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The Impact of GDP Growth and the Dependent Share

BY

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Working Paper No. 2010-11R

January 11, 2012

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11 January 2012

Abstract

China's national saving rate rose rapidly in the 2000s after declining through the late 1990s. These dynamics are not readily explained by the precautionary motive, the institutional distribution of income, or reform related processes in general. Rather, we find a compelling explanation lies with GDP growth fluctuations and demographic shifts. We estimate a vector autoregressive model for the period 1978-2008, then generate in-sample simulations that successfully replicate the 2000s run-up in the saving rate. Our out of sample forecasts show the saving rate dropping in the 2010s as the dependent share falls and GDP growth moderates.

Many explanations for China's high rate of national saving have been proposed, and any or all of them may hold some measure of truth. But the phenomenon of Chinese saving as it has attracted attention in relation to global imbalances is about more than just a high rate of saving. Only with a very rapid increase in China's saving rate in the 2000s did saving diverge from domestic investment to yield a ballooning trade surplus and a massive accumulation of foreign reserves. Prior to this, through the late 1990s, China's saving rate was actually declining. To explain the imbalances that erupted in the mid-2000s then, a theory of Chinese saving behavior must account for a sudden, sharp rise in the saving rate.

In section 1, we outline alternative theories of Chinese saving behavior and argue against those based on the precautionary motive or distortions in the market mechanism. We contend instead, in section 2, that the dependent share in the population and the growth rate of GDP offer the best prospects for explaining observed movements in the saving rate. We compile data series for these variables for the period 1978-2008 in section 3. We then present results in section 4 from estimation of a vector autoregressive (VARX) model that treats the saving rate and GDP growth as endogenous variables and the dependent share as exogenous. The model is shown to perform well in explaining the 2000s increase in the saving rate. Section 5 applies the model to simulate paths for the saving rate under alternative assumptions regarding growth and demographics. Section 6 concludes by noting that the momentum is shifting toward a decline in the saving rate in years to come as the dependent share turns upward and GDP growth moderates. This bodes well for a rebalancing of the economy.

1. The Case against the Precautionary Motive and Market Distortions

Explanations for China's high and rising saving rate have revolved largely around three theories. First, the "precautionary theory" posits that economic reform has pushed the household saving calculus toward a more guarded stance to meet the risks of ill health, job loss, ageing, and other vicissitudes of post-socialist life (Chamon and Prasad 2010; Lardy 2006; Blanchard and Giavazzi 2006). Second, the "distortions theory" maintains that high interest rates, an undervalued currency, and other market distortions have shifted income from consumption-oriented households to saving-fixated enterprises (Kuijs 2006; Aziz and Cui 2007; Pettis 2009). Finally, Modigliani's (1970) "life cycle theory" emphasizes faster growth in income and a falling dependent share in population (Modigliani and Cao 2004; Horioka and Wan 2007; Kraay 2000).

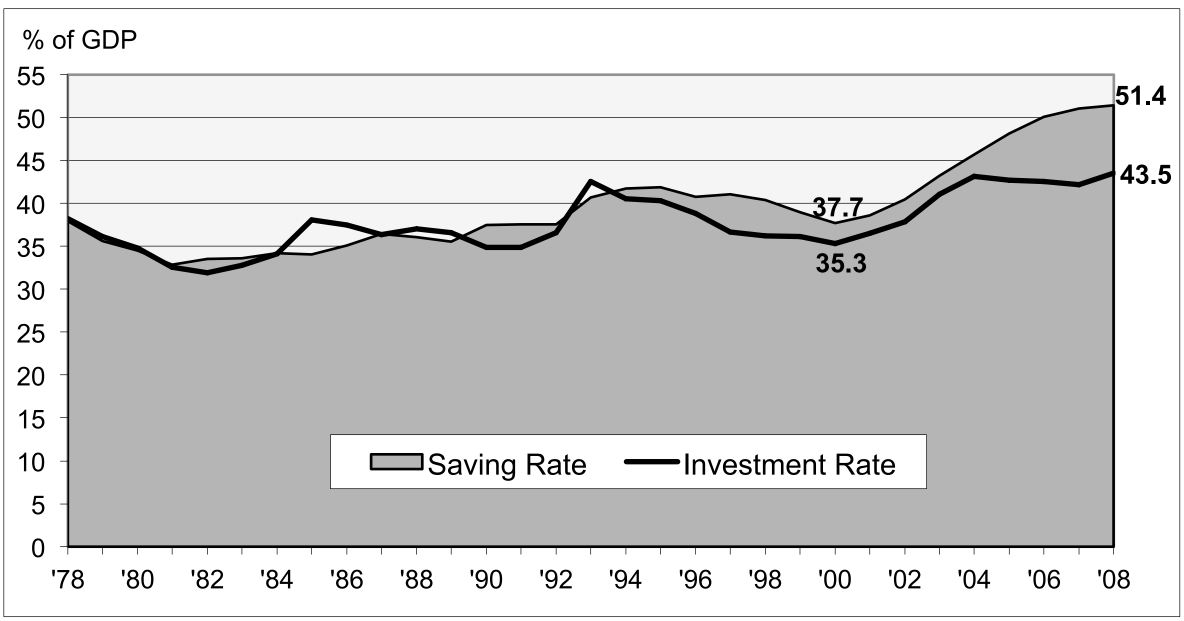
As is to be argued in this section, the precautionary and distortions theories do not accord with a declining national saving rate in the late 1990s and a rapid rise in the 2000s.[1] The precautionary theory has seemingly found support in econometric studies based on household survey data. Yet such studies do not provide a sound basis for drawing inferences as to the national aggregates. The life cycle theory is a more ready fit with the observed movement in the

[1] Other factors that have been cited for China's high national saving rate suffer from a similar failure to account for observed movements over time. These include the low share of employment in the service sector and the low level of financial development (Guo and N'Diaye 2010), as well as saving competition for brides (Wei and Zhang 2009).

national saving rate. It too has been tested with household survey data, to mixed results. Our contention, developed in the next section, is that the life cycle theory merits testing with aggregate data.

As shown in Figure 1, saving as a share of GDP reached a historic peak in 1995 of 41.9 percent having trended generally upward since the early 1980s. It then turned and headed downward through the late 1990s, bottoming at 37.7 percent in 2000. From there it surged, gaining 13.3 percentage points in just seven years between 2000 and 2007. Although the run-up in the saving rate began in 2000, imbalances did not erupt until after 2004. Until that point, the investment rate tracked the saving rate closely leaving only a modest saving-investment gap of 2.0-2.5 percent of GDP. From 2005 on, though, the investment rate was held in check through policy measures while the saving rate maintained its upward momentum.[2] In 2007, the saving-investment gap – and its reflection in the trade surplus – reached 8.9 percent of GDP, then subsided to 7.9 percent in 2008.

Figure 1: Saving & Investment Rates, 1978-2008



Data source: China National Bureau of Statistics

An explanation for high saving that rests on the precautionary motive and insecurities related to economic reform does not jibe with a decline in the national saving rate in the late 1990s followed by a steep rise in the 2000s. The late 1990s marked a high tide for reform of the urban economy. The state sector was down-sized radically, the line ministries and with them the state planning apparatus were abolished, workers were laid off in droves, and housing was privatized – all largely by 1998 (Liu 2010). Yet as life was becoming palpably more insecure,

[2] See Woo (2006) for an explanation of how policy restraints on investment have driven imbalances.

the saving rate fell. Conversely, it resumed its upward climb just as China joined the World Trade Organization and an economic boom got underway in earnest. Through the 2000s, gradual progress was made in building a social welfare system and mobilizing public support for health and education. Under the banner of "building a harmonious society", the rural minimum living allowance was established in 2005, the new rural cooperative medical scheme began to take shape in the same year, and free compulsory education through ninth grade was decreed in 2006 (Wong 2010). The urban pension system established in 1998 was reparameterized in 2005 to provide more generous benefits (Organization for Economic Cooperation and Development 2010, 196). Survey research by Whyte (2011) shows public health insurance coverage expanding from 29 percent of the population in 2004 to 82 percent by 2009. By all appearances then, the precautionary motive for saving should have been receding by the mid-2000s, yet the saving rate continued to climb.

Despite the logic of a diminishing need for precautionary saving as the 2000s unfolded, Chamon and Prasad (2010) concluded from their empirical work that "precautionary motives and the rising private burden of social expenditures has driven the increase in household savings rates." (p. 96) Their study draws upon urban household survey data for the period 1990-2005. For this sample, the saving rate trends generally upward throughout the period. As the authors show in an appendix table, however, the upward trend exhibited by their household data does not track with the aggregate household saving rate from the national accounts. The national accounts show a consistently higher household saving rate than the urban household survey data with a pattern that follows the national saving rate in declining through the late 1990s, then rising rapidly in the 2000s. China's National Bureau of Statistics, in arriving at the household saving rate reported in the national accounts, uses the household survey data as one point of information among many to produce a composite picture. Any statistical inferences drawn from the urban household survey data are thus of limited relevance for understanding movements in the aggregate household saving rate. To conclude, as Chamon and Prasad do, that "our preferred explanations for the high and rising savings rates are related to China's transition to a market economy" belies the observation that life was becoming less secure as the national saving rate fell and more secure as it later went back up.

