Savings and Growth in China

PRELIMINARY AND INCOMPLETE

E. Tani Fukui*

UCLA

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Abstract

China saves an extraordinary share of its GDP; moreover, this share has been growing steadily over the last two decades. More puzzling, however, is the persistence of this savings behavior in the face of the high rate of growth of the economy – a rate that shows no sign of abating. A standard neoclassical model would not predict such a relationship between the two variables, and would in fact predict the opposite: good future prospects should encourage borrowing today. To address the connection between savings and growth, the literature has frequently turned to the lifecycle model. I follow this tradition and employ a modified version of the lifecycle model in which human capital levels are closely tied to the year the individual enters the market.

In a lifecycle model with no labor market frictions, individuals behave in a forward looking manner and aggregate net savings will decline with imminent growth: each agent forecasts high future earnings and will thus tend to borrow in his youth while he is earning low wages. The

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data on individual income suggests that there are, in fact, labor market frictions in that income has not increased as rapidly as output. Therefore I augment the model with cohort specific wage levels under the presumption that with rapid growth comes rapid evolution in human capital requirements; as a result, an individual’s wages will rise more slowly than the overall economy while differences between cohorts will widen. A model thus specified makes significant progress toward explaining the relationship between high savings levels and growth in China.

1 Introduction

The coinciding nature of two aspects of China’s recent economic performance begs for an explanation. Most well known is China’s extremely high output growth rate, which has averaged more than 8% on a per capita basis over the past 20 years. At the same time, China has exhibited extraordinary savings rates: in 1986 the country saved 34% of its GDP; this ratio increased to 46% by 2004. The parallel movement between savings as a percentage of GDP and per capita GDP growth is displayed in figure 1.¹ A standard neoclassical model cannot account for these two features simultaneously, and in fact predicts the opposite: in the case of expected future growth, the standard model predicts that an economy ought to smooth its consumption, borrowing today when it is poor and repaying its debts in the future when it is rich.

There has been considerable empirical work done in documenting the existence of a significant relationship between savings and growth in China (e.g. Modigliani and Cao (2004), Kraay (2000) and Horioka and Wan (2006)). However, there remains a paucity of theoretical models structuring the question of China within a theoretical framework. In the current paper I attempt to fill this gap.

I use an augmented lifecycle model to obtain the high savings level from the growth rates over

¹¹I plot the Hodrick-Prescott filtered trends for the time series to highlight the trend movement over time, which is the primary focus of this paper.
the years 1971-2004. The crucial feature of the augmented model is the inclusion of a human capital concept. In the face of extremely rapid technological improvement, gains are not necessarily distributed equally among labor market participants. Under the presumption that the youngest participants have the technical skills most desired by the current market situation, I assume that marginal gains accrue solely to the newest job market entrants.

The significance of Chinese savings extends far beyond China itself: much of China’s excess savings winds up in foreign - and particularly in US - markets. Net exports – the residual of savings net of investment – are displayed in figure 2. The upshot of this is that the question of Chinese savings feeds into the broader question of global current account imbalances. This is the subject of Fehr, Jokisch, and Kotlikoff (2005) who place China’s extreme savings levels into the broader context of capital shortages across developed countries (especially the U.S., E.U., and Japan). In particular they explore the circumstances under which China persists in having excess savings that may be exported to the rest of the world. In their paper, the authors do not take Chinese savings as

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2Siegel (2005) raises a similar hypothesis with respect to China’s role in the world economy.
the focus of their paper, and therefore use a reduced form solution to achieve observed savings levels and savings growth rates. Caballero, Farhi, and Gourinchas (2004) also use what is effectively a lifecycle model to examine the question. As a background to this global current account story, it will be useful to obtain a greater understanding of one of the key players and its motives for savings.

Figure 2: Net Exports

Many papers confronting this or related issues have used the lifecycle model. The lifecycle model is intuitively appealing as there is an explicit savings motive placed on each agent via the retirement period. In a two period model (that is, where agents live for two periods), the relationship between growth to savings is always positive. However, in a more realistically calibrated model, the relationship becomes much less clear. In what follows, I discuss the details of this and propose a

\footnote{Specifically, they manipulate time preferences, using current savings rates as an initial target, then adjusting it over time to approach the time preference rate of the U.S.}

\footnote{One strand of literature has focused on a similar savings and growth pattern that occurred in post-war Japan; see for instance Chen, İmrohoroğlu, and İmrohoroğlu (2006) and Hayashi (1986). Deaton and Paxson (2000) and Deaton and Paxson (1997) explore the extent to which the micro level data supports the model in a few specific countries, and find mixed evidence.}
remedy.

