



Dynamic inefficiency, over-saving, and saving resilience

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博 士 論 文

令和元年 12 月

神戸大学大学院経済学研究科

経済学専攻

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Dynamic inefficiency, over-savings, and saving resilience
(動学非効率、過剰貯蓄および貯蓄の回復性に関する
研究)

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Chapter 1

Introduction

China has achieved unprecedented economic success and lifted over 300 million people out of absolute poverty during 1995–2015, with a nominal growth rate of 9%. On the other hand, economists have reached a consensus that the average return on capital has been stable at around 5% over time and across countries¹. According to the rate-of-return criterion derived from the traditional growth theories, as China’s economic growth rate has consistently exceeded its interest rates by a wide margin, China stands out as the most suitable candidate for surplus savers.

It is crucial to take a stance on nations’ overaccumulation status in the analysis of saving behaviors. In the saving literature, economists usually refer to macroeconomic theories that emphasize the importance of saving and investment—regarding saving as the source and prime engine for economic development². Typical examples are the Lewis model and the first and second “demographic dividend” hypotheses, which have thoroughly formulated the growth impact of saving. Moreover, there is ample evidence concerning the positive correlation between saving (investment) and economic growth, focused explicitly on the developing world (e.g., Mankiw et al. 1992). At the household level, saving accumulation, as a part of private assets, signals the improvement in living standards by moving beyond subsistence consumption. Simply put, it is

¹ See, for example, Homer and Sylla (1996) and Piketty (2014).

² That is, saving is a major source for corporate investments in plants and equipment needed to promote the productive capacity of the aggregate economy, and the enhanced income growth feeds back through stimulating household saving.

tempting to regard saving as a completely positive element thus overlook its adverse side.

However, there is much to be discussed regarding the internal threats that overaccumulation might bring about. In Chapter 2, this study re-estimates dynamic efficiency based on the AMSZ (1989) criterion by exploiting the largest dataset assembled to date. The empirical evidence reveals that major economies conform to a similar “U-shaped curve” in their evolution of capital accumulation; that is, a period of decreasing efficiency followed by one of increasing efficiency. The results also indicate that nations are not necessarily dynamically efficient if statistical bias is being considered. As a prime example of surplus savers, China today is unquestionably in a state of severe dynamic inefficiency. The study further discusses the practical and theoretical limitations of AMSZ (1989) and calls for breakthroughs in efficiency criteria.

Chapter 3 empirically investigates the underlying determinants of Chinese household saving and presents both intuitive and distinct insights. Given that overaccumulation has become a major threat to China’s economic performance, we find that factors that have contributed to China’s economic success (e.g., the SOE reform) are primarily responsible for the excess saving problem, and those generally deemed to be negative factors (e.g., real estate bubble) have essentially mitigated the surplus saving. This evidence indicates that China has achieved economic success through capital-extensive growth models, which rely critically on saving accumulation. We emphasize the imperative for Chinese economy to rebalance its growth model and create a more consumption-oriented environment.

In Chapter 4, we employ the synthetic control method (Abadie et al., 2003) to examine the short- and long-term effects of the 2008 Sichuan earthquake on saving behaviors. The results

indicate that, in the short-run, the earthquake has caused drastic declines in household saving rates—from 24% to 7% and from 23% to 21% for rural and urban populations, respectively. However, household saving rates recovered to the baseline shortly after the shock, and they exactly match their counterfactual counterparts in the period ahead. Overall, the earthquake has no discernible long-run impact on the saving propensity of the affected population, which implies the resilience of saving behaviors in China.

Chapter 2

Dynamic efficiency in world economy

2.1 Introduction

In path-breaking research, Samuelson (1958), and Diamond (1965) build a model that violates the first fundamental welfare theorem³. By introducing overlapping generations, even in the absence of market failures and distortions, the equilibrium of perfectly competitive market can be Pareto suboptimal. That is, when there is surplus capital accumulation, the interest rate falls below the economic growth rate. As a result, maintaining market equilibrium requires more investment than the economy actually produces (Fama and French, 2002; Weil, 2008). If over-accumulation holds, at the household level, increasing consumption today does not imply lower consumption in the future. This inefficiency enables Ponzi-schemes and leaves room for Pareto improvement. When capital stock exceeds the optimal level for maximizing social consumption, interest rates become so low that financial approaches for transferring resources from one's youth to old age become unproductive. Under inefficient environments, instead of letting individuals save on their own, social planners can take advantage of the high economic growth by redistributing resources from the youth to the elderly. Policy instruments such as the pay-as-you-go system

³ The theorem states that a market will tend toward a competitive equilibrium where the solution is Pareto efficient, when the market maintains the following three attributes: 1. complete markets 2. price-taking behavior 3. local non-satiation of preferences.

(Aaron, 1966) and public debt (Diamond, 1965; Blanchard and Weil, 2001) can promote everyone's welfare in the Pareto sense.

Dynamic efficiency is a central topic in the analyses of economic growth, corporate finance, and welfare economics. Knowing the actual efficiency status is of great significance for policy implications. The rate-of-return criterion, which directly compares interest rates with economic growth, is the most commonly used approach in the field. Early evidence shows that in the US the gross capital return overwhelms the nominal growth rate, which indicates the absence of over-investment in the US (Feldstein, 1977; Poterba, 1998). Recent studies based on the rate-of-return criterion have reached similar conclusions (e.g., Barbie et al., 2004; Homburg, 2014; Piketty, 2014). Therefore, it is tempting to conclude that dynamic inefficiency (over-accumulation) is merely a theoretical possibility rather than a real challenge to the world.

On the other hand, researchers find that real interest rates can even be negative and do not consistently exceed economic growth (e.g., Mishkin, 1982). For instance, Von Weizsäcker (2014) revisits the public debt issue and discovers negative real interest rates in OECD countries and China. Is the rate-of-return criterion empirically relevant? Above all, since there are too many "rates" to choose from, it is suspicious to believe any of the "rates" to be the best overall measure. Accordingly, the practical feasibility of the rate-of-return criterion remains questionable.

To overcome this shortcoming, Abel, Mankiw, Summers, and Zeckhauser (1989, AMSZ hereafter) establish a cash-flow efficiency criterion that is considered theoretically sound as well as empirically feasible. The AMSZ criterion is intrinsically equivalent to the conventional rate-of-return criterion. However, instead of comparing interest rates with growth rates (which emphasizes

the essence of dynamic efficiency), the ASMZ criterion bases its judgment on the comparison between capital return and capital investment (which transforms the question into observing the outcome of dynamic efficiency). The cash-flow criterion bypasses the complexity and selection bias in measuring interest rates. Employing the cash-flow criterion, AMSZ (1989) shows that major OECD nations have been consistently dynamically efficient⁴.

Empirical literature on dynamic efficiency has received little attention so far, partly due to AMSZ (1989)'s optimistic conclusions and because today's world indeed appears to be highly dynamically efficient⁵. Nevertheless, in recent years, the prevailing notion of "global saving glut" has raised numerous questions (e.g., Bernanke, 2005). Is the world perfectly efficient, as suggested by previous evidence, or partly efficient once we account for some measurement bias? Do major economies share a typical pattern in their history of capital accumulation? Are emerging economies as efficient as the developed ones? Which nation has the lowest efficiency level? The remarkable progress of statistical systems achieved in the past decade also renews the interest in answering the unresolved questions regarding efficiency estimates. In this study, we aim to fill the void in the efficiency literature by exploiting comprehensive datasets assembled to date.

The arrangement of this study is as follows. In the next section, we use the latest data to assess the dynamic efficiency of major economies and look into the evolution pattern of capital accumulation. In section 2.3, we review the literature on statistical bias and present the bias-

⁴ Employing the official statistics from the Bureau of Economic Analysis (BEA) and OECD, AMSZ (1989) find efficient states of the US over 1929–1985 and other major OECD economies (England, France, Germany, Italy, Canada, and Japan) over 1960–1984.

⁵ In recent years, the world-wide slowdown in both technological and demographic growths (especially for developed economies), relative to the stable long-term interest rate (about 5%), has contributed to the efficient status of world economy.

corrected estimates for the representative economies. We also evaluate the dynamic efficiency of the world's 44 largest economies and discuss the severe inefficiency in the Chinese economy. In section 2.4, the paper closes with brief concluding remarks and policy implications. Discussions over the practical and theoretical limitations of the AMSZ criterion are provided in the Appendix.

2.2 Reassessing dynamic efficiency

In this section, we assess the aggregate- and corporate-level dynamic efficiency of major economies using comprehensive datasets assembled to date, based on the AMSZ (1989) criterion. We search for common patterns in the evolution of capital accumulation—a question that has rarely been explicitly formulated in the literature. Unlike the conventional rate-of-return criterion, the AMSZ (1989) criterion contends that dynamic efficiency can be captured by measuring the cash flow generated in the capital sector. To be precise, an economy is deemed to be dynamically efficient if gross capital gains outweigh capital investment. Likewise, an economy is considered dynamically inefficient if capital investment exceeds gross capital gains.

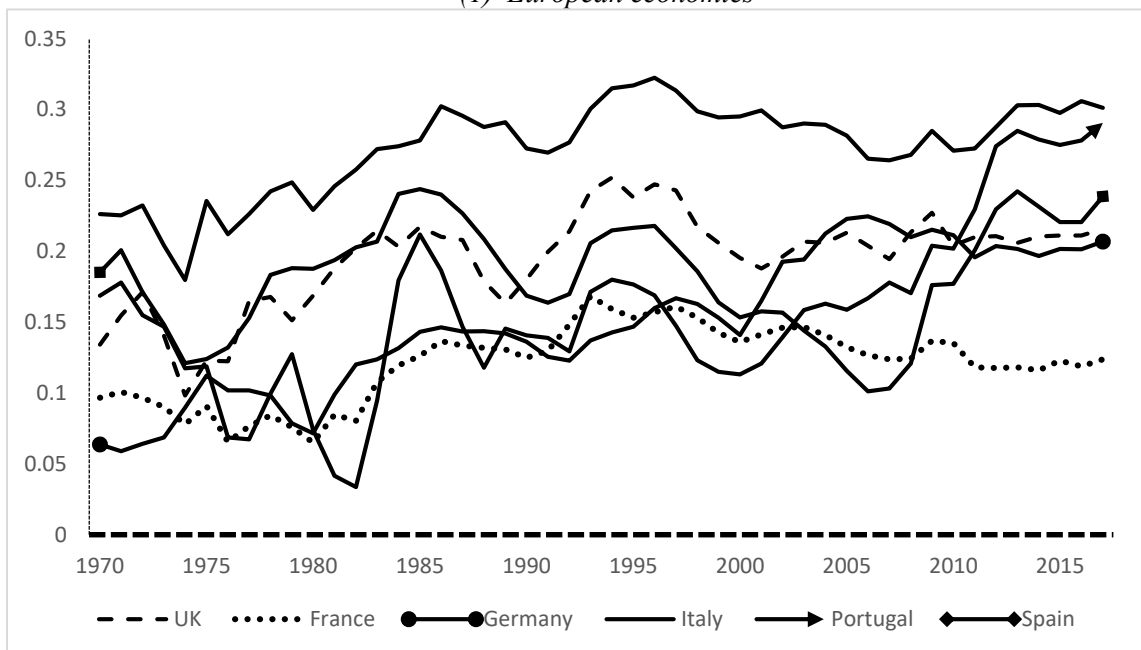
Efficiency criterion has abundant economic implications. First, it is a benchmark for the “pie distribution” problem. That is, for social planners, the criterion presents the welfare principle on which Pareto-improving intertemporal redistribution is feasible. Second, the criterion is a generalization of the golden rule condition addressed in Phelps (1961) and Diamond (1965), which suggests that efficiency status depends on the order of magnitude between interest rates and economic growth. Dynamic inefficiency signals over-accumulation under the neo-classical concept, since the capital stock has exceeded the optimal level for maximizing social consumption (the “welfare”). Third, the criterion evaluates the investment returns, which guide enterprises to enter and withdraw from markets.