The "distortions theory" similarly does not square with the empirical facts. The argument is that market distortions have redistributed income from households, who would consume the bulk of their receipts, to enterprises, whose retained earnings are by their nature saved in full. As Pettis (2009) puts it, "By transferring wealth from households to boost the profitability of producers, China severely hampered its ability to grow consumption in line with growth in the nation's GDP." (p. 4) Among policies that "systematically forced households implicitly and explicitly to subsidize otherwise unprofitable investment in infrastructure and manufacturing", Pettis lists: an undervalued currency; excessively low interest rates; a large spread between deposit and lending rates; sluggish wage growth due in part to restrictions on labor organizing; the unraveling social safety nets; and manufacturing subsidies including controlled land and energy prices. Also adopting this line of argument, Aziz and Cui (2007) cite the decline in the household income share in GNP rather than the rise in the household saving rate as "the elephant in the room"(p. 3) in explaining national saving and consumption patterns. Like Pettis, they see distortions in the financial sector as a powerful redistributive force, particularly as these distortions deprive small firms of working capital and thereby inhibit wage and employment growth.

The problem, again, is that this line of argument does not explain the observed decline in the national saving rate in the late 1990s and its rise in the 2000s. Based on flow of funds data revised retrospectively in 2009 by China's National Bureau of Statistics (accessed through CEIC), the share of household income in gross national disposable income (GNDI)[3] began a long decline from a peak of 68.6 percent in 1997 to 57.5 percent in 2007.[4] Until 2004,[5] most of the complementary gain in income share went to enterprises. Then, from 2004 to 2007, the enterprise share in GNDI contracted while the government share expanded substantially from 18.9 percent to 24.1 percent. While in principle the rising government share in income could have been allocated to public consumption, in fact the government consumption share in GNDI continued on a declining path even as the government income share rose. Government was thus a substantial contributor to the rising national saving rate in the mid-2000s. In any case, the bottom line is that income shifts from households to enterprises have not tracked the movement of the national saving rate.

By contrast, the household saving rate did move in sync with the national saving rate, declining in the late 1990s, then rising sharply in the 2000s as shown in Figure 2. This pattern came through, too, in household saving as a share in GNDI which fell from 21.6 percent in 1997 to 16.6 percent in 2000, then rebounded to 21.8 percent in 2007. Thus despite the protracted decline in the share of household income in GNDI through the 1997-2007 period, the pace was not sufficient in the 2000s to overcome the impact on national saving of a strongly rising household saving rate. The pattern in household saving thus fed through to the national aggregate.

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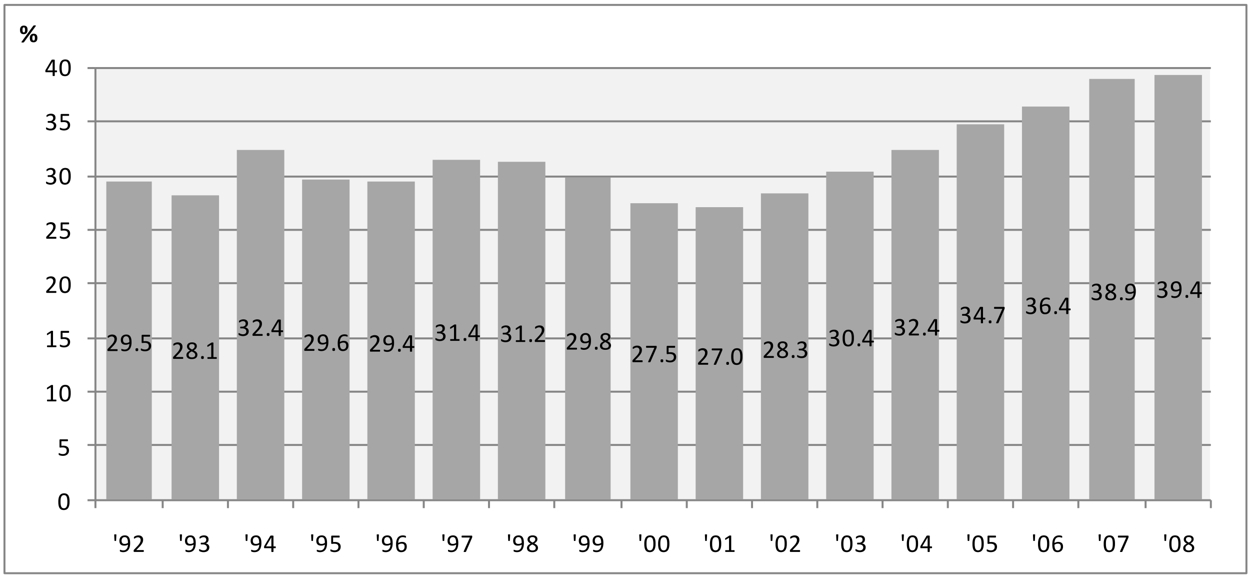
[3] National disposable income is the appropriate denominator against which to measure income shares because it comprehensively reflects all sources of income including net foreign-sourced factor income and transfers.

[4] Wiemer (2009) provides a detailed accounting of shares in income and saving by institutional type to substantiate the role of households and government in driving the increase in the national saving rate during the 2000s.

[5] The year 2004 shows erratic movement in income shares. Bai and Qian (2009) note that the economic census taken in that year provided the basis for a different methodology to be applied in compiling national statistics. They provide the service of cross-checking the flow of funds with other national accounts data, but use an earlier version of the flow of funds series that was overridden by the 2009 release. The revised series still appears to exhibit a discontinuity in 2004. For purposes of our analysis, we abstract from this discontinuity in examining longer-term trends.

Figure 2: Household Saving Rate in Household Disposable Income, 1992-2008



Data source: CEIC (drawn from National Bureau of Statistics flow of funds).

A story of China's national saving rate rising due to market distortions causing income redistribution from households to enterprises is not supported by the data. Moreover, this story usually takes such distortions as key to the Chinese growth model for their role in channeling resources to the state. It is a story of saving being forced upon the populace in order to achieve growth. But such causality running from saving to growth is, as a general rule internationally, not supported by the data either. Rather, cross-country studies have affirmed that causality runs in the opposite direction from growth to saving. In an application of panel techniques to a sample of 98 countries, for example, Loayza, Schmidt-Hebbel, and Serven (2000) found that an increase in the real growth rate of GNDI of one percentage point raised the national saving rate by 0.45 percentage points one year later. The ultimate effect was more than double that due to the tendency for saving increases to persist and to feedback on growth. This result was essentially unaltered when the model was applied more narrowly to private saving, and the authors found generally "that the public saving rate is driven by the same determinants as the private saving rate." Vivid evidence that a rise in saving has indeed followed, not preceded, faster growth is to be found among the successful developers of East Asia. Graphical analysis for South Korea, Singapore, and Vietnam presented in Wiemer (2008) shows that in all three cases, the saving rate climbed persistently well after the era of high growth began.

2. The Case for GDP Growth and the Dependent Share

The established finding that high GDP growth precedes a rise in the saving rate points to the "life cycle theory" which highlights the role of GDP growth and the dependent share. The foundation of the argument is that saving varies over the course of the life cycle. Because young and old age dependents consume while generating little or no income, populations with high proportions of youth and elderly tend to exhibit relatively low saving rates. The converse applies in the Chinese case where, due to the fall-off in the birth rate beginning in the 1970s, small youth cohorts and an expanding demographic concentration in the working ages have stoked a rising saving rate. The income growth rate comes into play in the life cycle model because working age cohorts that benefit from higher income growth save more relative to the dissaving of retirees who built their nest eggs in a lower-earning era. A counter-argument to the Modigliani story, however, is that when higher growth is anticipated, young earners would be expected to borrow against future wealth (or in the absence of well-functioning capital markets at least not save as much) in order to spread consumption more evenly over their lifetimes. Carroll, Overland, and Weil (2000) argue that for reasonable parameter values of the utility function this "human wealth effect" dominates Modigliani's "aggregation effect". The result is that higher growth does not lead to a higher saving rate in the way that Modigliani hypothesized and on the contrary may lead to a lower saving rate. This reasoning prevails, however, only if the higher growth is anticipated. If it is unanticipated, Friedman's (1957) permanent income hypothesis comes into play with higher growth leading unambiguously to higher saving.