The structure of the remainder of this paper is as follows. Section 2 presents a baseline model and discusses its shortcomings; section 3 proposes an augmented version of the model; section 4 presents some computational experiments on the model and brings the model to the data; section 5 presents some results based on China’s demographic patterns. Section 6 concludes.

2 Baseline Model

In this section I present a standard version of the lifecycle model, and demonstrate its particular features and failings. I assume a small open economy with two types of agents: individuals and firms; there is no government. There is no stochastic process affecting the economy; rather, I assume several sequences of perfectly foreseen exogenous variables, specifically productivity “shocks”, variables governing the demographic evolution of China and the international rate of interest.

2.1 Individual problem

An individual born at time $t$ maximizes his utility:

$$\max \left\{ \sum_{j=0}^{T} u(c_{t+j}^t) \beta^j \prod_{k=0}^{j} \phi_k \right\}$$

subject to

$$c_{t+j}^t + \phi_{j+1} a_{t+j+1}^t = w_{t+j} \varepsilon_j + (1 + r_{t+j}) a_{t+j}^t$$

for all $j \in [0, ..., T]$.

Each individual lives for a maximum $T$ years. He will work $J$ years (if he survives that long), and retires thereafter. During his working years, he supplies one unit of labor inelastically in each year. Income from wages depends on the age of the individual: $\varepsilon_j$ denotes the relative efficiency of an individual of age $j$, which I will call the age premium. The product $w_{t+j} \varepsilon_j$, which I will term
“earnings” denotes an age $j$ individual’s paycheck. This value generally increases with age. During retirement he earns no income and must thereafter survive off his savings.

The variable $\phi_{j+1}$ denotes the conditional survival probability of an individual surviving from age $j$ to age $j + 1$. The value of $\phi_0$ is defined to be 1.

Individuals have access to assets $a$; these assets are held by risk neutral foreign investors who provide a return $r_t$. The investors provide a discount to individuals based on their survival probability, in exchange for which they (the investors) keep all proceeds in the event of the individual’s death.

I assume that the individual begins life with zero assets (i.e. $a_t^i = 0$). By optimality, final period assets will also be zero (i.e. $a_{t+T+1}^i = 0$). The intertemporal budget constraint will provide a useful reduction of the problem:

$$c_t^i + \sum_{j=1}^{T} c_{t+j}^i \left( \prod_{k=1}^{j} \frac{\phi_k}{(1 + r_{t+k})} \right) = w_t \varepsilon_0 + \sum_{j=1}^{T} w_{t+j} \varepsilon_j \left( \prod_{k=1}^{j} \frac{\phi_k}{(1 + r_{t+k})} \right)$$

(1)

From the first order condition on assets we obtain:

$$u'(c_t^i) = u'(c_{t+1}^i) \beta (1 + r_{t+1})$$

(2)

for all adjacent periods.

I shall for the remainder of this paper use the CRRA form $u(c) = \frac{c^{1-\gamma}}{1-\gamma}$, Under this specification, equation (2) becomes:

$$c_{t+1}^i = c_t^i [\beta (1 + r_{t+1})]^{\frac{1}{\gamma}}$$

(3)

For brevity, I set the right hand side of equation (1) - which is the lifetime income of the individual born at time $t$ - equal to $Q_t$, and combining the equations (3) and (1), I can solve for initial period consumption $c_t^i$:

$$c_t^i = \xi_t Q_t$$

(4)
so that $\xi_t$ is the fraction of lifetime income that the individual consumes in his first period of life.\footnote{Specifically, this fraction is}

An agent facing no productivity shocks will have an earnings, consumption, and asset profile as illustrated in figure 3. Earnings increase with age as the worker becomes more productive ($\varepsilon_j$ increases) until his last several years of working life when his productivity declines somewhat.

![Figure 3: Individual Profile, Baseline Model](image)

For analytical tractability, I make two rather restrictive assumptions on the interest rate; first, it will be fixed at a constant rate throughout time; second, it will be pinned to the rate of time preference so that $\beta(1 + r) = 1$. These assumptions are not without loss of generality but provide sufficient gains to intuition to make it an attractive starting point.