2.2.1 Dynamic efficiency in the aggregate economy

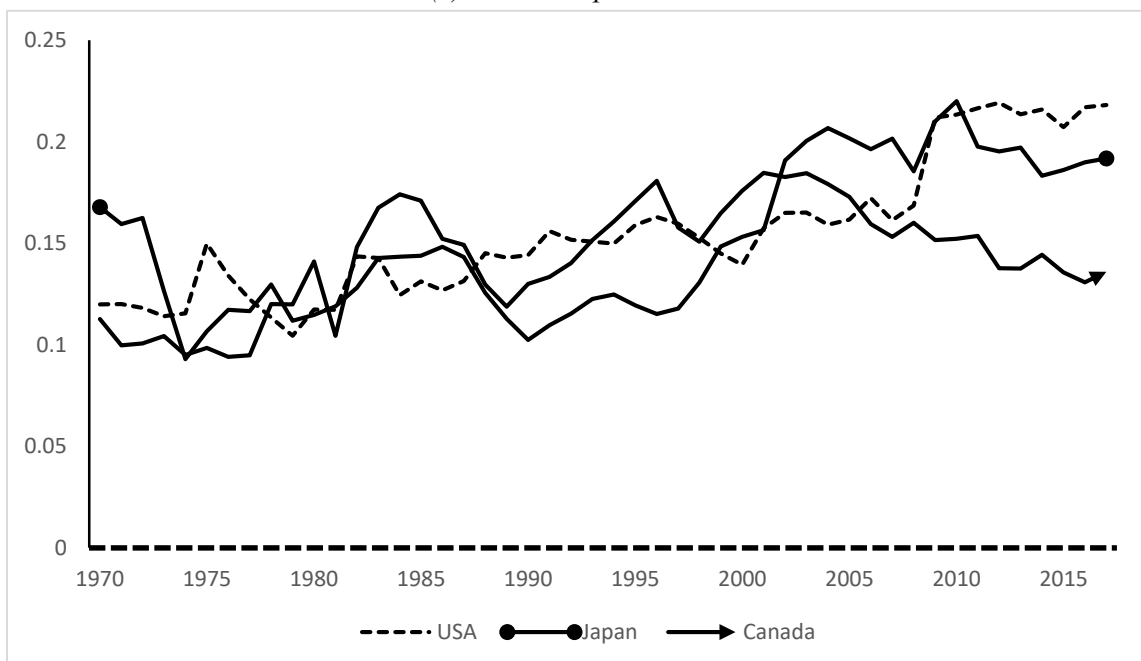
The OECD has established the harmonized system of national accounts (SNA, hereafter) for major economies covering the period of 1970-2017. As a preliminary analysis, we measure the cash flow in the capital sector as the difference between gross operating surplus (GOS) and gross capital formation (GCF). The efficiency level is expressed in the cash flow as a share of GDP, displayed in Figure 2.1. According to the results, the estimated efficiency varies over time and across countries. Several economies share an upward trend from 2005 onwards, which implies the increasing worldwide efficiency in the past decade. More importantly, capital investment has consistently produced greater income than expenditure, which satisfies the sufficient condition for efficient status by a wide margin. Accordingly, efficient status holds for all samples over 1970-2017.

Figure 2.1: Dynamic efficiency (percent)

(1) European economies



(2) Non-European economies



Source: Harmonized system of national accounts (OECD balance sheets).

Note: The cash flow in the capital sector is calculated as the difference between the gross operating surplus and the gross capital formation, expressed in fractions of GDP. That is, the percentage = Cash-flow/GDP.

On the one hand, the above analysis will only take us so far due to its short observation period. For advanced economies, a time span of 47 years is far from adequate to capture the historical evolution of capital accumulation. However, since modern economic development began much earlier than the emergence of sophisticated statistical systems⁶, the early stage of capital accumulation might be unobservable. On the other hand, longer is by no means necessarily better. As Piketty (2014) puts it, most nations have been severely plagued by two world wars and the subsequent political upheavals. As a result, statistical inferences derived from long-run historical data can be misleading (especially the statistics over 1910-1950)⁷. As a matter of fact, at the end of World War II, the world was so heavily disrupted that global capital accumulation had to start all over again (e.g., Piketty and Saez, 2003; Piketty, 2011, 2014). Quoting Piketty (2014, p.275): *“In the twentieth century it was war, and not harmonious democratic or economic rationality, that erased the past and enabled society to begin anew with a clean slate.”* From an economic point of view, wartime shocks have reset the on-going evolution of capital accumulation. This unique setting provides feasible experiments to capture the otherwise unobservable evolution process.

In this regard, 1950-2017 is not only a sufficient observation period for the research purpose but also a reasonable option for assessing the past and the present. We begin by gathering as extensively as possible the official datasets on advanced economies, focused on France, the US,

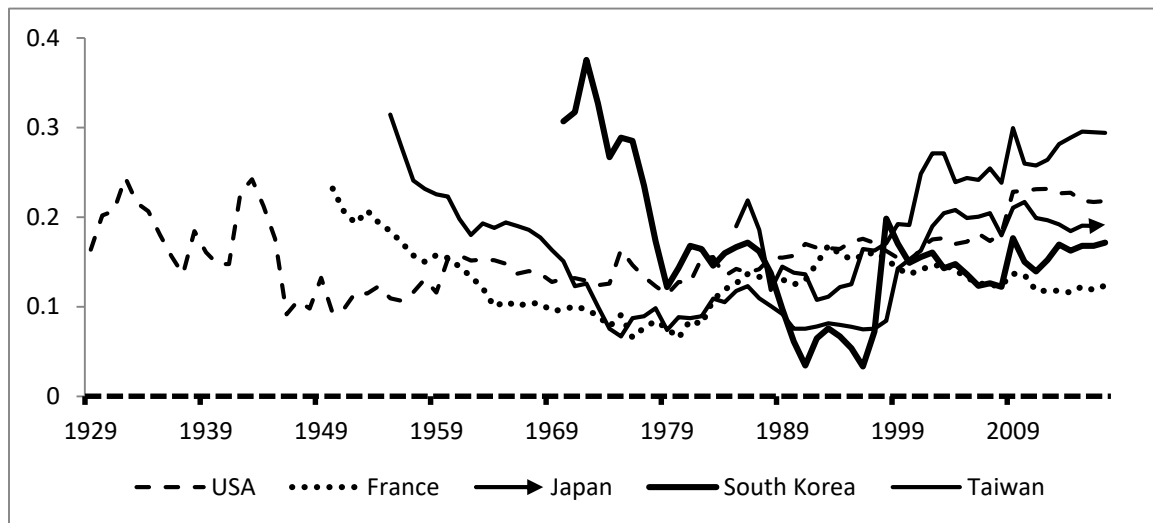
⁶ It is generally considered that modern capital accumulation in the US was originated in the early 1870s (after the Civil War in the 1860s). For France, it started in the 1860s (the Second Industrial Revolution).

⁷ A typical example is Kuznets’ celebrated article on inequality. According to Kuznets’ “bell curve” theory, the diminished US income inequality over 1913-1948 was achieved by rapid industrialization and innovation. However, there is ample evidence suggesting that the reduced inequality was essentially caused by wars and economic shocks in particular periods (e.g., Elmendorf and Mankiw, 1999).

and Japan. These are representative developed economies involved in world wars and have well-established statistical systems.⁸

Alternatively, it is illuminating to look into emerging economies such as the “four dragons of Asia.” Studying emerging economies might suit the research purpose better because emerging economies are late starters in socio-economic development and capital accumulation. Accordingly, there is no need to rely on earlier data sources (note that “earlier” usually means “less reliable”). This feature enables the utilization of the harmonized system of national accounts (the OECD balance sheets), which provides better accuracy and consistency in a statistical sense.

Figure 2.2: Dynamic efficiency in five economies (percent)



Source: The OECD SNA statistics for estimates for France and South Korea; The BEA NIPA statistics for the US; SNA68 statistics (from the Cabinet Office of Japan) for Japan; and SNA statistics (from the National Statistics of Taiwan) for Taiwan.

⁸ As the headquarter country and one of the founding members of the OECD, France established the earliest and most complete system of national accounts in 1950. As for Japan, the cabinet office built up the national account system in 1955 in a manner corresponding to the conventional SNA68 standard, which enables us to capture the early phase of capital accumulation in postwar Japan. For the US, we employ the historical data of the National Institute of Pension Administrators (NIPA). The NIPA has been widely tested and advocated by researchers.

Note: In the estimates for France, Japan, South Korea, and Taiwan, the cash flow in the capital sector is calculated as the difference between the gross operating surplus and the gross capital formation, expressed in a percentage of GDP. In the estimates for the US, the conventional GOS indicator is not available in the NIPA statistics until 1952, and the GCF indicator is not recorded until 1960. To extend the observation period, we follow the method presented by AMSZ (1989). We measure the gross capital flow as national income plus capital consumption allowance, less employee compensation and 67% of proprietors' income.

Employing the AMSZ criterion, Figure 2.2 displays the estimates of dynamic efficiency for France, the US, Japan, South Korea, and Taiwan⁹. In every instance, the net capital return was relatively high at the beginning, which implies the relative scarcity of capital stock. The early stage corresponds to the well-known “pre-Lewis turning point,” where rural labor surplus and capital shortage coexist. As the process unfolded, the net return declined until it reached the nadir. There are roughly two explanations for the phenomenon. One apparent reason is the continuous accumulation of capital, which lowered the marginal product of capital investment. Another reason is that the way capital accumulated during postwar periods was generally extensive and ill-deliberated. For economic stability and market expansion, most nations chose a government-led investment pattern and specific anti-capital policies in their “golden ages” of economic development. Examples include progressive taxes on capital income, restrictions on house rent, economy collectivization, and financial sector constraints—which have no doubt impaired the market effectiveness and investment efficiency. In the late stage, due to technological progress, rational bubbles (valuation effects), financial liberation, privatization of state-owned enterprises

⁹ We have also estimated the dynamic efficiency for Hong Kong and Singapore and reach similar conclusions. The results are not reported here due to the limited observation period.

(SOE), and structural reforms, efficiency recovered, and the net capital return flourished again. By and large, the estimated results are in line with historical experience.

The representative economies share a “U-shaped pattern” in their evolution of capital accumulation and evolve in a way consistent with the economic cycle. That is, firstly investment expands and efficiency declines during economic booms; efficiency then reaches a low level and holds for some time; finally, efficiency rebounds when a way out of over-accumulation is found. This U-shaped pattern has many remarkable parallels in economics, such as the U-shaped industry concentration and the U-shaped lifecycle wellbeing. Another feature worth considering is that emerging economies have transited more dramatically, both in magnitude and in direction, than advanced economies, consistent with the phenomenon of rapid transitions of economic development, demographic structures, and income inequality in the developing world.

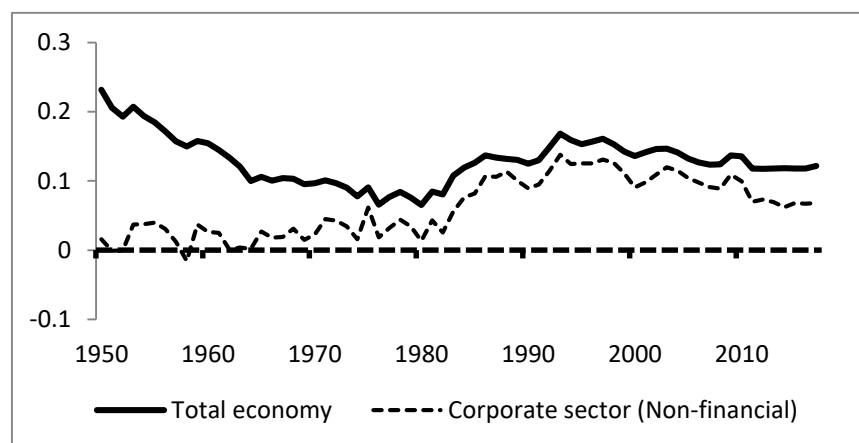
2.2.2 Dynamic efficiency in the corporate sector

Subsection 2.2.1 has documented the evolution of dynamic efficiency for five representative economies. Nevertheless, aggregate economy is comprised of many components, of which some are highly competitive sectors while others are not. Theoretically, studying aggregate-level efficiency might be misleading since the efficiency criterion relies critically on the assumption of completely competitive markets. Based on this view, Desai et al. (2011) examine the cash flow in the US investment abroad and find that the foreign investment sector is dynamically efficient over 1950-2010, which reflects the efficient status of the American economy. In this subsection, we look

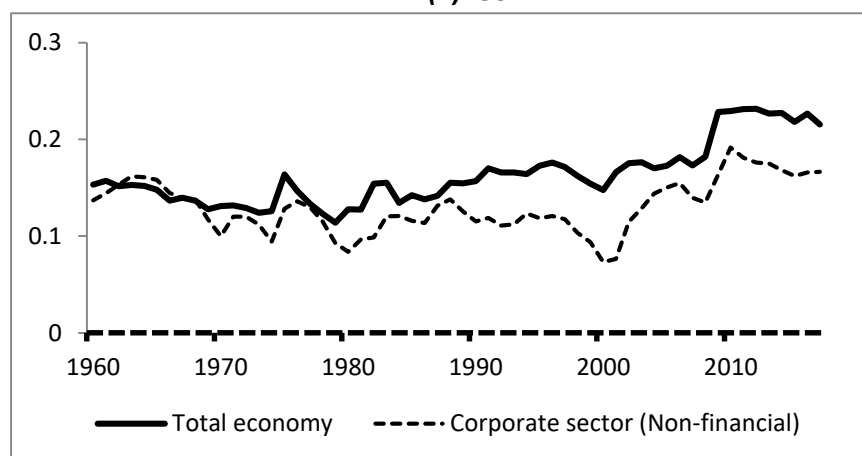
into the dynamic efficiency of non-financial corporate sectors. This angle sheds light on the efficiency features of aggregate economy and its competitive components.

Following the methodology and data sources used in subsection 2.2.1, we present the estimates of corporate-level efficiency for France, the US, and Japan. The estimates of both versions are demonstrated in Figure 2.3 to draw a comparison. The results suggest that corporate- and aggregate-level efficiencies share a similar pattern. In most periods, the trends lie above the critical line by a substantial margin. Hence, corporate sectors also seem to be dynamically efficient.