Carroll et al., propose an alternative basis for growth to cause saving even when the growth is sustained and anticipated. Their model of habit formation defines utility as a function not just of current consumption but of a habit stock of consumption derived from a weighted average of past consumption values. Households choose a current consumption level with an eye to its impact on the habit stock and hence on utility projected into the future. A given level of income is more rewarding if it has been arrived at through faster growth than through slower growth. Saving responds more positively to growth in a model with habit formation because households take advantage of an increase in income to save more and thus sustain a higher rate of consumption growth in future years. Fitted with reasonable parameter values, such a model of utility is shown by Carroll et al. to "generate growth-to-saving causality that is qualitatively similar to that observed in the data." (p. 1) In any case, Carroll et al, Modigliani, and Friedman all tell stories of growth causing saving, although their models differ in their behavioral premises.

A number of studies have tested Modigliani's saving determinants using Chinese household survey data. Modigliani himself, with co-author Cao (2004), tested his hypothesis for the Chinese case in what he called "a fitting conclusion to my life's work." (p. 145) Using nationally aggregated household survey data for the period 1953 to 2000, Modigliani and Cao obtained results indicating strong confirmation of a role for both the dependency ratio and the rate of income growth in influencing saving. Such a finding in this context is not surprising. China's household saving rate was below ten percent and trendless during the command economy era. It surged from 1978 onward to reach more than 30 percent by the mid-1990s coinciding with both the decline in the dependency ratio that followed from a drop in the birth rate and the rapid increase in income growth that accompanied reform and opening.

The Modigliani and Cao results have been in part challenged by Horioka and Wan (2007) who make use of household survey data at provincial level for the period 1949 to 2004. The cross-sectional variation captured by the provincial data cast doubt on the claim that the dependency ratio has had a bearing on saving. Confirmed though is the relationship between income growth and saving with results similar in magnitude to those of Loayza et al. from their cross-country panel estimation. Specifically, the initial effect of a one percentage point increase in the growth rate is a rise of about half a percentage point in the saving rate with a long run effect double or more that. Horioka and Wan's results are also at odds with those of Kraay (2000). Though Kraay too used the household survey data in a provincial-level panel, he found saving not affected by income growth while nevertheless affected as predicted by the dependency ratio. Horioka and Wan conclude that their dynamic panel techniques are superior to the two-stage least squares method of Kraay for discerning the true nature of the relationship.

Results, then, are mixed for tests of the Modigliani variables using household survey data. In any case, the problem in extending inferences from household survey analysis to the national aggregates again applies. A study by Ma and Zhou (2009) of China's net foreign asset position provides indirect support for an impact of demographics on saving at the national level. Due to the rapid increase in the saving rate relative to the domestic investment rate, China swung from a net debtor position of 9 percent of GDP in 1999 to a net creditor position of more than 30 percent of GDP in 2007. Ma and Zhou estimated the impact of five variables on this shift of which only the young age dependent share registers as significant through a variety of specifications of the model. Not significant under any of the specifications are the other four variables: China's rate of income growth relative to OECD countries; the ratio of government debt to GDP; measures of financial deepening; and the real effective exchange rate. The impact of the old age dependent share is difficult to gauge since although the point estimate is large, so is the standard deviation. This result is not surprising given the limited variation shown by this variable in years past.

Ma and Zhou's work notwithstanding, standard theories of saving as a function of income growth and the dependent share pertain to households. Given the non-conformance of the NBS household survey data with household saving as captured in the national accounts, one might wish to test the determinants of household saving using the national time series directly. Household data from the flow of funds date only to 1992, however, precluding any rigorous econometric analysis. Nevertheless, a case can be made that income growth and the dependent share act as determinants of saving for enterprises and government as well as to households in the Chinese case (Ma and Yi, 2010). This provides a foundation for undertaking a more encompassing analysis of the national saving rate to GDP which affords use of time series that are longer.

The link between rapid economic growth on the one hand and burgeoning enterprise earnings and government revenue on the other is reasonably straightforward. That enterprises were not compelled to give over more of this bounty to rising wages can be explained by strong labor force growth which was the counterpart to a shrinking young age dependent share. Wage rates for unskilled labor essentially stagnated through most of the 2000s, with enterprises thus able to amass earnings for reinvestment. As for government, the sweet spot in the demographic transition afforded an opportunity to build reserves in a nascent pension system thereby strengthening the net fiscal position. On the expenditures side, public consumption grew more slowly than public investment. The habit formation argument that applies to households may well extend to government in accounting for this. Moreover, provision of public services requires painstaking institutional development that can proceed only gradually. Public health and education services expanded significantly during the 2000s, yet not as fast as overall spending and only with much experimentation in devising forms of organization and delivery. Public spending for investment by contrast rolls out easily in the Chinese setting. Through all three institutional channels then, income growth and a declining dependent share seem to have worked in concert during the 2000s to boost the saving rate.

Gauging the impact of growth and demographics in China's saving rate rise of the 2000s is important for predicting future tendencies in the saving rate and hence for assessing the need for interventionist policies to restore domestic and external balance. Our revisions to the GDP growth series (laid out in the next section) show the 2000s to have been a period of exceptionally strong economic performance, to a greater degree even than is indicated by the official figures. At the same time, the share of young age dependents in the population took a marked drop. To the extent that these forces drove the rise in the saving rate, a reversal in their direction could well have a moderating effect on saving in years to come. This would make the rebalancing of the Chinese economy easier than is generally imagined and would undercut hardline views on the imperative of currency appreciation.

3. Compilation of Data Series

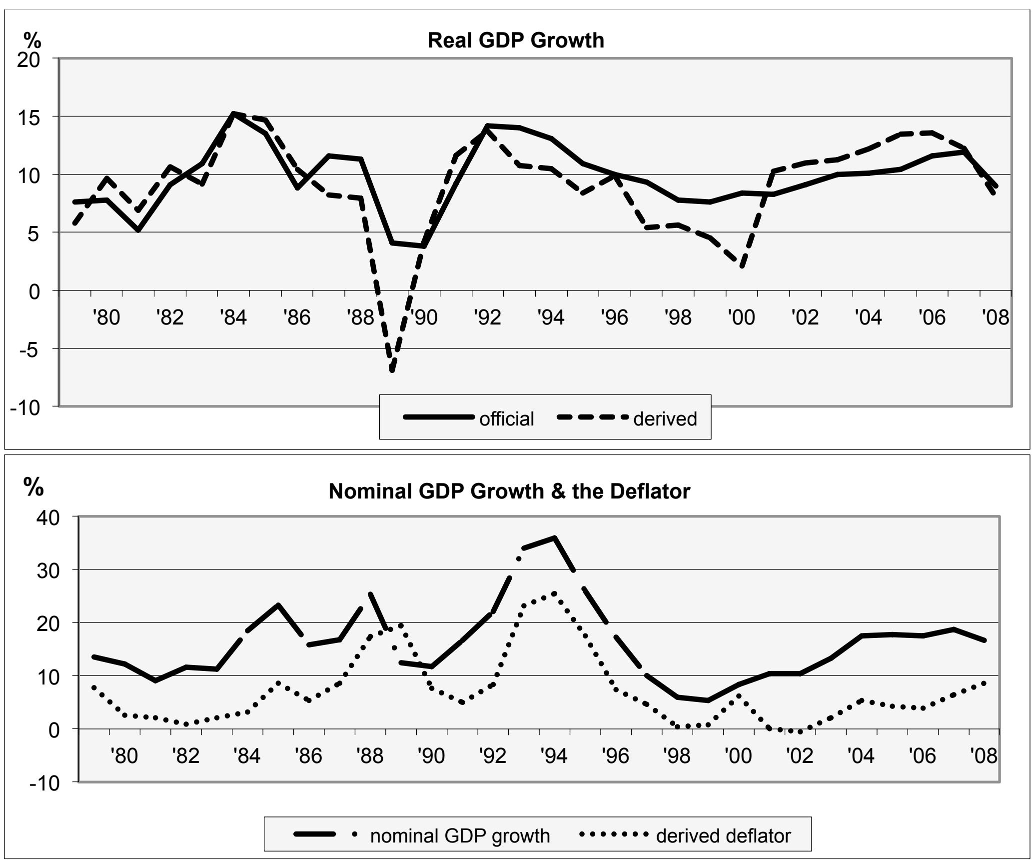
Data series for the national saving rate and the dependent share in population are suitable for use directly from official sources.[6] To obtain an appropriate series for real GDP, we deflate nominal GDP following Young (2003). Deriving real GDP by deflating nominal GDP is standard practice in most countries, but not so in China. The *China Statistical Yearbook* of 2010 describes an approach that has been in place since 1952 of calculating constant price GDP in the prices of a base year, with the base year having been reset seven times at varying intervals by the statistical authority.[7] Official real GDP growth rates are derived from these constant-price output series. According to Young, statistical reporting of constant-price output is done at the enterprise level. Since under a market economy businesses do not otherwise have reason to keep track of current year output measured in base year prices the numbers supplied are likely to be rather ad hoc. Young's alternative methodology involves constructing a GDP deflator as a weighted average of official price indexes for the three major sectors of the economy – agriculture,

[6] Data used in the econometric analysis of this paper are available at http://www.uhero.hawaii.edu/assets/ChineseSavingDynamicsdata.xlsx.
[7] National Bureau of Statistics, *China Statistics Yearbook, 2010*, http://www.stats.gov.cn/tjsj/ndsj/2010/indexch.htm (in Chinese; accessed July 19, 2011).

industry, and services. A GDP deflator derived in this way differs markedly from the deflator implicit in the official nominal and constant-price GDP series. Confronted with three inconsistent series – official nominal GDP, a deflator calculated from official sectoral inflation rates, and official constant-price GDP – we are inclined to place greater confidence in the first two for their relative ease of measurement based on observed magnitudes and reject the third.