These assumptions have two immediate implications. The first implication is that the parameter $\xi$ from equation 4 will be identical for every individual no matter when he is born. The second is that each agent will smooth his consumption perfectly during his lifetime.

\[\xi_t = \left[ 1 + \sum_{j=1}^{T} \beta_j \prod_{k=1}^{j} \phi_k (1 + r_{t+k})^{1-\gamma_k} \right]^{-1}\]
2.2 Firm problem

There is a single, representative, infinitely lived domestic firm. This firm maximizes profits

$$\pi_t = Y_t - w_t L_t - \rho_t K_t$$

where $\rho_t = r_t + \delta$. The parameter $\delta$ is the depreciation rate of capital. The return $\rho_t$ is so defined in order to provide equivalence between the first order condition for the firm with respect to capital, and the first order condition for the individual problem. Labor comprises (in equilibrium) the surviving members of those cohorts that are currently of working age. I assume a Cobb Douglas production function

$$Y_t = e^{z_t} K_t^\alpha L_t^{1-\alpha}$$

where $z_t$ represents a productivity shock.

The firm maximizes profits as usual:

$$w_t = (1 - \alpha) e^{z_t} K_t^\alpha L_t^{-\alpha}$$

$$r_t = \alpha e^{z_t} K_t^{\alpha-1} L_t^{1-\alpha} - \delta$$

For firms as for individuals, asset transactions are conducted solely with foreign investors.

2.3 Equilibrium

The capital markets and goods markets do not have a clearing condition; these markets are assumed to clear against the rest of the world’s supply and demand which are not modeled here. Interest rates are therefore exogenously determined. As a result, the individuals’ and firm’s problems are nearly completely divorced from one another: the only point at which the problems meet is via wages, where a change in the firm’s productivity will positively affect the wages of all individuals currently working.

There is no international movement of labor and so the labor market must clear domestically.
The size of a cohort born at time $t$ is denoted $N_t$. The market clearing condition for labor is:

$$L_t = \sum_{j=0}^{J} N_{t-j} \varepsilon_j \left( \prod_{k=0}^{j} \phi_k \right)$$  \hspace{1cm} (5)

### 2.4 Savings

I will be particularly interested in the aggregate savings ratio predicted by this model. That is:

$$S_t \equiv Y_t - C_t$$

where $C_t$, aggregate consumption is defined as $C_t \equiv \sum_{j=0}^{T} N_{t-j} c_{t-j} \prod_{k=0}^{j} \phi_k$

Some simple computations based on the above equation makes it clear that this “plain vanilla” model cannot establish a clear relationship between savings and growth. This can be seen as follows.

In lifecycle models, the presence of a retirement period induces savings at the individual level. When agents live for only two periods, there is an unambiguously positive relationship between savings and growth (with causality running from growth to savings). This is the relationship used to motivate empirical studies of the effect of growth on savings in Modigliani and Cao (2004) and Horioka and Wan (2006). The relationship stems from the fact that the savings ratio captures only contemporaneous changes in output; there is no sense in which net savings is influenced by future changes in productivity. This is clearly seen in the following equation, where equilibrium values for consumption are inserted into the savings equation.

$$\frac{S_t}{Y_t} = 1 - \xi (1 - \alpha) \left[ 1 + \frac{1}{e^{((1 - \alpha) \Delta z_t)}} \right]$$  \hspace{1cm} (6)

The variable $\Delta z_t$ is defined as $z_t - z_{t-1}$. The variable $\xi$ is as defined above, and is positive. This clearly implies that an increase in today’s productivity (i.e. an increase in $z_t$) will cause an increase in the savings ratio. However, this model effectively assumes a collective myopia: future productivity improvements (e.g. changes in $z_{t+1}$ and beyond) will have no effect on agents’ behavior.
With a more plausibly calibrated model, however, there is no straightforward relationship. More fundamentally, in any case where forward looking behavior is captured by the savings ratio, the relationship is broken. This point is demonstrated by examining a three period model. In such a model there is a qualitative change in behavior: agents will, if they are young enough, anticipate future good productivity shocks and will therefore reduce their savings in advance. The three period analog to equation (6) is:

\[
S_t \frac{Y_t}{\xi (1 - \alpha)} \left[ e^{\Delta z_1(t-\frac{1}{\alpha})} + \left( \frac{2r}{1+r} \right) \left( e^{\Delta z_1(t-\frac{1}{\alpha})} + 1 \right) + \left( \frac{1}{1+r} \right) e^{\Delta z_1(t+1)(t-\frac{1}{\alpha})} \right] \n\]