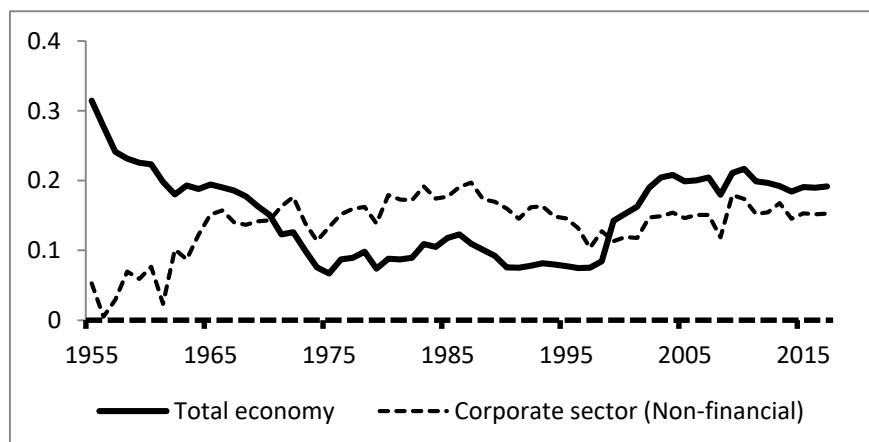
Figure 2.3: Dynamic efficiency in corporate sector (percent)
(1) France



(2) US



(3) Japan



Source: Consistent with Figure 2.2.

Note: As the SNA (from the Cabinet Office of Japan) did not record the GDP of the corporate sector, we assume that the corporate sector accounts for 60% of the total GDP in the estimates of Japan. For the US corporate sector, the GOS indicator is not available in the NIPA. We measure the cash flow as the gross value added, less compensation of

employees and indirect tax paid by producers, reduced by producer subsidies. In short, $GOS = GV - (IT - SU) - CE$.

Contrary to the previous evidence¹⁰, the estimates show that corporate-sector efficiency is lower than aggregate-level efficiency in the early stage of capital accumulation. Given the competitive essence of market economy, the net return (r) is not supposed to be either too high or negative on a steady-state growth path. That is, conditional on market effectiveness, the real interest rate of capital investment ought to converge to slightly positive values or oscillate around the critical line. This view is supported by the historical experience that the average asset return has been stable around 5% per annum, approximately 1/20 of the asset value. In this sense, the estimates seem to have properly captured the corporate-level efficiency.

On the other hand, dynamic efficiency also serves as an indicator of investment opportunities. Enterprises are profit-pursuing, whereas other sectors such as government and financial institutions are less interest-driven. Then, how to rationalize the fact that imperfectly competitive entity (aggregate economy) achieves higher returns than its highly productive component (corporate sectors)? How can the net profit exceed 25% in specific periods? The contrast clearly warns of the potential overestimation in the aggregate-level efficiency. In the next section, we turn to the issue of measurement bias to derive more accurate efficiency estimates.

¹⁰ AMSZ (1989) concluded that the level and fluctuation of dynamic efficiency in corporate sector were higher than in aggregate economy. Similarly, Kajitani (2012) found that corporate sectors in China have higher efficiency level and volatility than the aggregate economy.

2.3 Bias correction in efficiency estimates

In section 2.2, we have estimated the aggregate- and corporate-level dynamic efficiency for the representative economies. Based on the AMSZ criterion, the results support the efficient status for all samples covering the overall period. However, due to statistical bias, conventional SNA statistics are inclined to overstate the actual capital gains. Recall that the cash flow is calculated as the difference between capital gains and investments, the upward bias misleads researchers into becoming too sanguine about the real-world dynamic efficiency. In this section, we give a brief review of the statistical bias in applying the AMSZ criterion. We present bias-corrected estimates and the case study of dynamic inefficiency in China.

2.3.1 Bias correction

In the literature, three of the statistical biases have proven not only statistically significant but also empirically solvable:

1. Bias related to labor income: The AMSZ criterion contends that dynamic efficiency can be captured by measuring the cash flow generated in the capital sector, calculated as the difference between capital gains and investments. Employing national accounts, researchers measure the cash flow as the difference between gross operating surplus and gross capital formation. Since early versions of SNA statistics fail to distinguish between mixed income¹¹ and gross capital income, the GOS has recorded both capital income as well as the labor income from proprietors.

¹¹ Mixed income is the surplus or deficit accruing from production by unincorporated enterprises, which consists of both capital income and the labor income of proprietors.

The overstated GOS causes an upward bias in measuring capital returns.

In light of previous research in coping with the overstated capital income (AMSZ, 1989; Ahn, 2003; Kajitani, 2012; Geerolf, 2013), we take a conservative stance to assume the proportion of mixed income to GOS to be 10%¹². We further refer to Christensen (1971), who reveals that labor income contributes to about 2/3 of the total mixed income in the US unincorporated enterprises. Accordingly, 6.7% of the total GOS, which is essentially a kind of labor compensation, should be subtracted from the conventional GOS indicators.

2. Bias related to land rents: The AMSZ criterion is a benchmark of the supply-side capital accumulation. Cash flow represents the profit in the production sector, calculated as the difference between output and input in the production process. However, GOS indicators have recorded not only the output of “productive capital” but also the product from natural resources, such as land rent and the output of forest resources. Land rent is essentially an output of non-reproducible resources. For nations with real estate bubbles and scarce land resources (such as Japan and France), land rent contributes a large percentage to the aggregate capital income. In this sense, SNA statistics have magnified the notion of “new investment” thus leads to the overestimation of capital income.

To avoid the complexity in measuring land value¹³, AMSZ (1989) follows previous

¹² Time series data for mixed income is only available for several economies during specific periods, according to which the ratio of mixed income to GOS ranges from 15% to 40% across countries and over time. While not determinable, these estimates help to draw an initial impression of the magnitude of mixed income. To avoid over-correction, we assume the ratio to be 10% in the following analyses.

¹³ When referring to the market value of vacant land, the price reflects not only the “pure land value” that represents its capacity in the production process, but also the infrastructure around it and the geographical advantages distinguished by aggregate investments and construction. These features make it almost impossible to quantify the land value.

literature and assumes that land rent contributes to 6.7% of the total GNP in the efficiency estimate for the US. Similarly, for lack of reliable data, Ahn (2003) conservatively assumes the proportion to be 2% in the estimates for Asian economies. Piketty and Zucman (2014) propose that the pure land value should be less than half of the national income, which infers a land rent/GNP ratio of 2.5% (if the asset return is 5%).

On the other hand, it is more effective and meaningful to measure land rent as percentages of GOS, because the plus-minus of efficiency estimates depends on the order of magnitude between GOS and capital formation. In this vein, Geerolf (2013) refers to the evaluation of Goldsmith (1985) and Davis and Heathcote (2007), which indicate that land value contributes to 25% of the total value of tangible assets in the US. Accordingly, 25% of the GOS should be subtracted if land resources and other assets have identical interest rates. We assume the ratio to be 25% in the estimate for the US. For conservativeness, the ratio is set at 20% in the estimates for Japan and France¹⁴.

3. Bias related to production tax: As noted, GOS denotes the pretax gross capital income, which includes taxes in the production process. However, production taxes defined in the SNA standards consist not only of the duties and tariffs on capital gains but also taxes on labor income (He et al., 2007; Geerolf, 2013)¹⁵. Since capital gains have included part of the employee

¹⁴ According to the OECD database (SNA 2008 standard), in 2011, the land value/GDP ratio in France skyrocketed to 290 percent, and the ratio of land value to the total value of nonfinancial capital is above 44 percent in France (45 percent in Japan; see Homburg, 2014).

¹⁵ According to the SNA standards established by the OECD (available on the OECD homepage), taxes on production and imports consist of taxes payable on goods and services when they are produced, delivered, sold, transferred, or otherwise disposed of by their producers, plus taxes and duties on imports that become payable when goods enter the economic territory by crossing the frontier, or when services are delivered to resident units by non-resident units. They also include other taxes on production, which consist mainly of taxes on the ownership or use of land, buildings, or other assets used in production or on the labor employed,

compensation, we need to disentangle labor income tax from pretax capital income. To address this issue, we follow the method presented by He et al. (2007) to assign the ratio of labor income tax to total production taxes as the ratio of total employee compensation to gross capital income. Note that the actual labor income tax is likely to be lower than the estimates. Cautious readers should be aware of the potential over-correction and treat the estimates as a lower bound of the actual efficiency.

In summary, the bias correction process can be simplified in the following equation:

Bias corrected GOS

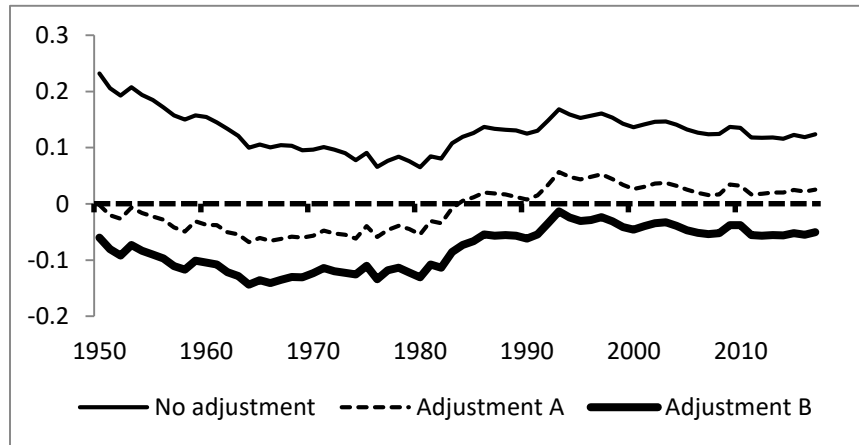
$$= \left(\text{GOS} - \frac{2}{3} \text{Mixed income} - \text{Tax on labor income} \right) \times \left(1 - \frac{\text{Land value}}{\text{Total asset value}} \right)$$

$$\text{Level of dynamic efficiency} = \frac{\text{Bias corrected GOS}}{\text{Gross domestic product}}$$

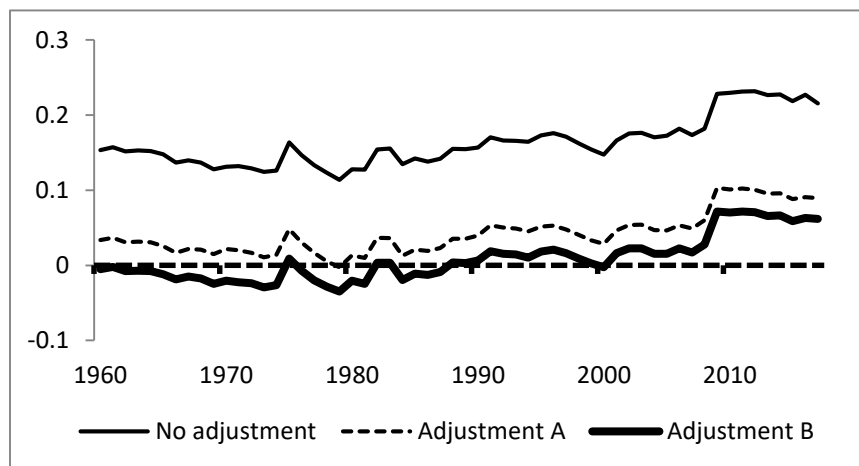
or compensation of employees paid.

Figure 2.4: Bias-corrected estimates (percent)

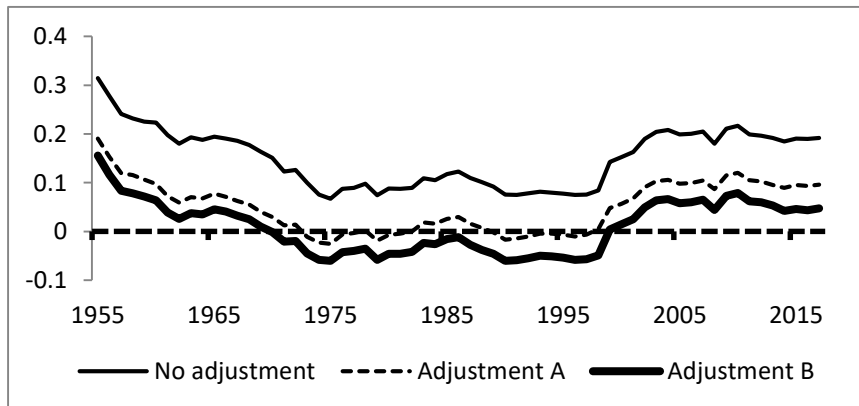
(1) France



(2) US



(3) Japan



Source: Consistent with Figure 2.2 and Figure 2.3.

Note: “No adjustment” denotes the aggregate-level estimates displayed in Figure 2.3. “Adjustment A” denotes the estimates after the correction for biases related to labor income and land rent. “Adjustment B” denotes the estimates after the correction for biases related to labor income, land rent, and production taxes.

Figure 2.4 displays the bias-corrected estimates of the aggregate-level dynamic efficiency for France, the US, and Japan. The estimate for France is considered more reliable than others, as mixed income is directly available from the OECD database over 1950-2017. In the early stage of postwar capital accumulation, un-incorporated enterprises played an important role in the French economy with “mixed income” contributing to over 25% of the total GDP. The bias correction concerning mixed income and land rent leads to a reduction in the efficiency level of 10-20%, and the correction for overall biases leads to a decrease of 25%. The results clearly point out that France has not been consistently dynamically efficient, especially during 1950-1985—the postwar recovery period and the early phase of modern capital accumulation. Turn to the estimates of the US and Japan. As expected, neither nation has consistently been in an efficient status over the observation period. Japan in its golden periods of economic development and the US during its economic booms might have encountered capital saturation and the consequent over-accumulation.