As shown in Figure 3, the derived real GDP growth series (upper panel dashed line) follows a more erratic pattern than the official series (upper panel solid line). Arguably, the derived result accords better with experience as perceived on the ground. In particular, a recession in 1989 is shown to have been extremely deep with the real rate of growth plummeting to -6.9 percent. Nominal growth dropped to 12.5 percent in that year from 25.3 percent in the preceding year (lower panel punctuated line) even as inflation carried on its momentum pushing up to 19.4 percent (lower panel dotted line). Inflationary pressures remained strong despite the weakening economy because the dual-track system of pricing which allowed free markets to operate in parallel with the state plan was giving way under the force of plan/market arbitrage.

Figure 3: Official & Derived GDP Growth Rates, 1979-2008



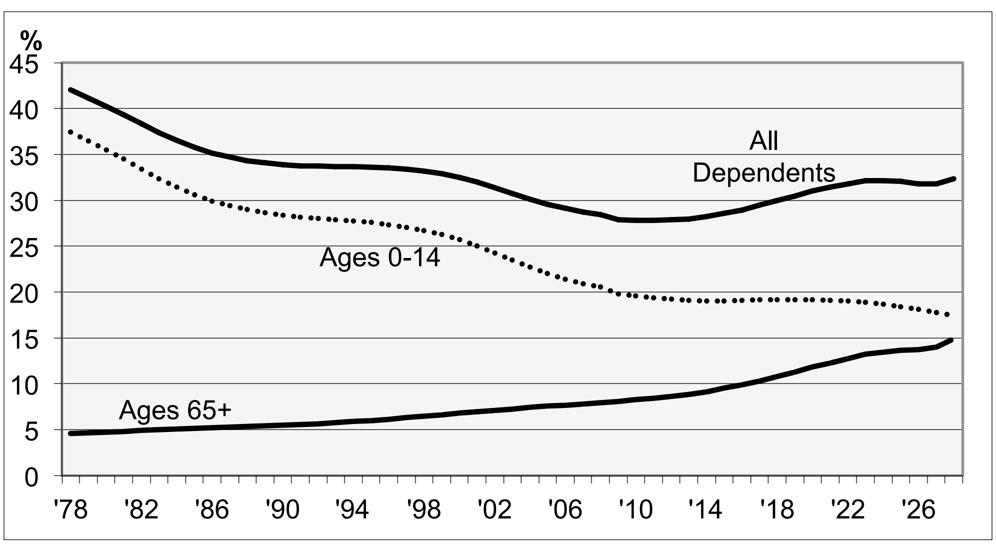
Data sources: CEIC and China National Bureau of Statistics

Street demonstrations, in part a reaction to corrupt officials exploiting the arbitrage opportunities of the transitional price system, pre-empted normal economic life for two months in cities all over the country. The eventual crackdown by the government brought a retrenchment in foreign engagement with China that choked off foreign direct investment and set back development of the domestic private sector. That a deep recession transpired is consistent with these realities.

The slowdown in growth of the late 1990s is also revealed by Figure 3 to have been more severe than official statistics suggest. Domestically, the economy was beset with massive lay-offs by state-owned enterprises and downsizing in government employment, while internationally, the Asian financial crisis took a toll. Modest nominal growth was undermined by inflation that rose to 6.3 percent in 2000 to leave real growth at a meager 2.3 percent. Against this deterioration in growth, the rebound that accompanied China's entry into the World Trade Organization appears far more pronounced than the official figures let on. The deflated nominal figures show growth reaching as high as 14.2 percent in 2006. This surge in growth following a deep trough coincides with the change in direction of the saving rate.

The dependent share in the population is calculated by combining those under 15 with those 65 and older. As shown in Figure 4, after declining throughout the reform era, the dependent share is bottoming out as of the turn of the decade, poised to move back up (US Census Bureau, 2009). Total fertility came down sharply beginning in the late 1970s inducing a long slide in the youth dependent share. Generational plateaus show up beginning in the late 1980s and again about 20 years later as larger adult cohorts give birth to larger cohorts of offspring. Longer life spans have steadily raised the share of the population age 65 and older but along a much more gradual course. From the mid-2010s, the rise in the elderly share is expected

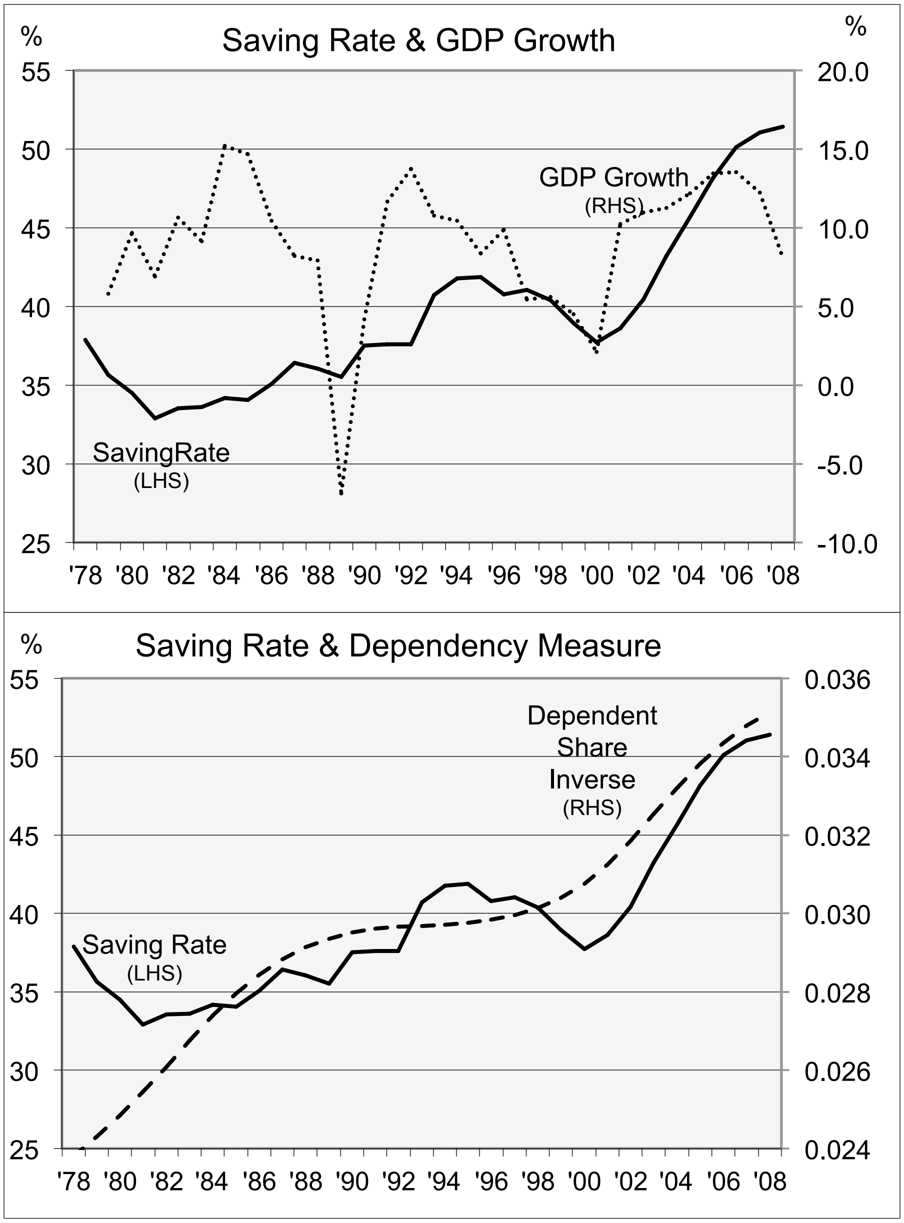
Figure 4: Shares of Young and Old in Population, 1978-2028



Data sources: World Bank & US Census Bureau to steepen as the baby boom of the 1950s hits its senior years. A trough at the mid-2020s reflects the impact of the famine of the early 1960s on births and infant mortality.