(7)

Here the relationship becomes blurred: increases in both current and future productivity will have an ambiguous effect on savings. More importantly, a future positive productivity shock (affecting only \(\Delta z_{t+1}\)) will have an unambiguously negative effect on savings. Therefore, when the only productivity shocks are in the future, we can expect (much like the standard dynastic model) a drop in savings. When I approach the model with the data, this ambiguity of the model becomes an important source of failure.

3 Analysis and an Augmented Model

In this section I focus attention on the micro-level implications of the baseline model. As will become apparent, these implications are demonstrably different from the evidence provided by the data, in particular along the dimensions of earnings and assets.

3.1 Counterfactual Implications at the Individual Level

In lifecycle models, the presence of a retirement period generally induces savings throughout the working span of the individual with dissaving occurring only during retirement. In the case of an economy that is growing very rapidly, however, results are starkly different. If the model assumes, as
is usually the case, that productivity improvements are immediately reflected in wage increases, each individual witnesses a much steeper upward slope of his earnings profile over time. Combined with a flat consumption profile it is clear that for high enough levels of growth an individual will actually *borrow* in youth and only begin saving in the several periods before retirement. The difficulty is illustrated in figure 4, which displays the model set to a 6% productivity growth, similar to that of China. The earnings slope is extremely steep, leading to high levels of borrowing during youth.

Such a borrowing-then-savings pattern may be an accurate representation of the pattern in a developed country with deep consumer credit markets (such as the US with its student loans and mortgages). However, this pattern is much less plausible in a developing country with less developed credit markets such as China.

In the dataset at my disposal, Riskin, Renwei, and Shi (2000), the data on assets and liabilities are organized by household rather than individuals, making it impossible to construct an asset profile by age. However, some crude analysis makes it clear that very few people obtain loans. Of the nearly 7,000 households surveyed, fully 90% of households claim to be completely free of debt; this includes
debt relating to the purchase or building of housing. Even of the few that do report some liabilities, 30% have positive net assets. From these observations alone it is clear that a story that suggests even temporary episodes of borrowing by individuals is problematic.

The next area of concern is the wage implications of the model. I make use of the ICPSR’s survey on urban individuals. The survey collected data on the current income and age of individuals as well as on his or her prior 5 years of income. The effective income growth rate implied by the model from 1990 to 1995 is 11.6% per year. This records only income, not age premium adjusted earnings which would predict an even steeper growth rate. The data suggest an average annual income growth rate nearly an order of magnitude less, at 1.42%. This figure is based on raw real reported income and so implicitly includes any age premium. I hypothesize from this admittedly preliminary analysis that workers’ earnings are not keeping up with economy-wide growth. As a remedy to these two counterfactual implications, I shall modify the model along two specific dimensions as explained in the following section.

3.2 Augmented Model

The first augmentation is simply to impose a borrowing constraint for each individual. As noted in the discussion above, this is a reasonable description of the economy. I impose, somewhat arbitrarily, the borrowing constraint at zero such that

\[ a_{t+1}^t \geq 0 \]

The second augmentation is with respect to wages. I assume that technological change is happening so rapidly that new entrants to the job market are in some respects better equipped to contribute to production than are more mature workers. In modeling terms, wages for the new job entrant are determined as follows. Each of the \( J - 1 \) cohorts obtains some wages, denoted \( \bar{w}_t \), determined at the time of their entry into the job market. Their wages are adjusted by their efficiency, \( \varepsilon_j \), at every
age. The new wage bill allocation in every period is \( w_t L_t = (1 - \alpha) Y_t \). New job market entrants retain the difference between the allocated wage bill and the prior obligations thus:

\[
\bar{w}_t N_t \varepsilon_0 = w_t L_t - \sum_{j=1}^{J} N_{t-j} \bar{w}_{t-j} \varepsilon_j \prod_{k=0}^{j-1} \phi_k
\]