Are these estimates empirically relevant? Recall that in inefficient environments where capital has accumulated beyond the optimal level for maximizing social consumption, lowering investment today does not necessarily reduce social consumption in the future. According to the OECD balance sheets, the capital formation ratio (GCF/GDP) in France had been declining noticeably from 29% to 21% over 1974-1984, whereas the consumption ratio (FCE/GDP) had been stable at 54% from 1974 onwards. Similar tendencies can be observed for the US and Japan. The

efficiency estimates verify the objective existence of over-accumulation, which suggests that dynamic inefficiency is more than a theoretical possibility and should never be shelved in the library of impractical economic theories.

2.3.2 Dynamic efficiency in world economy

The findings in subsection 2.3.1 suggest that developed economies have experienced inefficient states in the middle stage of postwar economic development. Opposite to Bernanke (2005)'s caveat that a “global saving glut” prevails in the 21st century, the “U-shaped pattern” indicates that the world today appears highly efficient (even after bias correction)¹⁶. In today's world, is there any nation dynamically inefficient? Which nation has the lowest efficiency level? To have an ex-ante understanding of these questions, one can refer to the causes and manifestations of dynamic inefficiency. Literature along this line suggests that over-accumulation is closely associated with the following attributes: 1. a large share of monopoly enterprises 2. a high level of government intervention 3. market imperfection and distortion 4. speculative bubbles 5. excess savings and consumption stagnation 6. rapid economic growth. Intuitively, Asian and socialist economies stand out as potential candidates for the victims of over-accumulation.

Previous evidence indicates that Japan, South Korea, and Taiwan might have once encountered inefficient states (e.g., Ahn, 2003; and Geerolf, 2013), while little is known about the emerging economies in Asia and other regions. Based on the AMSZ criterion, we exploit the

¹⁶ Fischer (2017) developed a generalization of the AMSZ criterion and revealed that dynamic efficiency always prevails. The author found signs of increasing efficiency in major OECD economies over 1990-2010.

comprehensive datasets to evaluate the 21st century dynamic efficiency of the world's 30 largest economies ranked by GDP and other OECD participants, presented in Table 2.1¹⁷. For the lack of sophisticated data, we do not conduct bias correction in this part. According to previous estimates, the efficiency level can be systematically overestimated by 15%-25% under the criterion; thus, it is reasonable to label the economies with efficiency levels under 15% as potential victims of over-accumulation. These economies are: China (-4.97%), India (9.65%), Sweden (10.25%), Taiwan (10.65%), Slovenia (11.12%), Iceland (11.68%), Estonia (12.43%), Denmark (12.84%), France (13.03%), Australia (14.58%), and South Korea (14.95%).

Table 2.1: 21st century dynamic efficiency (percent; without bias correction)

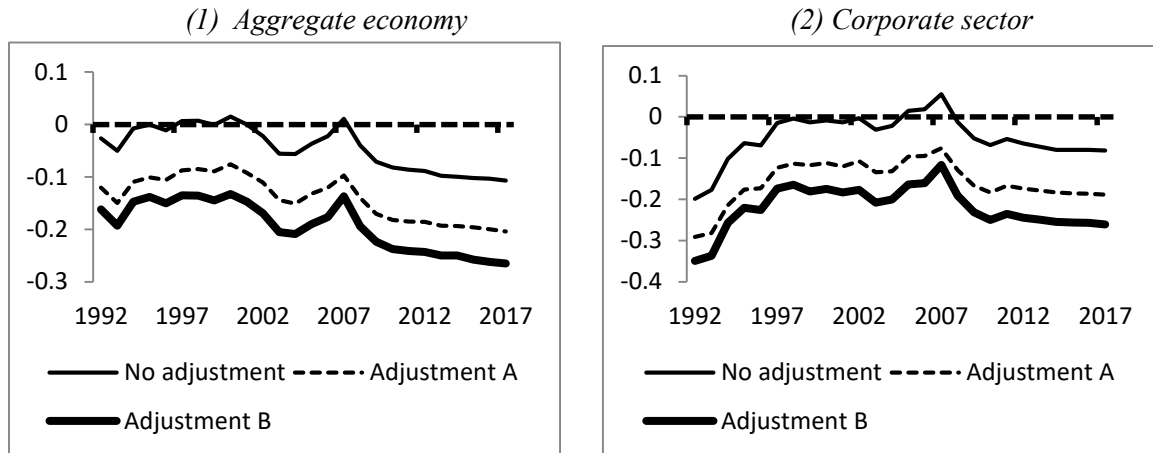
GDP Ranking	Country	Dynamic efficiency	Averaged over	GDP Ranking	Country	Dynamic efficiency	Averaged over
8	USA	18.53%	2000-2017	15	Austria	16.38%	2000-2017
74	China	-4.97%	2000-2017	3	Norway	21.17%	2000-2018
22	Japan	19.27%	2000-2017	26	Israel	19.51%	2000-2017
19	Germany	20.10%	2000-2017	9	Denmark	12.84%	2000-2018
21	UK	20.49%	2000-2017	93	South Africa	23.67%	2008-2017
24	France	13.03%	2000-2017	5	Ireland	27.62%	2000-2017
145	India	9.65%	2000-2017	89	Columbia	35.55%	2000-2017
27	Italy	28.60%	2000-2017	57	Chile	32.47%	2003-2017
72	Brazil	21.54%	2010-2016	17	Finland	17.41%	2000-2018
18	Canada	15.89%	2000-2017	40	Portugal	20.11%	2000-2017
29	Korea	14.95%	2000-2017	42	Greece	24.98%	2000-2017
71	Russia	17.63%	2011-2017	41	Czech Republic	22.61%	2000-2017
11	Australia	14.58%	2000-2017	23	New Zealand	22.18%	2010-2017
30	Spain	16.71%	2000-2017	58	Hungary	18.47%	2000-2017
73	Mexico	44.61%	2003-2017	44	Slovak Republic	27.18%	2000-2017
64	Turkey	32.15%	2009-2017	1	Luxembourg	20.18%	2010-2017
14	Netherlands	19.80%	2000-2018	62	Costa Rica	24.15%	2012-2016
2	Switzerland	15.55%	2000-2017	38	Slovenia	11.12%	2000-2017
37	Taiwan	10.65%	2000-2017	53	Lithuania	26.59%	2004-2017
12	Sweden	10.25%	2000-2018	55	Latvia	19.15%	2000-2017
60	Poland	28.28%	2000-2017	43	Estonia	12.43%	2000-2017
20	Belgium	16.29%	2000-2017	7	Iceland	11.68%	2000-2017

Source: SNA (2008) statistics (from the National Statistics of Taiwan) for Taiwan; statistics on employee compensation used to compute GOS are not available for India at the aggregate level, we instead use the statistics on the non-financial corporate sector as an alternative, obtained from the Ministry of Statistics and Program Implementation of India; data for other nations is directly obtained from the OECD database. For Brazil, statistics on acquisitions less disposals of valuables

¹⁷ Among the Top-30, we drop the observations of Indonesia, Saudi Arabia, Argentina, Thailand, Iran, and the United Arab Emirates, as official statistics for these nations are not up to the standards for applying the AMSZ criterion.

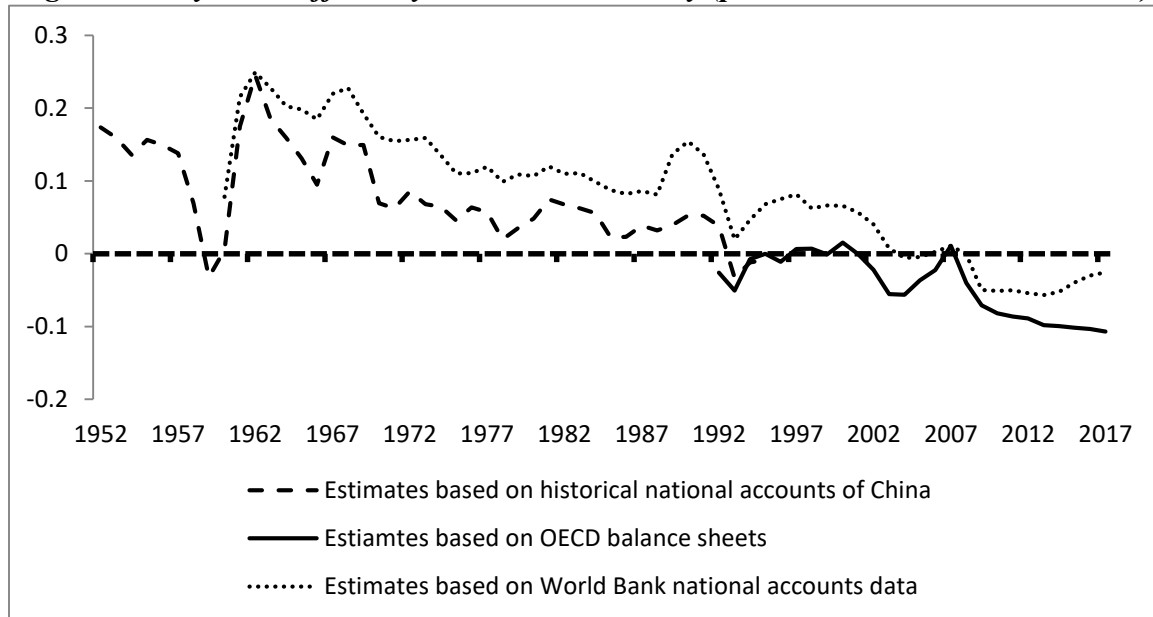
used to compute gross capital formation are not available in the OECD database; we instead use the statistics on gross fixed capital formation as an alternative, which might to some extent overstate the efficiency level.

Figure 2.5: Bias-corrected estimates for China (percent)



Source: Harmonized system of national accounts (OECD balance sheets).

Figure 2.6: Dynamic efficiency in Chinese economy (percent; without bias correction)



Source: Estimates over 1992-2014 are based on the OECD balance sheets. Estimates over 1960-2017 are based on the *World Bank national accounts data*. Estimates over 1952-1995 are based on the *historical national accounts of China*, conducted by the State Statistical Bureau of China (SSBC) and the Institute of Economic Research of Hitotsubashi University.

Note: We calculate the GOS/GDP ratio of China using the OECD balance sheets and find that the ratio fluctuates from 35% to 40% during 1992-2017. The GOS indicator is not available in the *World Bank national accounts data* and the *historical national accounts of China*. For conservativeness, we assume the ratio to be 40% in using the *World Bank national accounts data* and the *historical national accounts of China*.

Among the observations, China has undoubtedly been in a state of severe dynamic inefficiency in the past decade. Figure 2.5 displays the bias-corrected estimates for China's aggregate- and corporate-level dynamic efficiency (based on the OECD balance sheets). The results come as no surprise that even the estimates without bias correction suffice to verify China's over-accumulation over 1992-2017. The bias-corrected estimates lie well below the critical line, which sets a record for inefficiency estimates obtained in the literature.

To depict the evolution of capital accumulation in China, we extend the observation period to the 1960s and 1950s by referring to the *World Bank national accounts data* and the *estimation of historical national accounts of China*. Figure 2.6 displays the sequences of efficiency estimates. The three sequences demonstrate similar patterns and overlap closely in the period of 1992-2017, which verifies the good quality of the data and result consistency. According to the estimates, China has experienced a highly efficient status in the early stage of capital accumulation, consistent with the "U-shaped pattern" documented in section 2.2. However, the efficiency level has been gradually declining ever since, which results in severe inefficiency today. The continuous deterioration is broadly in line with China's history of socio-economic development over 1950-1990, during which the market efficiency has been significantly impaired by the government-led investment pattern

and production disruption (e.g., the “great leap forward” strategy, the “great famine” in China, and the “the cultural revolution”).

If the “U-shaped pattern” holds, an inescapable fact is that China today is in its middle stage of capital accumulation, where capital saturation and an alarming level of inefficiency prevail. Given previous findings on the long duration of middle-stage economic transitions (see Figure 2.2), China is likely to sustain the inefficient status in the near future. Faced with these challenges, the capital-extensive investment pattern is difficult to continue, and it is imperative for governments to reform the growth model to improve the allocative efficiency in Chinese economy.

2.4 Conclusion

This study aims to document the evolution of capital accumulation in the world economy from the perspective of dynamic efficiency. Section 2.1 briefly introduces the theoretical background and previous literature on dynamic efficiency. In section 2.2, we exploit comprehensive datasets to estimate dynamic efficiency for major economies based on the AMSZ (1989) criterion. The results show that the representative economies exhibit a similar “U-shaped pattern” in their evolution of capital accumulation. That is, the efficiency swings from high-to-low in the early stage, holds for some time in the middle stage, then rebounds from low-to-high in the late stage of capital accumulation.