Juxtaposing the derived real GDP growth series against the domestic saving rate in the upper panel of Figure 5 brings out the association. Periods of high growth have corresponded to periods of rising saving rates. Growth reached a level of 15 percent in the mid-1980s and the saving rate moved upward. Again in the early 1990s growth shot up to double-digit levels and an increase in the saving rate followed. Conversely, the growth recession in the late 1990s was associated with a slide in the saving rate. Finally, the recent protracted period of extraordinary growth has seen the saving rate ascend to an unprecedented 50 percent plus. In the lower panel of Figure 5, the inverse of the dependency share is shown as well to move in connection with the saving rate. Most notably, both variables exhibit a steep rise in the 2000s. The rise in the dependency measure of a generation earlier does not move in such close sync with the saving rate. On the contrary, the initial break from the planned economy brought a sharp fall in the national saving rate as income shifted from a saving-oriented state to households just pulling away from the margin of subsistence. This would presumably have overridden the influence of demographic factors.

Figure 5: The Saving Rate and Its Determinants



4. Estimation of a Structural VAR

To study the dynamic relationship between China's saving rate, real income growth, and demographic change, we estimate a vector autoregressive model.[8] The model allows, in

[8]Studies relying on panel data that afford a large number of observations typically include an array of independent variables to explain saving. Our approach making use of a 30 year time series does not permit such expansiveness. Our unrestricted recursive SVARX with 2 lags (equations 5 and 6) involves estimation of 17 parameters; adding just one endogenous variable to explore other potential relationships would mean estimating an additional fourteen parameters. Our limited sample size requires that we keep our model small, but still allows us to model the complex interaction over time between saving and the crucial variable of income growth.

principle, for causality to run from saving to growth as well as from growth to saving. A high level of saving facilitates a high level of investment, which in a Rebelo (1991)-type endogenous growth model contributes to sustained high growth in output. Alternatively, in the neoclassical growth model an increase in saving only temporarily increases growth. Growth in the steady state depends strictly on the rate of technological change. With the introduction of habit formation a la Carroll et al., shocks to growth result in a transition path in which the saving rate rises over a horizon that is longer the greater the strength of habit formation. In any model though, to the extent that increases in saving are channeled abroad, as they were in China post-2004, the feedback link to output growth is undercut. Given the theoretical ambiguities, we specify a model such that the impact of changes in saving on growth, and vice versa, may be estimated empirically.

Consider the simple one lag structural VAR with exogenous variables (SVARX),

$$s_t = b_{10} - b_{12}g_t + \gamma_{11}s_{t-1} + \gamma_{12}g_{t-1} + \omega_{10}d_t + \omega_{11}d_{t-1} + \varepsilon_{st} \tag{1}$$

$$g_t = b_{20} - b_{21}s_t + \gamma_{21}g_{t-1} + \gamma_{22}s_{t-1} + \omega_{20}d_t + \omega_{21}d_{t-1} + \varepsilon_{gt}, \tag{2}$$

where s_t is the national saving rate, g_t is the growth rate of real GDP, and d_t is the exogenous dependency measure.[9] The shocks to the structural equations, ε_{st} and ε_{gt}, are assumed to be uncorrelated white-noise disturbances. Because both equations in the SVARX allow for contemporaneous feedback, the shocks are correlated with the contemporaneous variables in each equation, and estimation by Ordinary Least Squares (OLS) is not possible. Typically the SVARX is transformed into its reduced form representation,

$$s_t = a_{10} + a_{11}s_{t-1} + a_{12}g_{t-1} + w_{10}d_t + w_{11}d_{t-1} + e_{st} \tag{3}$$

$$g_t = a_{20} + a_{21}g_{t-1} + a_{22}s_{t-1} + w_{20}d_t + w_{21}d_{t-1} + e_{gt}. \tag{4}$$

Assuming the lag length is adequate, the errors e_{st}, and e_{gt} are serially uncorrelated and uncorrelated with the predetermined and exogenous regressors. Yet these error terms are almost certainly correlated with each other, and cannot be used for tracing out the impact of "structural" shocks to real GDP growth or the saving rate as the reduced form errors are linear combinations of the desired structural shocks ε_{gt} and ε_{st}.[10]

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[9]We follow Feldstein and Horioka (1980), Dooley, Frankel, and Mathieson (1987), and others in treating the dependent share as an exogenous variable.

[10]Writing the structural and reduced form VARs in matrix form we have $Bx_t = \Gamma_0 + \Gamma_1 x_{t-1} + \omega_0 d_t + \omega_1 d_{t-1} + \varepsilon_t$ and $x_t = A_0 + A_1 x_{t-1} + W_0 d_t + W_1 d_{t-1} + e_t$, where $x_t = (s_t, g_t)', e_t = (e_s, e_g)', \varepsilon_t = (\varepsilon_s, \varepsilon_g)'$, and $A_i = B^{-1}\Gamma_i, W_i = B^{-1}\omega_i$, for $i = 0,1$ with $B = \begin{bmatrix} 1 & b_{12} \\ b_{21} & 1 \end{bmatrix}$. The relationship between the structural shocks and the reduced form errors is $e_t = B^{-1}\varepsilon_t$.

To study the dynamic response of the saving rate to a shock to real GDP growth, say due to an improvement in productivity, it is necessary to impose some restrictions on the relationship between the reduced form errors $e_t = (e_{st}, e_{gt})'$ and the unknown structural shocks, $\varepsilon_t = (\varepsilon_{st}, \varepsilon_{gt})'$. While various methods have been developed for identifying structural shocks in VAR models, for our analysis of the saving rate and real growth, the recursive system introduced by Sims (1980) is suggested by theory.[11] Standard growth models imply that productivity shocks will have an immediate impact on the growth of real output, whereas shocks to the saving rate will only impact output with a lag via the accumulation of capital. Imposing the restriction that shocks to the saving rate have no contemporaneous effect on real GDP growth, $b_{21} = 0$, we can rewrite the structural VARX in recursive form.[12]

$$s_t = b_{10} - b_{12}g_t + \gamma_{11}s_{t-1} + \gamma_{12}g_{t-1} + \omega_{10}d_t + \omega_{11}d_{t-1} + \varepsilon_{st} \tag{5}$$

$$g_t = b_{20} + \gamma_{21}g_{t-1} + \gamma_{22}s_{t-1} + \omega_{20}d_t + \omega_{21}d_{t-1} + \varepsilon_{gt}. \tag{6}$$

Below we estimate equations (5) and (6) and evaluate the dynamic relationship between saving and growth using impulse response analysis and simulation of our model. But first we evaluate the stochastic properties of each time series in our model. We conduct GLS detrended Augmented Dickey Fuller (DF-GLS) tests for unit roots in the saving rate, GDP growth rate, and dependency measure (see Elliott, Rothenberg, and Stock 1996). Based on Figure 5, it appears that both the saving rate and the dependency measure may be $I(1)$ processes, while real GDP growth is likely $I(0)$, and our results confirm these expectations. We reject the null hypothesis of a unit root in real GDP growth at the 5 percent marginal significance level based on the DF-GLS test, but are unable to reject the same null for either the saving rate or the dependency measure.[13]

Because of the possibility that some of our series are $I(1)$ processes, we follow the prescriptions of Sims, Stock, and Watson (1990) for testing hypotheses in VARs that contain a mixture of $I(1)$ and $I(0)$ processes.[14] For example, while Wald tests for the null hypothesis that an $I(0)$ series such as real GDP growth Granger-causes an $I(1)$ series such as the saving rate will have a limiting χ^2 distribution, the converse is not true. And, tests of whether an $I(1)$ series such as the dependency measure Granger-causes another $I(1)$ series will not have a limiting χ^2 distribution unless the two series are cointegrated.

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[11] See Watson (1994), or Enders (2004) for a discussion of common methods of identification.

[12] This restriction is exactly the same as would be obtained by using a Choleski decomposition to form a triangular version of the variance covariance matrix for the reduced form VAR. That is, the restriction $b_{21} = 0$ implies that $e_{st} = \varepsilon_{st} - b_{12}\varepsilon_{gt}, e_{gt} = \varepsilon_{gt}$, and $E(ee') = \Sigma = \begin{bmatrix} \sigma_s^2 + b_{12}^2\sigma_g^2 & -b_{12}\sigma_g^2 \\ 0 & \sigma_g^2 \end{bmatrix}$. Note that other restrictions are also possible. For example, we could follow Blanchard and Quah (1989) and impose the restriction that shocks to the saving rate do not have permanent effects on real GDP growth as is also implied by the neoclassical growth model.