(8)

Figure 5: Augmented Model: Individual agent behavior

An individual’s problem can be written recursively. For an agent born at time \( t \) the problem is as follows:

\[
V_j (a_j) = \max_{c_j} \{ u(c_j) + \beta V_{j+1} (a_{j+1}) \}
\]

subject to

\[
c_j + a_{j+1} \phi_j = \bar{w}_t \varepsilon j + (1 + r_{t+j})
\]

\[
a_{j+1} \geq 0
\]

for all \( j = 0, \ldots, T - 1 \). For \( j = T \), the problem is simply

\[
V_T (a_T) = u(c_T)
\]
The values $\bar{w}_t$ are obtained from the equation (8). This system of equations can be readily solved by backward induction.\(^6\)

### 3.3 Individual Level Results

Individual behavior now follows a distinctly different pattern. Consumption can now only be smoothed to the extent allowed by the borrowing constraint. Earnings rise less steeply over the lifetime of an individual. Due to these two factors, there is no borrowing at the individual level, as well as less desire to borrow, due to the relatively flatter earnings profile. The modified individual behavior is displayed in figure 5.\(^7\)

### 4 Quantitative Exercise

In this section I choose some realistic values for the model parameters and apply these, along with the appropriate observed time series, to the model and evaluate them in relation to the data.

The basic parameters are set out in Table 1. As stated previously, the interest rate $r$ is set such that $\beta(1 + r) = 1$.

The age premium is computed using individual income data from Riskin, Renwei, and Shi (2000). The data strongly suggests the existence of an age premium. I compute age premia based on the average of the last two years of the survey (1994 and 1995). Based on reporting frequency I infer that the usual employment period for an individual is from age 22 to 61: the share of individuals

\(^6\)Computational Note: The addition of the borrowing constraint precludes the simple solution of the baseline model (which was based on the closed form solution for initial consumption allocations). For the augmented version, I construct wages according to equation (8), then use backward induction from each cohort’s final period of life to its first by performing a grid search for optimal asset paths.

\(^7\)In the displayed figure, the individual does not face a binding borrowing constraint since his earnings profile is relatively flat. A more pronounced age premium would cause the borrowing constraint to take effect.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
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<td>Capital Share</td>
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<tr>
<td>$\beta$</td>
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<td>Time Preference</td>
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<tr>
<td>$\gamma$</td>
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<tr>
<td>$\delta$</td>
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<td>Depreciation Rate</td>
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</table>

Table 1: Basic Parameters

Figure 6: Median Wages over Working Lifespan

reporting wages falls off dramatically prior to age 22 and after age 61. Agents begin life in my model at age 22 (i.e. $j = 0$ is their first year in the job market); they work for 40 years (if they survive that long); and die by age 104.

Conditional survival probabilities are determined from UN Population Division data. The conditional survival probabilities for three sample cohorts (those born in 1850, 1970 and 2160) are displayed in figure 7. For the following exercises, I take the conditional survival probabilities as being fixed to the 1970 estimated probabilities (that is, the conditional survival probability for an
agent born in 1970). In a subsequent section, I discuss the effects of the change over time of these probabilities.

4.1 Some experiments on the model

In order to illustrate the workings of the models at hand, I perform the following experiment on both the baseline and the augmented model. I apply a sudden but perfectly foreseen productivity shock: the economy switches from a steady state (i.e. constant) productivity level to a state where productivity improves constantly. The shocks are shown in panel (a) of figure 8. The effects on the baseline and augmented model are shown in panels (b) and (c) respectively. The aggregate savings ratio (S/Y), consumption ratio (C/Y) and investment ratio (I/Y) are depicted.

The baseline model response follows the analysis of equation (7) discussed above. Intuitively, the anticipation of future positive productivity (and hence future wage increases) induces young agents to smooth consumption by borrowing today. The retired population will receive no benefit from future productivity and so will dissave at the same rate as without the productivity shock: the net
effect is a decrease in savings. Once the old die and are replaced with new young who can anticipate future high productivity, the savings rate recovers.\footnote{Whether the economy “recovers” to its pre-shock level depends on parameters values, in particular the relationship between the interest rate and the time preference rate.}

The augmented model is qualitatively different from the baseline model. Individuals entering the market even one period before the productivity shock cannot respond to the productivity shock as they reap no benefit, and thus maintain their level of savings. On the other hand, the cohort entering the job market at the time of the shock receives a wage boost relative to their immediate predecessors; the productivity shock affects only this cohort. If the individual would have otherwise faced a binding borrowing constraint, his borrowing constraint is now less tight (and may no longer

Figure 8: Effect of productivity shock
bind); he will therefore begin saving sooner (or immediately upon entering the workforce). If he did not previously face such a constraint, he will save more immediately.

