the within-province variation because we add fixed effect in all regressions.

## 8.4 Data for Simulations

In this section, we present the data we used in our simulations. We use annual data from the China Statistical Yearbook-2014 released by China’s National Bureau of Statistics (NBS) starting from 1978 for GDP by expenditure, consumption, government expenditures, investment, and net exports in the construction of the time-series data on TFP and the net national saving rate.<sup>41</sup> Employment data (persons employed) is from The Conference Board Total Economy Database (January 2014, <http://www.conference-board.org/data/economydatabase/>).

We construct the capital stock using the Perpetual Inventory Method given by:

$$K_{t+1} = (1 - \delta)K_t + I_t$$

where  $I_t$  is investment and the depreciation rate,  $\delta$ , is assumed to be 10%. We calculate the initial capital stock using:

$$K_0 = I_0/(\delta + g)$$

where  $g$  is the average growth rate of GDP between 1960 and 2011. For the investment series, we use “Gross

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<sup>41</sup>The series we employ are consistent with Chang, Chen, Waggoner, and Zha (2015) who provide macroeconomic time series on China both at the annual and quarterly levels.

Capital Formation” series (which is inclusive of inventories) from NBS as recommended by Bai, Hsieh, and Qian (2006). We deflate all nominal series by the GDP deflator (base year 2000) from the World Bank, World Development Indicators. TFP series,  $A_t$ , is calculated as:  $A_t = \frac{Y_t}{K_t^\alpha N_t^{1-\alpha}}$ . As shown in Imrohoroglu and Zhao (2017), our estimated TFP series are highly consistent with the TFP estimates obtained from Penn World Tables.

It is challenging to measure the average effective capital income tax rates and consumption tax rates in China accurately due to lack of detailed data. We have experimented with several different possibilities. In the benchmark results, we use the findings in Liu and Cao (2007) for the capital income tax rate. They measure the average effective tax rate at the firm level using a panel data on 425 listed companies in China’s stock market between 1998 and 2004. Based on their findings, we set the capital income tax rate to be 15.28% from 1980 onward. Next, we calculate the consumption tax rates in the steady states and along the transition path to match the actual government tax revenues as (as a share of GDP) reported in the Chinese Statistical Yearbooks.

In Table 8, we present the growth rates of the TFP factor,  $(\gamma_t - 1)$ , government tax revenues (% of GDP) and the world interest rates that are used in our simulations.

Table 8: Data for Simulations

Year	TFP factor growth rate	Rate of Return on Foreign Bond (US 10yrs T-bill)	Government tax revenues (% of GDP)
1981	-0.02		0.13
1982	0.07		0.13
1983	0.11		0.13
1984	0.17		0.13
1985	0.1		0.23
1986	0.04		0.20
1987	0.1		0.18
1988	0.07		0.16
1989	-0.05		0.16
1990	-0.02	0.031	0.15
1991	0.08	0.036	0.14
1992	0.16	0.040	0.12
1993	0.12	0.029	0.12
1994	0.13	0.045	0.11
1995	0.1	0.038	0.10
1996	0.08	0.035	0.10
1997	0.08	0.040	0.10
1998	0.06	0.037	0.11
1999	0.06	0.034	0.12
2000	0.08	0.027	0.13
2001	0.07	0.022	0.14
2002	0.08	0.03	0.15
2003	0.08	0.017	0.15
2004	0.07	0.016	0.15
2005	0.1	0.009	0.16
2006	0.13	0.016	0.16
2007	0.15	0.018	0.17
2008	0.06	-0.001	0.17
2009	0.05	0.036	0.17
2010	0.07	0.016	0.18
2011	0.06	-0.003	0.19
2012	0.04	-0.003	0.19
2013	0.04	0.009	0.19
2014	0.04	0.02	0.19

Note: we do not report the interest rates on foreign bonds before 1990 as the model economy was assumed to be closed until then.