[13] Results are available from the authors on request.

[14] See Watson (1994) or Enders (2004) for accessible summaries of the problems with, and prescriptions for, dealing with mixed $I(1)$ and $I(0)$ VAR analysis.

To select the lag length for our recursive VARX, we begin by estimating a *VARX*(p) with a maximum lag length of p=4.

$$y_t = c + \sum_{i=1}^{p} \phi_i y_{t-i} + \sum_{j=0}^{p} \omega_j d_{t-j} + e_t. \tag{7}$$

We test the null hypothesis $H_0 : \phi_p = \omega_p = 0$, for p=4,…,1. We are unable to reject the null hypothesis that all coefficients on lags 4 or 3 are jointly equal to zero, but we reject the null hypothesis that all coefficients on lag 2 are zero at the five percent marginal significance level.

We next estimate the recursive VARX in equations (5) and (6) with the lag length set to two. Given our sample of only 29 years of data, we choose to further restrict our model.[15] However, given the possibility that at least two of the three series under study are $I(1)$ processes, we do not rely on Granger causality tests to inform our restrictions. Instead, we use results from t-tests on single lags of individual series. As in the case of the lag length selection, so long as it is possible to rewrite our recursive VARX so that the hypothesis we are testing concerns a coefficient on a zero mean stationary regressor, our t-tests will be normally distributed. Specifically, in our equation for the saving rate, we exclude both lags of the dependency measure based on t-statistics near zero, and we exclude the second lag of the saving rate for the same reason. In the equation for real GDP growth, we exclude the dependency measure at all lags (including the contemporaneous value) based on t-statistics of 0.5 or smaller. We also exclude the second lag of the dependent variable.

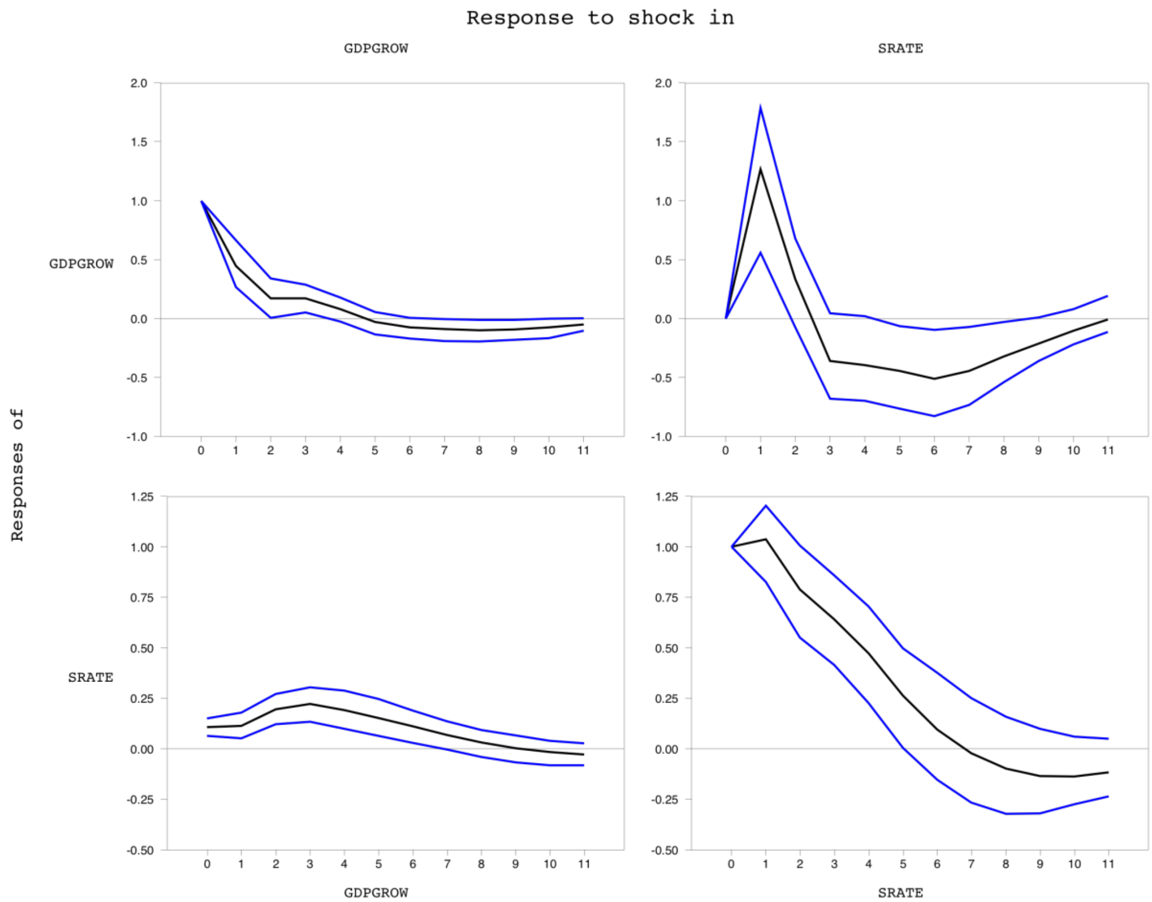
We follow standard practice in analyzing the performance of our VAR using impulse response functions (Stock and Watson, 2001).[16] The first column of graphs shown in Figure 6 presents the results for a unit shock to real GDP growth and the second column the results for a unit shock to the saving rate. The recursive nature of the model is clear in the top right quadrant in that real GDP growth shows no response to a one percentage point shock to the saving rate at time $t+0$, even as a positive and significant response comes through in periods $t+1$ and $t+2$. Three periods after the shock to the saving rate, the response of real GDP growth is insignificantly different from zero and remains very nearly zero from then on. In the lower right quadrant, we see evidence of the persistence of the saving rate that we also found in our unit root

[15]Krolzig (2003) suggests general-to-specific reduction strategy to reduce the large number of parameters and resulting estimation uncertainty in SVAR impulse responses. He shows that the GETS reduction strategy produces impulse responses that are more precisely estimated than from unrestricted SVARs. We do not follow his recommendation to apply the specific PcGETS reduction strategy because his analysis assumes no unit root processes in his VAR.

[16]Because we have moved away from a system where each equation has exactly the same regressors, we estimate our two-variable system as a Seemingly Unrelated Regression, and calculate impulse responses and confidence intervals using Monte Carlo integration with importance sampling. All calculations are done using RATS v7.1. We use the montesur.prg written by Thomas Doan for calculating impulse responses and fractiles of the distribution of simulated responses. Following Sims and Zha (1999) we use 16 percent and 84 percent fractiles corresponding to one standard deviation for symmetrical error bands based on estimates of the variance. All data and programs are available from the authors on request.

tests. A one-percentage point shock to the saving rate in period $t+0$ actually raises the saving rate further in period $t+1$ due in part to the impact of higher GDP growth in that period. The own shock to the saving rate takes more than five years to die off completely. The own shock to real GDP growth dies off quickly consistent with our finding that real GDP growth is stationary. We interpret the detectable persistence of real growth to its own shock as the result of feedback from the highly persistent saving rate. That is, an initial shock to real GDP growth boosts the saving rate and the lingering impact of that in turn boosts GDP growth. The lower left quadrant shows a one percentage point shock to real GDP growth has a positive and statistically significant impact on the saving rate for six years after the initial shock.

Figure 6: Impulse Response Functions



While the shock to real GDP growth produces a statistically significant response in the saving rate, at first glance this response appears small. Cumulating the responses over time, however, indicates that a 1 percentage point shock to real GDP growth leads to a sixty-four basis point increase in the saving rate after three years, and a maximum impact of 1.2 percentage points after eight years. These results are similar in magnitude to those obtained by Loayza et al. and Horioka and Wan.[17]

5. Simulations

To disentangle the role of real GDP growth and the dependent share in the movement of China's saving rate, we have conducted a number of simulations of our VARX. We focus on explaining the surge in the saving rate from a trough of 37.7 percent in 2000 to 51.4 percent in 2008. We first use our model to prepare dynamic forecasts over the eight-year period from 2001 to 2008. These forecasts are based on the model estimated over the full sample, so we are primarily illustrating goodness of fit. These are dynamic forecasts so predicted values for the saving rate and real GDP growth at time t=2000 are used to predict subsequent rates in t+1, … , T=2008. We treat the dependent share as an exogenous variable throughout.