The upshot of this analysis is that the only change in behavior will be a contemporaneous increase in savings. Effectively, there is no ability for currently working agents to anticipate and adjust to future productivity shocks.

4.2 Comparison of Model and Data Savings Ratios

In this experiment, I feed into the model a set of productivity shocks obtained as residuals from observed capital and labor levels. I compare the savings to GDP ratios with those observed in the data.

The level of savings is a function of exogenous parameters, principally the time preference parameter. In somewhat of a happy coincidence, a highly reasonably value for the time preference and the consequent assumed value for $r$ give savings level that in the benchmark model give nearly identical values to the savings ratio. Nevertheless, in figure 9 I normalize the first value (for 1970) for the model results to fit the 1970 savings ratio precisely; the figure thus focuses on the predicted versus actual trend. Table 2 gives the values for the growth rates.

<table>
<thead>
<tr>
<th>Data</th>
<th>Benchmark</th>
<th>Augmented</th>
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</thead>
<tbody>
<tr>
<td>0.0137</td>
<td>-0.0024</td>
<td>0.0142</td>
</tr>
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</table>

Table 2: Average annual growth rate of the savings ratio

5 Some Observations on Demographics

The lifecycle model effectively forces the researcher to take seriously the underlying demographic structure of the economy. In my case, demographics become doubly relevant because of the unique
and radically changing demographic structure in China.

I perform some extremely preliminary exercises on the augmented model. The results suggest how the model – as a byproduct of the above modifications – will respond to certain trends in Chinese demographic data. There are two characteristics of the data in particular that stand out. The first is the decline in new births. The imposition of the one child policy in approximately 1980 has led to a significant decline in the number of new births. Figure 10 displays the declining proportion of children in China. The second characteristic is the ongoing improvement life expectancy. As figure 7 shows, conditional survival probabilities have increased, particularly for the working age population. The significance of these two characteristics manifests itself clearly in the aggregate population breakdown. The working age population is currently experiencing a “peak” as a share of the total population; in past decades, there were far more children, and in future decades there will be far more retirees. At the moment, however, the country is experiencing a bounty of able-bodied workers.
I perform two experiments to explore the role of demographics in the savings question. The first experiment is a sudden decline in the birth rate. I implement the drop in 1980, in order to correspond to the imposition of the one child policy. This has the effect of suppressing the savings ratio. Earnings profiles are relatively flat, so that agents will save at all ages until they retire. With the sudden drop in new cohorts, the economy has fewer young (savers) relative to old (dissavers). The savings ratio drops permanently. The effects are displayed in figure 11.

The second experiment is a sudden change in conditional survival probabilities. The shock is set so that the individuals entering the job market in 1980 or later experience higher conditional survival probabilities than the prior cohorts. The increase in conditional survival has a transitory positive effect on the savings ratio. An individual that is expected to live longer than his predecessors will need to save more during his working life. While the two types of agents (short-lived and long-lived) coexist, savings will be higher than in the steady state; as long-lived individuals begin to retire, their dissaving decreases the overall savings ratio. The effects are displayed in 12.
6 Conclusion

In this paper, I have sought to determine the extent to which a lifecycle model, disciplined at the individual level, can act as a predictor of aggregate outcomes. The preliminary results are encouraging.

There are clearly several areas that require continued exploration. One result in particular begs for further elaboration. The one-child policy works against the savings tendency of my model. This is immediately problematic, as it contradicts one of the more intuitively comfortable explanations for the savings growth rate. Previously, Chinese parents could rely upon their children to provide for them in their old age. Since the one-child policy, this pension “plan” is less assured, forcing individuals to save more today. It would be useful to explore the extent to which this channel contributes to the savings question. An extension to the current model in this direction would improve the micro-foundation upon which my results are based.
Figure 12: Augmented Model: Change in conditional survival probabilities

References


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