In section 2.3, we review the literature on statistical biases in measuring dynamic efficiency and present the bias-corrected estimates. Contrary to previous evidence, the results imply that France, the US, and Japan have been inconsistently dynamically efficient, especially in the early phases of capital accumulation and during the golden periods of economic development. The following analysis suggests that China today is, at any rate, in a state of severe dynamic inefficiency. The level of excess capital is extremely high, and the inefficient status is likely to continue in the near future. It is imperative for Chinese governments to reform the growth model to improve allocative efficiency. Likewise, for economies that confront moderate inefficiency (e.g., India), it will be mostly harmless and reasonable to stimulate consumption, lower the capital/labor ratio, raise interest rates, and reduce idle capital. The key message is that making full use of policy

designs (such as pension systems and public debt) is not only the most beneficial option to obtain “free” welfare gains¹⁸ but also the ultimate solution to the saving glut.

In the Appendix, we look into the practical and theoretical limitations of the AMSZ criterion. We argue that the shortcomings of the AMSZ criterion do not devalue its feasibility and versatility, and the advantages of the method vastly exceed its limitations. This study explores a brand-new angle for investigating the evolution of capital accumulation. Some of the findings might be helpful to reconcile the mixed conclusions of recent studies, and we look forward to breakthroughs in efficiency criteria and improvements of statistical systems.

¹⁸ Dynamic inefficiency represents “the future devours the current” state (Piketty, 2014; p.571), which leaves room for Pareto improvement through intertemporal redistribution. In a $g > r$ environment, policy designs such as the pay-as-you-go system can promote everyone’s welfare in the Pareto sense. Governments can rollover public debts forever to improve social welfare since there are always emerging investors to replace the formers.

Chapter 3

Counterintuitive facts regarding household saving in China: the saving glut*

3.1 Introduction

Saving behavior is a central topic in economics. Theoretical literature along this line primarily features the life-cycle considerations and precautionary saving motives. Empirical literature, which presents diverse findings and seemingly contradictory insights, has concentrated on the saving impacts of pension system, demographic structure, economic transition, and financial liberation. So far, empirical research on saving has been scattered without offering significant policy prescriptions. Policy implication has been rendered self-evident since from various perspectives (especially for economic growth) saving accumulation is deemed to be an overall beneficial factor. This stereotype is in line with the stylized fact that many countries have frequently been engaged in saving promotion activities (such as the “SMarT plan”), whereas only few have limited such activities. However, this narrow view can overshadow the reality and lead to arbitrary policy-making decisions.

In recent years, the prevailing notion of “saving glut” has raised numerous questions (e.g., Bernanke, 2005). It warns of the possibility that mature economies might have accumulated excess capital, which may change our attitude towards saving. A growing body of research has provided policy recommendations to trim the excess saving in East Asian economies, mainly to help resolve

the problems faced by developed countries (e.g., current account deficits)¹⁹. In fact, as we will clarify, surplus savers in Asia have their internal reasons to disaccumulate capital, rather than merely to attenuate the external effects on industrial countries.

Household is the basic economic decision-making unit. What separates the overaccumulated nations apart from the rest of the world are their abnormally high household saving rates, especially in the case of China (Blanchard and Giavazzi, 2006). In this study, focusing on China's overaccumulation problem, we utilize the GMM estimators to identify the factors responsible for China's excess saving and present policy prescriptions.

The structure of this study is as follows. Section 3.2 reviews the issue of excess saving and evaluates China's overaccumulation status. The results suggest that China today is undeniably in a serious state of overaccumulation. Section 3.3 introduces data sources and econometric methods. Section 3.4 identifies the key determinants of Chinese household saving and presents policy implications. Section 3.5 concludes the study.

¹⁹ An exception is Nabar (2011). After specifying the determinants of China's excess saving, the author proposes explicit policy options to help lower household saving and boost domestic consumption in China. This research has a lot in common with the current study but lacks a rigorous verdict on China's overaccumulation status.

3.2 Overaccumulation in China

3.2.1 Stylized facts

To draw an initial impression of China's overaccumulation problem, we would like to demonstrate several salient features regarding Chinese economy. First, China has achieved unprecedented economic success and lifted over 300 million people out of absolute poverty during 1995–2015, with a nominal growth rate of 9%. On the other hand, empirical evidence suggests that the average capital return has been stable at around 5%, over time and across countries (Homer and Sylla, 1996; Piketty, 2014). According to conventional growth theories, as China's economic growth has exceeded its interest rates by a wide margin, China stands out as the most likely candidate for surplus savers.

Second, China's household, corporate, and national saving rates have been among the highest since 1995, which makes this emerging economy one of the largest capital holders and exporters worldwide. According to the OECD statistics, China has the largest current account surplus and the lowest consumption ratio (FCE/GDP) among developing countries, which verifies China's surplus savings in both domestic investment and consumer demand.

Third, China is known as a socialist “command economy.” It has a large proportion of state-owned enterprises (SOE, hereafter), high government spending, severe market distortion, and the deep-rooted issue of monopoly. These inefficiencies have significantly reduced the real capital return, making China's capital less lucrative and more susceptible to the overaccumulation problem. In summary, China could be facing a severe state of excess saving.

3.2.2 China's dynamic inefficiency

There is a growing body of research arguing that overaccumulation is not just a theoretical possibility but rather a real challenge confronting the real-world economy (Kajitani, 2012; Kapelko et al., 2014; Luo et al., 2018). For example, He et al. (2007) estimate that China has been in a state of dynamic inefficiency over 1992–2003; Leonard and Prinzinger (2001) find that China had accumulated excess capital over 1980–1996.

Efficiency criterion serves as the benchmark for assessing the status of overaccumulation. In this subsection, we refer to the efficiency estimates in Luo et al. (2018)—our earlier work on the dynamic efficiency of representative economies—summarized in Table 3.1²⁰. The estimates are based on the Abel, Mankiw, Summers and Zeckhauser's (1989) criterion (AMSZ, hereafter), which contends that dynamic efficiency can be measured by the cash flow generated in the production sector. To be precise, an economy is deemed to be dynamically inefficient (overaccumulated) if the total capital investment overwhelms the gross capital gains, and vice versa. For comparability, the efficiency level is expressed as the proportion of the cash flow in GDP.

²⁰ The estimates are directly taken from Luo et al. (2018). Interested readers can refer to this study for a comprehensive survey on the assessment of dynamic efficiency.

Table 3.1: 21st century dynamic efficiency (percent)

GDP Ranking	Country	Dynamic efficiency	Averaged over	GDP Ranking	Country	Dynamic efficiency	Averaged over
1	USA	18.53%	2000-2017	28	Austria	16.38%	2000-2017
2	China	-4.97%	2000-2017	31	Norway	21.17%	2000-2018
3	Japan	19.27%	2000-2017	34	Israel	19.51%	2000-2017
4	Germany	20.10%	2000-2017	35	Denmark	12.84%	2000-2018
5	UK	20.49%	2000-2017	39	South Africa	23.67%	2008-2017
6	France	13.03%	2000-2017	40	Ireland	27.62%	2000-2017
7	India	9.65%	2000-2017	43	Columbia	35.55%	2000-2017
8	Italy	28.60%	2000-2017	44	Chile	32.47%	2003-2017
9	Brazil	21.54%	2010-2016	45	Finland	17.41%	2000-2018
10	Canada	15.89%	2000-2017	47	Portugal	20.11%	2000-2017
11	Korea	14.95%	2000-2017	50	Greece	24.98%	2000-2017
12	Russia	17.63%	2011-2017	51	Czech Republic	22.61%	2000-2017
13	Australia	14.58%	2000-2017	53	New Zealand	22.18%	2010-2017
14	Spain	16.71%	2000-2017	58	Hungary	18.47%	2000-2017
15	Mexico	44.61%	2003-2017	66	Slovak Republic	27.18%	2000-2017
17	Turkey	32.15%	2009-2017	76	Luxembourg	20.18%	2010-2017
18	Netherlands	19.80%	2000-2018	77	Costa Rica	24.15%	2012-2016
19	Switzerland	15.55%	2000-2017	86	Slovenia	11.12%	2000-2017
22	Taiwan	10.65%	2000-2017	88	Lithuania	26.59%	2004-2017
23	Sweden	10.25%	2000-2018	100	Latvia	19.15%	2000-2017
24	Poland	28.28%	2000-2017	105	Estonia	12.43%	2000-2017
25	Belgium	16.29%	2000-2017	112	Iceland	11.68%	2000-2017

Source: SNA (2008) statistics (from National Statistics of Taiwan) for Taiwan; statistics on employee compensation used to compute GOS are not available for India at the aggregate level; instead, we use the statistics on non-financial corporate sector as an alternative, obtained from Ministry of Statistics and Program Implementation of India; data for other nations are directly obtained from the OECD database. For Brazil, statistics on acquisitions less disposals of valuables used to compute gross capital formation are not available in the OECD database; therefore, we use the statistics on gross fixed capital formation as an alternative, which might, to some extent, overstate the efficiency level.

As many studies have suggested, although the AMSZ criterion has several advantages over other approaches, this method suffers from statistical limitations that may eventually cause an upward bias in the efficiency estimates (e.g., Abel et al., 1989; Ahn, 2003; Geerolf, 2013; Luo et al., 2018). In this regard, estimates without bias correction tend to provide over-optimistic evaluations. According to the results, however, it turns out that even the preliminary estimates suffice to verify China's over-saving status. Among the representative nations, China has encountered the most severe problem of overaccumulation in the past decade. It is tempting to conclude that if overaccumulation does exist and only exists in a specific country, China would be the one.

3.2.3 Analytical stance in viewing saving issues

Before proceeding, we would like to clarify the necessity to take a stance on China's overaccumulation status. In the saving literature, economists usually refer to conventional growth theories that emphasize the importance of saving and investment—regarding saving as the source power for economic development²¹. Typical examples are the Lewis model and the first/second “demographic dividend” hypotheses, which have thoroughly formulated the growth impact of saving. There is ample evidence on the positive correlation between saving (investment) and economic growth (e.g., Mankiw et al. 1992). At the household level, saving signals the improvement in living standards beyond subsistence consumption. Simply put, it is tempting to regard saving as a completely positive element thus overlook the negative side of over-saving.

However, there is much to be discussed about the hazard of overaccumulation. First, if an economy has overaccumulated capital such that interest rate (r) falls below economic growth rate (g), maintaining the market equilibrium will require more investment (gK) than the economy actually produces (rK) (Fama and French, 2002; Weil, 2008). Second, capital saturation ($g > r$) will render additional investment pointless, since the capital stock has exceeded the optimal level for maximizing social consumption. In this sense, over-saving is a practice of “extravagance” (Luo et al. 2018). According to the OECD statistics, whereas China's capital formation ratio (GCF/GDP) has increased from 35% to 46% over 1990–2015, the consumption ratio (FCE/GDP) has declined

²¹ Saving is a major source for corporate investment in plant and equipment needed to promote the productive capacity of aggregate economy, and the enhanced income growth feeds back through stimulating household saving.

sharply from 64% to 52% during the same period. In other words, China's capital-extensive growth pattern has never achieved desirable welfare gains (socially inefficient). Third, overaccumulation always triggers speculative bubbles and income inequality, which can jeopardize market effectiveness and social stability.

Whereas it is almost impossible to gauge the overall impact of overaccumulation, we believe that the capital-extensive growth model is pathological and unsustainable. For Chinese policymakers, it will be mostly beneficial to encourage consumption, increase interest rates, and eliminate idle capital, rather than sticking to the saving-promotion strategy.

In viewing China's saving issues, factors commonly regarded as positive elements (i.e., the saving-promoting factors) might have negative repercussions on China's economic performance because they have actually aggravated the current problem of overaccumulation. Similarly, those regarded as negative factors (i.e., the saving-inhibiting factors) might have virtually reduced the idle capital thus served as remedies for the overaccumulation problem. Analytical stance is of utmost importance in empirical research: we need the right analytical stance to derive constructive policy prescriptions from empirical evidence.

3.3 Data and empirical strategy

3.3.1 Data

The analysis is based on China’s official panel dataset, which covers 30 administrative units divided into rural and urban samples over 1995–2015. All the variables are taken or constructed directly from Chinese statistics yearbooks, population and employment statistics yearbooks, and finance and banking yearbooks, published by the National Bureau of Statistics of China.

One drawback of the dataset is that some indicators are not available for specific administrative units over particular periods. For instance, we drop the unit “Tibet” due to the problem of missing values; Chongqing city became independent from Sichuan province in 1997 thus some figures were not recorded until 1997. In addition, data on several major indicators are available only at the provincial level, making it difficult to distinguish between the separate impacts on rural and urban regions. However, this limitation can be attenuated by altering the variable definition and will be discussed in later sections. For completeness, descriptive statistics and pairwise correlation matrix are displayed in Appendix, which provides basic information on the incorporated variables.

3.3.2 Econometric framework

To identify a broad range of saving determinants, instead of adhering to structural-form approaches, we prefer reduced-form linear specification that helps to derive straightforward empirical regularities.

$$S_{i,t} = \beta_1 S_{i,t-1} + \beta_2 X_{i,t} + \delta_t + \mu_i + \varepsilon_{i,t} \quad (3.1)$$

The specification outlined above is a standard regression designed to assess the saving determinants. The subscripts t and i represent the time period and region, respectively; S denotes the household saving rate; X is the set of explanatory variables; δ and μ represent the unobservable time- and region-specific effects, respectively; ε is the disturbance term.