The baseline forecast for the saving rate shown in the upper panel of Figure 7 indicates that our model explains most of the observed increase. Our dynamic forecast of the saving rate climbs to 49.7 percent by 2008, only 1.7 percentage points below its actual value.[18] The difference between our dynamic in-sample forecast and the actual saving rate is due to two factors. First, model misspecification and the stochastic shocks to the saving rate cause forecasted values to differ from actual values. Second, as illustrated in the lower panel of Figure 7, our baseline GDP growth rate forecast is below the actual growth path throughout the entire forecast period but for the final year. Over this period, China's actual GDP growth, as captured by our derived measure, accelerated from a recessionary low of 2.3 percent in 2000 to more than 14 percent in 2006 before settling to 8.0 percent in 2008. The actual compound GDP growth rate by our measure was 11.1 percent vs. our baseline forecast of 9.3 percent.

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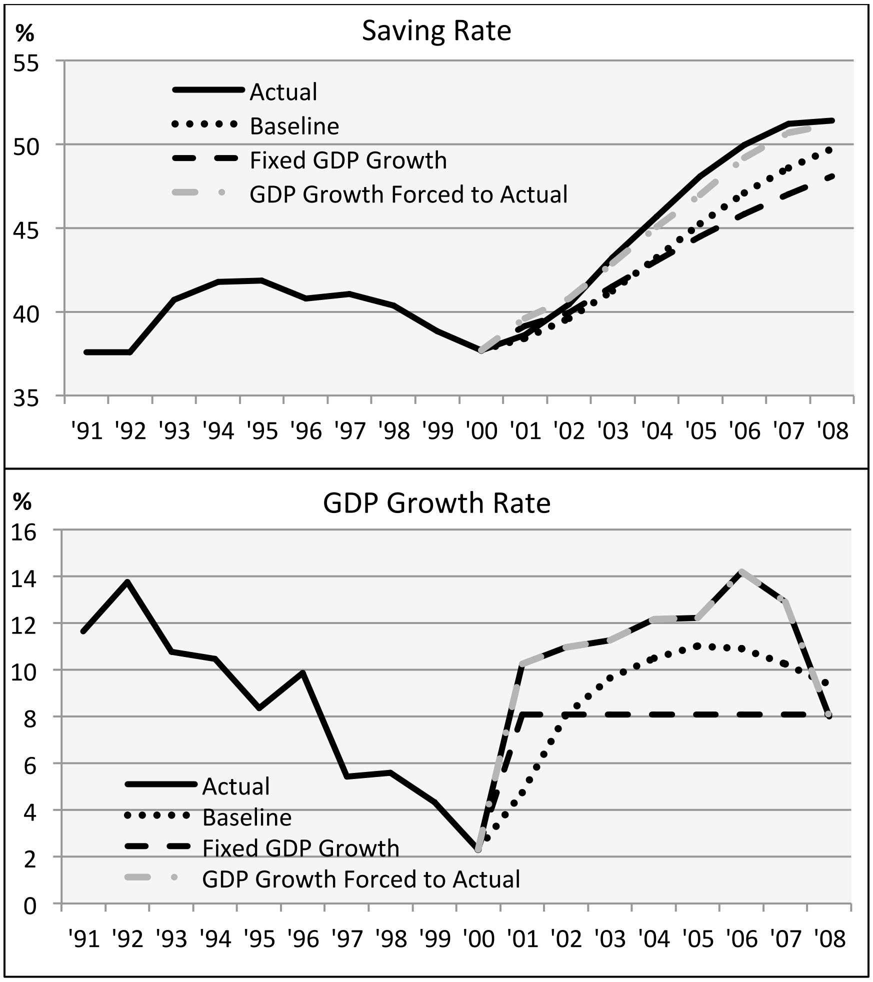
[17] For comparison, we also estimated our VAR using official data on real GDP growth. Following the same procedure to select variables, we arrived at a model that differs in retaining the second lag of the saving rate in the saving equation and both lags of real GDP growth in the GDP growth equation. While the point estimates for the response path for saving from a one percentage point shock to GDP growth are similar, there is much loss in precision. The cumulative response in the saving rate is an estimated 65 basis points after three years and 1.12 percentage points after eight years. However, the impact differs significantly from zero for only one year as opposed to six years when our derived GDP growth measure is used.

[18] We obtain similar results using the official measure of real GDP growth. The dynamic forecast of the saving rate climbs to 49.5 percent by 2008, 2 percentage points below its actual value.

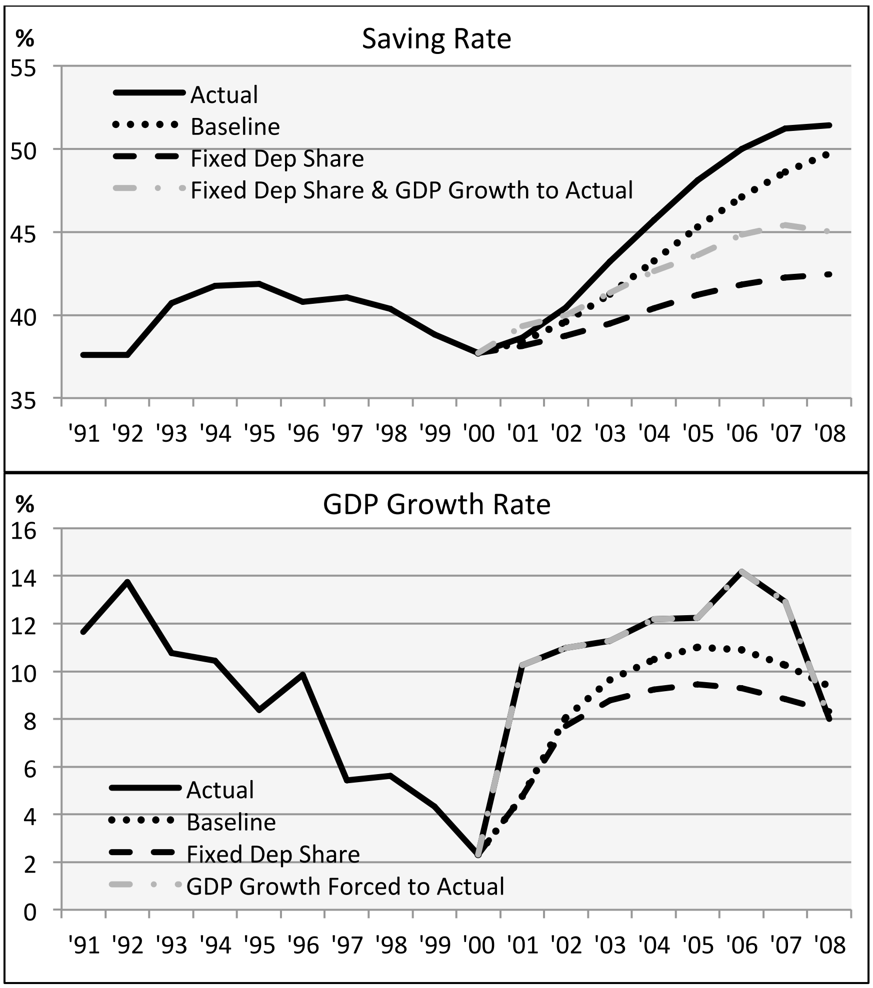
Figure 7: Simulations for Alternative GDP Growth Scenarios



To explore how much of the shortfall in the saving forecast is due to our model's failure to capture the growth boom over this period, we generate a second forecast for the saving rate while forcing simulated GDP growth to match the reality. This forecast is labeled "GDP Growth Forced to Actual" in Figure 7. Clearly, most of the shortfall in our baseline saving rate forecast is due to our model under-predicting real GDP growth during the boom years. Another way to see the effect of China's tremendous growth on saving is to simulate our model under the assumption that real GDP growth over the 2001 to 2008 period remained constant at its average value over the previous two decades of 8.1 percent. Forcing GDP growth to be a full 3 percentage points lower than its actual rate from 2001 through 2008 leads to a peak saving rate in 2007 that is 1.6 percentage points below the baseline forecast and 3.3 percentage points below the actual saving rate.

While the surge in real GDP growth clearly played a role in explaining China's saving rate increase of 13.7 percentage points from 2000 to 2008, it is not the whole story. To explore the role of demographics, we prepare another dynamic forecast under which we hold the dependent share fixed at its value in 2000 with the results shown in Figure 8. Over the period 2000 to 2008, the actual dependent share fell from 32.5 to 28.5. Fixing the dependent share at its 2000 level and simulating our VARX produces a saving rate forecast for 2008 that is 8.9 percentage points lower than the actual rate. Demographics thus figure enormously in the saving rate run-up of the 2000s.

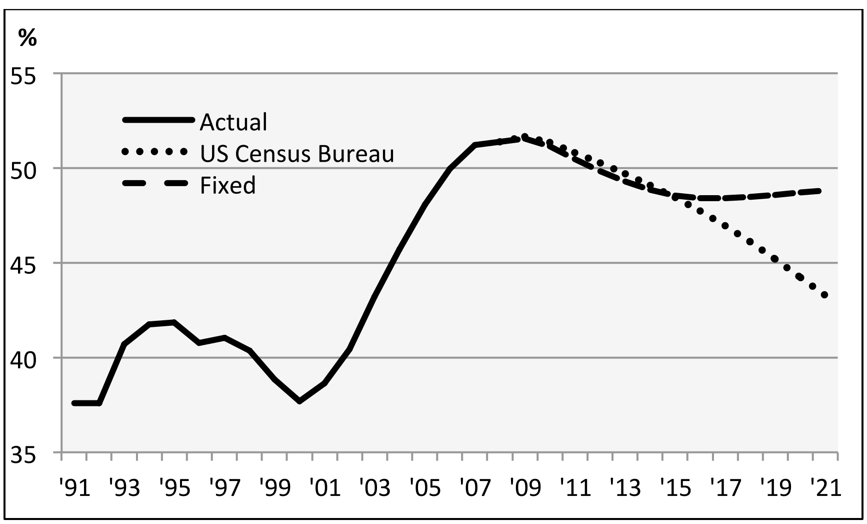
Figure 8: Simulations for Alternative Dependent Share Scenarios



To summarize, the dynamic forecast simulation from our VARX model explains all but 1.6 percentage points of the 13.7 percentage point increase in the saving rate that occurred over the 2000-2008 period. When we impose actual GDP growth in place of our baseline simulated growth rate, our model explains all but 0.2 percentage points of the saving rate increase. By contrast, when we hold GDP growth to its historic mean of 8.1 percent, 3.3 percentage points of the actual saving rate increase are left unexplained. And when we hold the dependent share constant at its 2000 level rather than letting it follow its actual declining path, at the same time forcing GDP growth to its actual path, 6.4 percentage points of the saving rate increase are left unexplained.

That the rise in the saving rate in the 2000s may be explained by a falling dependent share and rapid GDP growth suggests that a reversal in these forces may bring a decline in the saving rate in the future. We assess the tendencies for this by conducting an out-of-sample forecast based on projections for China's dependent share. The projections, from the US Census Bureau, show the dependent share rising from 28.5 percent in 2008 to 31.9 percent in 2021. For comparative purposes, we also run a simulation with the dependent share fixed at its 2008 level. The GDP growth rate is determined endogenously in the simulations. As shown in Figure 9, both simulations predict an immediate turnaround in the saving rate as the dependent share levels out and the growth rate slows. Under the Census Bureau projection, the saving rate continues downward as the dependent share rises reaching about 43 percent by 2021. By contrast, with the dependent share held constant the saving rate levels out around 48 percent.

Figure 9: Saving Rate Forecast for Alternative Dependent Share Projections, 2009-2021



For comparison we also evaluate a model where the dependent share is disaggregated into its young and old components. Given the limited variation in the old-age dependent share depicted in Figure 4, we expect that much of the impact of demographics is driven by the young element, and that is what we find. Adopting our specification from Section 2 but replacing the aggregate dependent share with its two components, we find that the parameter on the contemporaneous old age dependent share is insignificantly different from zero with a t-value of only -0.36. Using only the young dependent share, our model performs very much the same as with the aggregate share, explaining all but 1.5 percentage points of the rise in the saving rate from 2001 to 2008. This implies a caveat for our out-of-sample forecasts. The rise in the dependent share in future years will rest on an increase in elderly dependents whereas our parameter estimates derive mainly from variation in young-age dependency. Recourse to other studies that have captured the effects of ageing populations on saving through use of cross-country panel data suggests that our imputation of an impact on saving from ageing may nevertheless hold up. Higgins (1998) found negative consequences for saving associated with elderly cohorts to be at least as great as for youth cohorts. His empirical analysis led to the conclusion that the 'four tigers' (Hong Kong, Korea, Singapore, and Taiwan) were likely to see saving rate declines of several percentage points due to population ageing. With China's even sharper ageing process, an even greater drop in the saving rate seems plausible.

Our simple VARX predicts that GDP growth will vacillate down to a modest four to five percent rate in the coming decade. That together with the expected turnaround in the dependent share yields a steady decline in the saving rate. Our forecast is for a decline of about three-quarters of a percentage point per year, which is well short of the torrid two percentage point per year pace at which it went up. Were GDP growth to slow more drastically, the decline in the saving rate would be quicker, but that is hardly a recipe for rebalancing. Policy interventions could also steepen the pace of decline.

6. Conclusion

The increase in China's national saving rate during the 2000s can be largely explained by the combination of a declining dependent share in the population and extraordinarily high rates of GDP growth. These forces worked in concert through households, enterprises, and government. Rapidly rising incomes were absorbed in higher saving by both households and government due to habit formation in private as well as public consumption. At the same time income growth plumped up enterprise earnings which were retained as saving rather than being distributed for consumption purposes. The shrinking dependent share in population meant that more people were earning incomes relative to those at the young and old age extremes who for the most part strictly consume. Rapid expansion in the labor force kept wages in check boosting enterprise profitability and earnings retention. Government saw strong infusions to social welfare funds with limited pay-outs for the pensions and health care required for the elderly or the schooling required for the young.

We estimate a structural VARX model for 1978 to 2008 treating the saving rate and GDP growth as endogenous and the dependent share as exogenous. We demonstrate the model's ability to explain the behavior of China's saving rate by dynamic simulation over the 2000 to 2008 sample. With GDP growth determined endogenously, the model explains all but 1.7 percentage points of the 13.7 percentage point run-up in the saving rate. Actual GDP growth was substantially higher than the model predicts. When we simulate the model while forcing

GDP growth to follow its actual path, all but 0.2 percentage points of the saving rate increase is explained.

As of 2010, both the dependent share and the GDP growth rate are due for a course change. After decades of decline, the dependent share is bottoming out and poised to move up as fast as it went down. The GDP growth rate cannot be predicted with as much certainty, but clearly the 12 percent average rate (by our measure) sustained during the 2001-07 period must give way to a more measured pace which, judging by the historical record for the preceding two decades, may be more on the order of 8 percent, and even that would be an impressive feat at this stage in China's development. What these prognostications mean for the saving rate is that it can be expected to come back down. Our dynamic simulation shows a pace of decline of about three-quarters of a percentage point per year over the span of a decade to reach 43.3 percent by 2021. That pace would be hastened by slower GDP growth than we predict or effective policy interventions.

This 43.3 percent marker puts the saving rate back where it was in 2003 and close to where domestic investment rates have been throughout the mid to late 2000s. With saving and domestic investment aligned at this level, the reliance on net exports to sustain aggregate demand would be alleviated.

We have argued that popular explanations for China's saving rate increase do not fit the historical facts. The saving rate did not take up its rise until the 2000s and indeed was falling through the late 1990s. Neither a precautionary story of saving nor a story based on the institutional distribution of income jibes with this. Reform dislocations were at a peak in the late 1990s when the saving rate was declining. The 2000s then ushered in strong growth and a gradual rebuilding of the social safety net, yet the saving rate soared. Likewise, a pattern of income redistribution from households to enterprises applies mainly to the late 1990s with a more mixed picture emerging by the mid 2000s as government claimed a greater share of income and the enterprise share fluctuated. Overriding any distributional dynamic was a clear-cut decline in the household saving rate in the late 1990s and a powerful increase in the 2000s. This carried through to the household saving share in national disposable income.

That the precautionary motive and the institutional distribution of income are not manifestly associated with the run-up in the national saving rate does not mean these factors are irrelevant in the quest to achieve rebalancing. But this is almost beside the point. Most of the policy prescriptions involved are worth pursuing apart from any impact they may have on saving. Rebuilding the social safety net, strengthening public support for health care and education, developing the financial system, and eliminating price distortions are all justifiable on equity and/or efficiency grounds. Any impact such measures have on expediting rebalancing is a bonus.

We subscribe to the view that consumption is in significant part a function of habit. This applies not only to private consumption but to public consumption. Saving is thus more of a residual, alternately absorbing fluctuations in income growth on the upside or being diminished by them on the downside. Akerlof and Shiller (2010, 122) see saving as imbued with animal spirits, describing it as “haphazard” and prone to “the default option”. Looked at in this way, the rate of increase in Chinese consumption in the 2000s was actually incredibly fast. In nominal terms, consumption grew at an annual compound rate of 11.7 percent between 2000 and 2008 even as GDP grew at 15.2 percent (with our derived GDP deflator increasing at 3.7 percent). In an extremely rapidly expanding pie, consumption was a shrinking share despite the slice itself enlarging fantastically. The consumption standards of the Chinese people improved by leaps and bounds. This involves lifestyle changes. Exploiting the possibilities presented by fast rising incomes takes time. In the interim, saving absorbs the difference.

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