We pay careful attention to the endogeneity and heterogeneity considerations—the main challenges confronting empirical research. Following previous saving literature (Loayza et al., 2000, 2012; Schrooten and Stephan, 2005; Horioka and Wang, 2007; Hung and Qian, 2010; and Nabar, 2011), we utilize the GMM estimator (Generalized-Method-of-Moment²²) to assess the saving determinants. The GMM estimator is deemed to be an analytically sound and empirically feasible approach, which is superior to other approaches in several aspects:

First, the GMM framework allows for dynamic specification by incorporating lag terms of dependent variables. Lagged saving rates represent the inertia and persistence of saving behaviors, which account for a large proportion of time variations in saving.

Second, the Difference-GMM estimator controls for the time-invariant effects (e.g., the region-specific effects). The first-difference process (equation 3.2) can mitigate the heterogeneity bias by eliminating the overall unobservable effects.

$$\Delta S_{i,t} = \beta_1^* \Delta S_{i,t-1} + \beta_2^* \Delta X_{i,t} + \Delta \varepsilon_{i,t} \quad (3.2)$$

Third, econometric analyses are often plagued by the limited availability of exogenous

²² See Arellano and Bond (1991) and Arellano and Bover (1995) for a full description of the GMM estimator.

instruments in coping with the endogeneity concern. To control for the overall endogeneity, the Difference-GMM estimator exploits the internal instruments (i.e., the lag values of explanatory variables) to steer clear of simultaneity and reverse causality. Assuming that the error term is serially uncorrelated and that the explanatory variables are by construction weakly exogenous, the Difference-GMM estimator is expressed in the following moment conditions.

$$E[S_{i,t-k} \cdot \Delta \varepsilon_{i,t}] = 0 \quad \text{for } k \geq 2; k = 3, \dots, T \quad (3.3)$$

$$E[X_{i,t-k} \cdot \Delta \varepsilon_{i,t}] = 0 \quad \text{for } k \geq 2; k = 3, \dots, T \quad (3.4)$$

3.3.3 Empirical strategy

The GMM estimator pivots critically on the validity of instrument variables, similar to the case of Instrument Variable method. To this question, we perform two specification tests. First, the Hansen test is used to inspect the overidentification restriction on instrument variables. Failure to reject the null hypothesis lends credence to the weak exogeneity and joint validity of the internal instruments. Second, the first- and second-order serial correlation tests are employed. Failure to reject the second and rejection in the first verify the random-walk process in AR (2)²³, which supports the overall reliability of the GMM estimator.

Many empirical attempts have been made to explain China's extraordinarily high saving rates. Nevertheless, concrete evidence is lacking, and the literature tends to be limited in the validity of econometric settings. We propose our solutions as below:

²³ By construction (i.e., the first-difference procedure), the error term ($\Delta \varepsilon_{i,t}$) is expected to be correlated with the dependent variable ($\Delta S_{i,t}$) thus leads to a rejection in the first-order serial correlation test.

1. According to Blundell and Bond (1998), the internal instruments employed in the first-difference process are not likely to serve as proper instruments. Many researchers suggest that the Difference-GMM method underemphasizes the time-invariant effects and tends to over-difference the specification²⁴. To overcome this limitation, we use the System-GMM method advanced by Blundell and Bond (1998), which combines the difference and level equations into one system to control for the potential bias.

The System-GMM estimator incorporates the lagged differences of variables as internal instruments for level equations, based on the Difference-GMM estimator. The incorporated instruments are valid if the correlation between each variable and the region-specific effect is constant over time (equation 3.5).

$$E[X_{i,t+p} \cdot \mu_i] = E[X_{i,t+q} \cdot \mu_i] \quad \text{and} \quad E[S_{i,t+p} \cdot \mu_i] = E[S_{i,t+q} \cdot \mu_i] \quad \text{for all } p \text{ and } q \quad (3.5)$$

In the System-GMM estimator, the above assumptions are formulated into additional moment conditions (equation 3.6), which can contribute to more accurate and efficient estimates.

$$E[\Delta X_i \cdot \mu_i] = 0 \quad \text{and} \quad E[\Delta S_i \cdot \mu_i] = 0 \quad (3.6)$$

2. Windmeijer (2005) indicates that the conventional one-step GMM estimator tends to inefficiently specify the weight matrix in computing coefficient estimates, due to the uncontrolled heterogeneity and tenuous restrictions on the weight matrix. This limitation impairs the reliability of the overidentification test and causes an upward bias in the statistical significance (especially for finite-sample estimations). However, Arellano and Bond (1991) and Bond (2002) argue that the

²⁴ For instance, Alonso-Borrego and Arellano (1999) suggest that if the sample size is limited and the variables are highly persistent over time, the internal instruments of the Difference-GMM method can be weak instruments. This feature jeopardizes the asymptotic stability thus results in estimation bias.

one-step method can reduce the overfitting bias in small-sample estimations, and the efficiency gains of using the two-step framework are only marginal. Given that the sample size in question is neither small nor sufficiently large, we employ both the one- and two-step System-GMM estimators to test the result robustness.

3. Roodman (2007) and Loayza et al. (2012) suggest that short lag lengths help to attenuate the overfitting bias in the GMM estimations. Furthermore, the GMM estimators are sensitive to the selection of lag periods (Tauchen 1986). For conservativeness, we perform consistency tests by experimenting with different lag lengths (from 2-3 to 2-5) combined with robust standard errors.

4. In the System-GMM estimations, the introduction of internal instruments usually causes a surge in the number of instruments thus leads to the overidentification bias. To address this problem, we adopt the command “collapse” developed by Bond (2002) to restrict the size of potential instruments. In addition, following Loayza et al. (2000) and Wang et al. (2012), we utilize the command “noconst” to compress the constant term that represents the time trend and overlaps with the notion of saving persistence.

5. As Masson et al. (1998), Loayza et al. (2000), and Kraay (2000) have suggested, empirical analyses on saving determinants are particularly sensitive to the selection of econometric settings and variable definitions. In the current study, perhaps the most important concern is the conceptual difference between China’s urban and rural saving behaviors. Accordingly, it is desirable to examine the rural and urban samples separately. Moreover, scholars have reached a consensus that the conventional saving determinants have limited power in explaining the exceptionally high saving rates in China (Kraay, 2000; Horioka and Wan, 2007; Hung and Qian,

2010; Wei and Wang, 2011; Horioka and Terada-Hagiwara, 2012). There is an urgent need to exploit a broader range of variables (the newly formed, country-specific, and less standard determinants) to resolve the conundrum.

3.4 Specification test, result, and interpretation

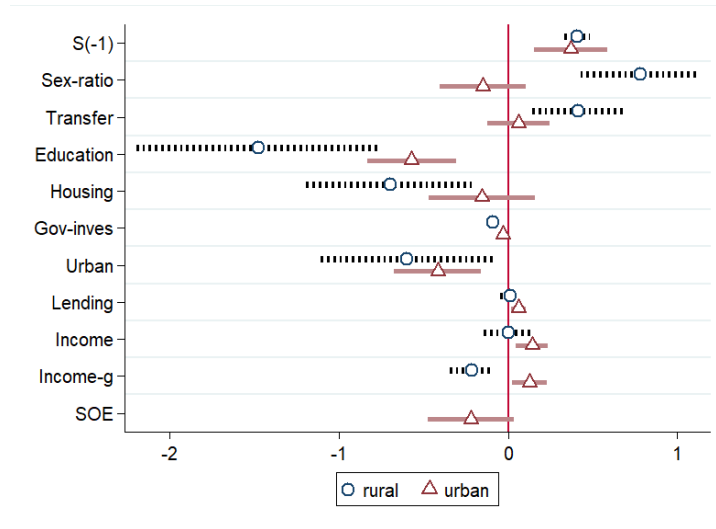
In this section, we first briefly introduce the main results then investigate each variable. To allow for concise expressions, for each variable, we combine the definition, estimate, and interpretation in the following subsections. Tables 3.3 and 3.4 demonstrate the estimates for rural and urban samples, respectively. For overall comparability, both parts use the same econometric settings and variable definitions. It is reassuring that the Hansen and serial correlation tests support the validity of the estimations, and the results are robust to different lag choices and econometric specifications—the Fixed-effect²⁵ (column 1), one-step (columns 2–4), and two-step System-GMM methods (columns 5–7). The obtained parameters are theoretically justifiable and will be discussed in detail. We also conducted the consistency tests; the results in Tables 3.5 and 3.6 suggest that major determinants retain the statistical significance as well as coefficient signs after the inclusion of additional covariates.

In the estimations, we include conventional income-related determinants as control variables. Our focus is on the less standard determinants, which are essentially the predominant drivers of Chinese household saving. As typical demographic variables, sex ratio, urbanization ratio, and share of SOE employees are assumed to be strictly exogenous. Total bank lending is also presumably exogenous. Other variables are deemed to be endogenous or predetermined thus correlated with the error term, which justifies the application of the GMM estimator.

²⁵ The within estimator (fixed-effect) is employed to test the robustness and explanatory power (i.e., the R-squared) of the incorporated explanatory variables. The results indicate that the variables explain 87.6% of the variations in household saving.

To draw a comprehensive picture of the results, Figure 3.1 summarizes the estimated coefficient (the marginal effect) and confidence interval of each variable; Table 3.2 displays the estimated long-term contribution of each variable to the variations in saving rates—the larger the parameter and higher the deviation, the more pronounced impacts on saving. Accordingly, the education and housing expenses, transfer income, government investment, urbanization ratio, and sex ratio are deemed to be the main driving forces of rural household saving. In turn, the education expenses, government investment, bank lending, urbanization ratio, and share of SOE employees are considered to be highly influential on urban household saving.

Figure 3.1: Explanatory power of each determinant



Source: The coefficients and their confidence intervals are derived from estimates of the one-step System-GMM regressions in the choice of Lag (2 5), as shown in Tables 3.3 and 3.4.

Table 3.2: Contribution of each determinant

Variable	Average(1995)	Average(2015)	ΔDifference	Coefficient	Estimated effect	ΔSaving rate
S	0.462	0.177	-0.285			-28.50%
Sexratio	105.637	105.572	-0.065	0.779 ***	-5.06%	
Transfer	0.035	0.178	0.143	0.412 ***	5.89%	
Education	0.062	0.086	0.024	-1.476 ***	-3.54%	
Housing	0.088	0.168	0.080	-0.696 ***	-5.57%	
Gov-inves	1.795	2.275	0.480	-0.092 ***	-4.42%	
Urban	0.363	0.566	0.203	-0.598 **	-12.14%	
(Rural sample)						
S	0.173	0.305	0.132			13.20%
Education	0.072	0.076	0.004	-0.570 ***	-0.23%	
Gov-inves	1.795	2.275	0.480	-0.029 ***	-1.39%	
Urban	0.363	0.566	0.203	-0.416 ***	-8.44%	
Lending	0.821	1.507	0.686	0.060 ***	4.12%	
SOE	0.226	0.081	-0.145	-0.222 *	3.22%	
(Urban sample)						

Source: The coefficients are obtained from estimates of the one-step System-GMM regressions in the choice of Lag (2 5), as showed in Tables 3.3 and 3.4.

Table 3.3: Determinants of rural household saving rate

	Fe-Robust	System-GMM-Robust			Twostep-System-GMM-Robust		
S (-1)	0.556*** (0.00)	0.352*** (0.00)	0.386*** (0.00)	0.409*** (0.00)	0.319*** (0.00)	0.350*** (0.00)	0.370*** (0.00)
Sexratio	0.153* (0.06)	0.888*** (0.00)	0.839*** (0.00)	0.779*** (0.00)	0.926*** (0.00)	0.903*** (0.00)	0.841*** (0.00)
Transfer	0.357*** (0.00)	0.478*** (0.00)	0.487*** (0.00)	0.412*** (0.00)	0.487*** (0.00)	0.492*** (0.00)	0.438*** (0.01)
Education	-1.152*** (0.00)	-1.796*** (0.00)	-1.735*** (0.00)	-1.476*** (0.00)	-1.798*** (0.00)	-1.740*** (0.00)	-1.438*** (0.00)
Housing	-0.823*** (0.00)	-0.889*** (0.00)	-0.855*** (0.00)	-0.696*** (0.01)	-0.980** (0.02)	-0.891*** (0.01)	-0.866** (0.04)
Gov-inves	-0.051*** (0.00)	-0.088*** (0.00)	-0.087*** (0.00)	-0.092*** (0.00)	-0.089*** (0.00)	-0.089*** (0.00)	-0.094*** (0.00)
Urban	-0.237** (0.04)	-0.562* (0.07)	-0.571** (0.04)	-0.598** (0.02)	-0.518 (0.11)	-0.520* (0.06)	-0.495* (0.10)
Lending	0.008 (0.54)	0.004 (0.89)	0.008 (0.79)	0.012 (0.69)	-0.003 (0.92)	-0.001 (0.99)	-0.001 (0.90)
Income	-0.054* (0.09)	-0.016 (0.85)	-0.009 (0.91)	0.002 (0.98)	-0.024 (0.81)	-0.026 (0.76)	-0.015 (0.86)
Income-G	-0.016 (0.72)	-0.261*** (0.00)	-0.235*** (0.00)	-0.217*** (0.00)	-0.281*** (0.00)	-0.262*** (0.00)	-0.242*** (0.00)
Constant	0.532*** (0.00)						
Observations	590	590	590	590	590	590	590
Number of province	30	30	30	30	30	30	30
R-square	0.876						
P-value of Hansen test		0.33	0.61	0.62	0.33	0.61	0.84
P-value of AR(1)		0.00	0.00	0.00	0.00	0.00	0.00
P-value of AR(2)		0.87	0.90	0.84	0.68	0.84	0.97
Instruments for difference equation	Levels of S (-1), Transfer, Education, Housing, Gov-inves, Income and Income-G						
Instruments for level equation	Differences of S (-1), Transfer, Education, Housing, Gov-inve, Income and Income-G						
Lag option for key determinants	Lag(2 3)	Lag(2 4)	Lag(2 5)	Lag(2 3)	Lag(2 4)	Lag(2 5)	
Lag option for income-G, income	Lag(2 10)						

Robust p-value in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 3.4: Determinants of urban household saving rate

	Fe-Robust	System-GMM-Robust			Twostep-System-GMM-Robust		
S (-1)	0.625*** (0.00)	0.369*** (0.00)	0.360*** (0.00)	0.370*** (0.00)	0.335* (0.06)	0.198 (0.21)	0.251 (0.21)
Sexratio	-0.053 (0.21)	-0.156 (0.23)	-0.151 (0.24)	-0.150 (0.24)	-0.138 (0.25)	-0.081 (0.35)	-0.085 (0.38)
Transfer	0.053** (0.02)	0.076 (0.46)	0.052 (0.59)	0.062 (0.51)	0.105 (0.39)	0.134 (0.25)	0.114 (0.33)
Education	-0.369*** (0.00)	-0.608*** (0.00)	-0.576*** (0.00)	-0.570*** (0.00)	-0.692*** (0.00)	-0.777*** (0.00)	-0.748*** (0.00)
Housing	-0.023 (0.51)	-0.154 (0.35)	-0.178 (0.27)	-0.154 (0.33)	-0.084 (0.68)	-0.180 (0.35)	-0.199 (0.20)
Gov-inves	-0.001 (0.69)	-0.027*** (0.00)	-0.027*** (0.00)	-0.029*** (0.00)	-0.031*** (0.00)	-0.026*** (0.01)	-0.027*** (0.00)
Urban	0.087** (0.02)	-0.410*** (0.00)	-0.410*** (0.00)	-0.416*** (0.00)	-0.411** (0.04)	-0.254 (0.11)	-0.299** (0.04)
Lending	0.004 (0.49)	0.060*** (0.00)	0.060*** (0.01)	0.060*** (0.01)	0.045* (0.07)	0.053** (0.02)	0.051** (0.02)
SOE	-0.031 (0.44)	-0.206* (0.10)	-0.225* (0.07)	-0.222* (0.09)	-0.268* (0.07)	-0.334** (0.04)	-0.323** (0.02)
Income	0.017 (0.30)	0.141*** (0.00)	0.142*** (0.00)	0.141*** (0.00)	0.144** (0.02)	0.120*** (0.01)	0.124*** (0.01)
Income-G	0.110*** (0.00)	0.118** (0.01)	0.118** (0.01)	0.126** (0.02)	0.143*** (0.01)	0.078 (0.13)	0.098* (0.09)
Constant	0.058 (0.46)						
Observations	590	590	590	590	590	590	590
Number of province	30	30	30	30	30	30	30
R-square	0.856						
P-value of Hansen test		0.55	0.90	0.96	0.55	0.90	0.96
P-value of AR(1)		0.00	0.00	0.00	0.01	0.02	0.02
P-value of AR(2)		0.12	0.11	0.10	0.22	0.22	0.20
Instruments for difference equation	Levels of S (-1), Transfer, Education, Housing, Gov-inves, Income and Income-G						
Instruments for level equation	Differences of S (-1), Transfer, Education, Housing, Gov-inve, Income and Income-G						
Lag option for key determinants	Lag(2 3)	Lag(2 4)	Lag(2 5)	Lag(2 3)	Lag(2 4)	Lag(2 5)	
Lag option for income-G, income	Lag(2 10)						

Robust p-value in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 3.5: Consistency test (Rural sample)

	System-GMM-Robust						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
S (-1)	0.940*** (0.00)	0.881*** (0.00)	0.895*** (0.00)	0.545*** (0.00)	0.391*** (0.00)	0.412*** (0.00)	0.409*** (0.00)
Sexratio		0.111** (0.01)	0.188*** (0.00)	0.777*** (0.00)	1.135*** (0.00)	0.783*** (0.00)	0.779*** (0.00)
Transfer			0.211*** (0.00)	0.624*** (0.00)	0.638*** (0.00)	0.419*** (0.00)	0.412*** (0.00)
Education				-1.792*** (0.00)	-1.678*** (0.00)	-1.465*** (0.00)	-1.476*** (0.00)
Housing				-1.442*** (0.00)	-0.925*** (0.00)	-0.703*** (0.01)	-0.696*** (0.01)
Gov-inves					-0.070*** (0.00)	-0.090*** (0.00)	-0.092*** (0.00)
Urban						-0.558** (0.02)	-0.598** (0.02)
Lending							0.012 (0.69)
Income	-0.003 (0.24)	-0.029*** (0.00)	-0.057*** (0.00)	-0.113*** (0.00)	-0.180*** (0.00)	-0.002 (0.97)	0.002 (0.98)
Income-G	0.129** (0.02)	0.097* (0.07)	0.105* (0.05)	-0.138** (0.01)	-0.208*** (0.00)	-0.228*** (0.00)	-0.217*** (0.00)
Observations	618	610	609	609	590	590	590
Number of province	31	31	31	31	30	30	30
P-value of Hansen-J	0.11	0.09	0.20	0.46	0.86	0.86	0.62
P-value of AR(1)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
P-value of AR(2)	0.00	0.00	0.00	0.59	0.71	0.62	0.84
Instruments for difference equation	Levels of S (-1), Transfer, Education, Housing, Gov-inves, Income and Income-G						
Instruments for level equation	Differences of S (-1), Transfer, Education, Housing, Gov-inve, Income and Income-G						
Lag options	Lag (2 5) for key determinants, Lag (2 10) for income and income g						

Robust p-value in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 3.6: Consistency test (Urban sample)

	System-GMM-Robust							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
S (-1)	0.911*** (0.00)	0.790*** (0.00)	0.653*** (0.00)	0.649*** (0.00)	0.631*** (0.00)	0.586*** (0.00)	0.569*** (0.00)	0.370*** (0.00)
SOE		-0.0955** (0.02)	-0.131*** (0.01)	-0.165*** (0.01)	-0.191** (0.01)	-0.224** (0.02)	-0.208** (0.02)	-0.222* (0.09)
Education			-0.256*** (0.00)	-0.348*** (0.00)	-0.546*** (0.00)	-0.441*** (0.00)	-0.548*** (0.00)	-0.570*** (0.00)
Housing			-0.010 (0.81)	0.024 (0.64)	-0.120 (0.22)	-0.108 (0.27)	0.003 (0.98)	-0.154 (0.33)
Urban				-0.107 (0.20)	-0.221** (0.02)	-0.192** (0.02)	-0.200*** (0.01)	-0.416*** (0.00)
Lending					0.037** (0.04)	0.040*** (0.01)	0.033** (0.04)	0.060*** (0.01)
Gov-inves						-0.016** (0.01)	-0.018*** (0.00)	-0.029*** (0.00)
Transfer							0.095 (0.15)	0.062 (0.51)
Sexratio								-0.150 (0.24)
Income	0.006** (0.01)	0.015*** (0.00)	0.030*** (0.00)	0.045*** (0.00)	0.057*** (0.00)	0.061*** (0.00)	0.061*** (0.00)	0.141*** (0.00)
Income-G	0.056 (0.19)	0.069* (0.09)	0.095** (0.02)	0.102** (0.02)	0.103** (0.03)	0.170*** (0.00)	0.152*** (0.00)	0.126** (0.02)
Observations	614	614	614	614	614	598	598	590
Number of province	31	31	31	31	31	30	30	30
P-value of Hansen-J	0.36	0.29	0.60	0.52	0.53	0.89	0.92	0.96
P-value of AR(1)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
P-value of AR(2)	0.01	0.00	0.01	0.01	0.01	0.03	0.02	0.10
Instruments for difference equation	Levels of S (-1), Transfer, Education, Housing, Gov-inves, Income and Income-G							
Instruments for level equation	Differences of S (-1),Transfer,Education,Housing,Gov-inve,Income and Income-G							
Lag options	Lag (2 5) for key determinants, Lag (2 10) for income and income g							

Robust p-value in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Dependent variable

Household saving rate. Household saving rate is calculated as the ratio of household saving (i.e., the difference between income and total expenditure) to household disposable income. Chinese household saving rates have been higher than any other nation since 1995. Rural household saving rate (as provincial average) has decreased sharply from 46.2% to 17.7% during 1995–2015, whereas the urban counterpart has increased from 17.3% to 30.5% over the same period. The following parts introduce the determinants of the rising and falling household savings in China.

Explanatory variables

Inertia and persistence. According to the estimates, the one-year lag of saving has a positive and significant impact on the current household saving, which confirms the presence of saving persistence. The coefficients range from 0.32 to 0.56 for rural samples and from 0.34 to 0.63 for urban samples (statistically significant estimates only). The results imply that the long-run effect of saving inertia is 1.47 to 2.70 times the respective short-run effect, lower than the previous findings on saving persistence²⁶.

This evidence suggests that China's "saving glut" is not attributable to the high propensity to save—the Confucian heritage: diligence and thrifty—an idea frequently picked up by the mass media. Moreover, there is no noticeable disparity between rural and urban saving inertias. Accordingly, saving persistence does not explain China's excess saving, nor has it contributed to

²⁶ In previous studies such as Such as Loayza et al. (2000), Schrooten and Stephan (2005), Horioka and Wang (2007), Hung and Qian (2010), and Nabar (2011), the estimated coefficients range from 0.3 to 0.8.

the discrepancy in urban and rural household savings.

Sex ratio. the number of males per 100 females in the provincial population. In the past decades, the world has witnessed China's efforts in the implementation of population policies. In the early 2000s, China has an "abnormal" sex ratio at birth: over 1.2 boys per girl (Wei and Zhang, 2011). What stabilized the sex ratio (around 1.06 males per female in 2015) are the family planning policies and restrictions on sex-selective abortion—which have introduced profound changes in Chinese society.

In the context of Chinese traditional culture, men ought to play the dominant role whereas women were expected to be their subordinates. This kind of feudal ethic usually undermines females' saving motives. Wei and Zhang (2011) and Hung and Qian (2010) find that parents with a son raise their household savings in a competitive manner in order to improve their son's attractiveness in marriage markets. In contrast, Banerjee et al. (2010) find that Chinese households with a daughter tend to save more due to precautionary motives. In a macro-based analysis, Nabar (2011) identifies only weak linkages between sex ratio and household saving in China.

Theoretically, the so-called feudal ethic is entrenched in less-developed regions thus rural residents should respond strongly to the fluctuations in sex ratio. As expected, the estimates suggest that rural saving relates strongly to sex ratio. As a rough evaluation, the declining sex ratio has a considerable negative effect (-5%) on rural household savings. Although China's population policies have been subject to much criticism for moral considerations and the pessimism of economic slowdown, the rebalanced sex ratio has significantly attenuated the excess saving

problem in rural China.

Transfer income ratio. the share of transfer income in household disposable income.

Transfer income denotes the total amount of inter-family transfers, such as bequests, alimony, and gifts.

Due to the immature social safety net in underdeveloped regions, inter-family transfers have been serving as the primary vehicle for rural households to guard against risks. Mainstream theories regard income transfer as a tool to help smooth lifetime consumption. In this sense, transfer income is compensatory and usually impairs receivers' saving motives. Overall, existing theories predict a negative correlation between transfer income and household saving.

In contrast to the conjecture, the estimates demonstrate a significant and positive saving impact. The derived coefficients indicate that receivers tend to consume only a small part of their transfer income. On average, rural recipients will save one-half of the transfer income, rather than adhering to the general saving pattern (the average saving rate is around 25%). This evidence suggests that transfer income is not meant to be consumed but to be preserved, which seems to contradict the mainstream theories. As a rough estimate, the increasing transfer income ratio (from 3.5% to 17.8%) has a tremendous promoting effect on rural household saving (by 5.8%). The unclear mechanism plays an equilibrating role in moderating the declining rural saving, which has aggravated the problem of surplus saving.

There is some early but indirect evidence on such a phenomenon. For instance, Mizoguchi (1970), Ishikawa and Ueda (1984), Meng (2003), and Ravallion and Chen (2005) find that the

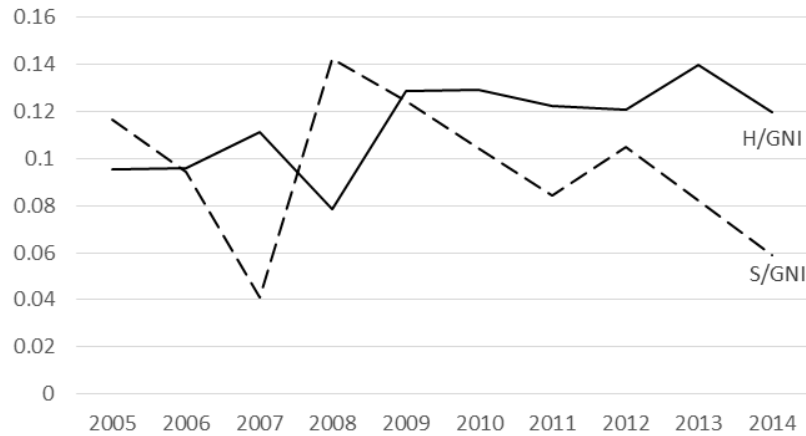
marginal propensity to save out of regular income can be lower than that out of temporary income (such as bonus and other lump-sum transfers); Hayashi (1986) infers that the increase in annuities did not lead to higher consumption of the elderly in Japan. As predicted by Barro's dynastic altruism model, transfer income might have a Ricardian effect on household saving. That is, receivers perceive the transfer as a "loan" that better be reimbursed in the future, rather than temporary income that can be dispensed discretionarily²⁷. As supportive evidence, Luo (2019) find that 95% of the inter-family transfers in China were driven by exchange motives.

Housing and education expenses. the shares of housing and education expenses in disposable income, respectively.

Due to the flexible monetary policy and incomplete restriction on property purchase, China's real estate market has begun to expand at an unprecedented rate since the initiation of housing stock privatization in the 1990s. Figure 3.2 plots the total real estate investment against the growth in national cash deposit over 2005–2015. At first glance, there is an apparent substitution relationship between real estate investment and saving accumulation at the aggregate level.

²⁷ There are other plausible explanations for such phenomenon. For instance, rural residents might save a large portion of transitory income (e.g., inter-family transfers) due to the inferior rural welfare benefits, predicted by the permanent income hypothesis. Another likely explanation is that low-income individuals tend to save a half or two-third of temporary income, which is a general rule of thumb.

Figure 3.2: Total real estate investment and the growth in cash deposit



Source: From the National Bureau of Statistics of China. Both indicators are expressed as percentages of gross national income.

On the other hand, China began to pursue the Higher Education Reform in 1999, and the system of nine-year compulsory education was being implemented in earnest. The establishment of education funding and the decreasing fertility rate have succeeded in relieving households' burden of education expenditure: in 2015, education expense on average accounts for only 8% of household income.

To capture the variations in household expenditure, we incorporate the share of each expenditure in the estimations. While this approach is empirically feasible, it should be noted that saving as well as other expenses are parts of household budget. Accordingly, there is a neutral crowding-out relationship between any two expenditures in the estimations²⁸—an empirical issue overlooked by previous literature. Coefficient values above -1 (in real numbers, hereafter) do not

²⁸ Saving is a residual concept. That is, $\text{Saving/Income} = 1 - (\text{Expenses/Income})$. In this sense, the crowding-out effect alone leads to an estimated coefficient of -1.

imply a substitution effect but a complementary effect on saving²⁹. Whereas the specification is not rigorous and deserves further investigation, it is a useful first step to gauge the empirical regularity between saving and household expenditure.

According to the estimates, the coefficients of education expenses range from -1.80 to -1.44 for rural samples and from -0.78 to -0.57 for urban samples. Education expenses have a significant substitution effect on rural saving but a complementary effect on urban saving. On the other hand, housing expenses have a moderate complementary effect on rural saving, whereas the coefficients in the urban estimations are statistically insignificant, implying a strong complementary effect.

City dwellers generally have much higher expenses than rural residents. However, the estimates point towards a significant substitution relationship between education expense and rural saving, which implies the need for rural residents to break into household savings to finance education expenditure. On the other hand, the substitution effect on urban saving is somewhat muted, even though urban residents are confronting much higher prices. In a similar vein, the results suggest that home purchase of urban residents is not largely financed out of household saving (at the very least, the rising housing expense of urban residents does not seem to influence household saving). Such phenomenon also prevails in Japan, where high saving rates of young population triggered by the surging housing prices did not translate into high aggregate saving (Hayashi 1986;

²⁹ Theoretically, if the expenditure is a substitute for saving, its coefficient is expected to be lower than -1 (since the crowding-out effect alone can lead to a coefficient of -1). Similarly, if the expenditure and saving experience a joint demand, the coefficient should be above -1; if the complementary relationship is strong, the coefficient might even obtain positive values.

Horioka and Watanabe 1997), in contrast to the literature that emphasizes the saving motives for homeownership and life-cycle events (e.g., Chamon and Prasad 2010; Nabar 2011).

In the past decade, the world faced a common threat posed by real estate bubbles (e.g., the Lehman shock). However, rational bubbles can help absorb excess saving in many ways, such as relieving the surplus saving of potential home buyers. In this sense, asset bubbles have, to some extent, attenuated the excess saving in China. The estimates imply that the increasing housing expense in the past 20 years has contributed to a notable reduction (-5.6%) in rural household savings.

On the other hand, the education reform has become one of the most successful policy designs in Chinese history. The highly subsidized education system has lifted millions out of illiteracy and helped rural population pursue college education. However, the favorable education system has a compensating effect on household saving. Over 2000–2012, the diminishing educational burden has stimulated 4% and 3% increases in rural and urban household savings, respectively, which have worsened the over-saving problem in China.

Government investment ratio. the ratio of public investment to financial revenue. Following previous literature (Masson et al. 1998; Loayza et al. 2000; Hung and Qian 2010), we examine the saving impact of public investment from two perspectives.

First, we discuss the efficiency of government investment: ineffective investment is likely to reduce the resources available to private sectors thus undermines households' saving accumulation. Second, we examine the Ricardian equivalence effect: if typical agents are rational

and forward-looking, government investment should have non-negative effects on household saving³⁰. Given the ample evidence that full rationality and complete equivalence are empirically irrelevant (e.g., Bernheim 1987; Elmendorf and Mankiw 1999), we expect to capture negative saving impacts of government investment.

According to the estimates, public investment has significant and negative impacts on rural and urban household savings, which reject the Ricardian hypothesis. The estimated coefficients suggest that a 1% increase in the investment ratio is associated with -0.09% and -0.03% decreases in rural and urban household savings, respectively, implying the urban-favoring nature of public investment in China.

The size and fiscal deficit of Chinese government have been maintaining high levels, and the average investment ratio has increased from 1.795 to 2.275 over 1995–2015. As a consensus view, minimal government involvement promotes market efficiency and encourages innovation. The phasing out of government intervention and the introduction of competitive mechanisms are considered to be the key to economic success. On the other hand, the increasing public investment has contributed to considerable reductions in rural and urban household savings (by -4.4% and -1.4%, respectively) over the past 20 years, which have counteracted the over-saving problem.

Urbanization ratio. the share of urban population in the total population.

Many studies have examined the relationship between urbanization ratio and household

³⁰ If individuals can anticipate that the deficit (surplus) in government budget will only lead to future increases (reductions) in their tax liabilities, any expansion (reduction) in government spending can be completely offset by increases (decreases) in household saving.

saving (e.g., Loayza et al. 2000; Hung and Qian 2010). Part of the literature argues that rapid urbanization adds to uncertainty and stimulates precautionary saving motives. However, some researchers suggest that urbanization is usually accompanied by financial liberations, which relieve the borrowing constraints thus undermine saving accumulation. In these cases, urbanization ratio serves as a proxy for the level of urbanization construction. In China's case, however, higher urbanization ratios do not imply higher levels of urbanization construction³¹. Instead, urbanization ratio is a proper proxy for the rural-urban population movement in the dual economy, which explicitly accounts for the ongoing phenomenon of "Rural Hollowing."³²

The main participant in rural-urban migration is also the main force in saving accumulation: prime-age adults at their peak earning years. Mainstream theories predict a negative impact of the workforce movement on rural saving but a positive impact on urban saving, since the "newcomers" (rural labor) presumably have a higher saving propensity. According to the estimates, the saving impacts are negative and statistically significant for both rural and urban samples. The results suggest that the newcomers have brought down the urban household saving rate, probably because migrant workers usually earn less while confronting higher living expenses in urban regions.

The phenomenon of Rural Hollowing has so far become a global challenge. It has aggravated the shortage of rural labor resources, worsened the problem of aging society in the

³¹ In China, urbanization ratio depends crucially on the established administrative divisions. A typical example is Hebei province. The province is known for its heavy industries and high level of urbanization construction. However, the urbanization ratio of Hebei was merely 0.50 in 2015, which is the lowest among all administrative units.

³² To be clear, urbanization ratio also reflects other mechanisms, such as the effect of financial development. We control for the confounding effects by incorporating explanatory variables such as bank lending and income-related determinants, discussed fully below.

countryside, and caused population explosion and soaring prices in metropolitan areas. However, as a rough evaluation, rural-urban population movement has reduced the rural and urban household savings by 12.1% and 8.4% over the past two decades, respectively. Accordingly, the declining rural saving is primarily attributed to the rural-urban population movement, which has been serving as the most potent mechanism against the overaccumulation problem in China.

Total bank lending. the ratio of total bank lending to provincial nominal GDP.

Many critics believe that there is a priority order in China's banking system. That is, bank loans are provided preferentially to local governments and SOEs, whereas private enterprises suffer discrimination in credit provision due to the small scale and limited sources of repayment. Consequently, private enterprises in China tend to retain a large proportion of earnings in preparation for bad times and finance the expenditure from unrecorded contributions of workers. This "hidden" rule applies equally to the case of private borrowing, in which the priority order favors upper-income citizens in receiving preferential treatment, whereas rural households seem least likely to benefit from the impressive progress in China's financial liberation.

Greater availability of consumer credits usually impairs households' saving motives. In related literature, Wang et al. (2012) and Horioka and Terada-Hagiwara (2012) find that financial liberations in East Asian economies have a hump-shaped effect on national saving. That is, most financial developments first occur in corporate sector and then permeate into the household sector. Accordingly, financial development initially stimulates aggregate saving through promoting firms' ability to expand and then reduces household saving through the expansion in private credits.

However, this hypothesis overlooks the possibility that the promoting effect can be directly captured by private sectors.

Increasing bank lending does not necessarily reduce household savings. Instead, the outcome depends on who/which sector receives the expanding credits. If low-income group acquires most of the credits, bank lending will undermine the saving motives; if the credits are largely obtained by high-income population and large enterprises, the expansion in bank lending might even stimulate saving accumulation, because the richest always saves the most³³. As expected, the estimates confirm the so-called priority order and the presence of borrowing constraints on rural households³⁴. The increasing bank lending ratio (from 0.85 to 1.51) over the observation period has contributed to a 4% increase in urban household saving, which well explains the rapid saving accumulation in urban China.

SOE employee share. the share of SOE employees in total employment.

SOEs have played a dominant role in Chinese economy before 1990, and SOE employees still constituted 23% of the total employment in 1995. SOE workers enjoyed a generous cradle-to-grave social security, known as the “iron rice bowl,” which has undermined the saving motives of SOE workers. In the 1990s, alongside the deepening SOE reform and the progress in constructing pro-market environments, SOEs began to downsize and even withdrew from competitive industries.

³³ Since most corporates are privately owned, and because there is an incentive to pursue the favorable corporate tax treatment, high earners can benefit from the expansion in both private and business loans.

³⁴ The insignificant impact of income level on rural saving (see Table 3.3) is also an indication of the presence of liquidity constraints on rural households.

The SOE reform has yielded massive layoffs, resulting in an upsizing share of private sectors that are characterized by short-term employment. The emergence of competitive market, shift in social safety net, abolishment of lifetime employment, and the breaking of “iron rice bowl” have significantly stimulated the precautionary saving in urban China.

The shift from state-run to market-oriented economy and the introduction of competitive mechanisms have no doubt rewarded China with substantial economic success in the past decades. However, the picture is reversed when it comes to the issue of overaccumulation. The results suggest that Chinese urban residents have responded strongly to the ever-rising uncertainty by raising household saving, in line with the promoting effects documented by previous literature (Kraay, 2000; Meng, 2003; Chamon and Prasad, 2010; Chamon et al., 2010; Nabar, 2011). The SOE reforms implemented in the past 20 years have contributed to a 3.2% increase in urban household saving, which has worsened the problem of excess saving.

Growth and level of income. the growth rate and level (logged) of household disposable income.

We incorporate the growth rate and level of income as control variables³⁵. According to the Keynesian models, marginal propensity to save increases with income level after exceeding subsistence consumption requirements, which predicts a positive saving impact of income level. The overall effect of income growth is more complicated and *ex-ante* ambiguous, which can be

³⁵ To allow for greater time persistence of the income-related effects, we adopt a longer lag length (Lag 2 10) on both variables.

roughly decomposed into three competing mechanisms: pension demand, precautionary saving motive, and demographic effect.

In the estimates, the saving impact of income level appears muted for rural samples but significant and positive for urban samples. On the other hand, income growth tends to be negatively (positively) related to rural (urban) saving, broadly consistent with the existing literature on saving behaviors (e.g., Kraay 2000). In this study, we will limit our discussion on income-related variables since previous literature has well documented the level and growth effects.

3.5 Conclusion

So far, empirical literature on saving has been scattered without offering constructive policy prescriptions, since most research pays attention only to the growth impact of saving and argues in favor of saving-promotion policy designs (e.g., Qian 1988; Loayza et al. 2000). In the past decade, however, the prevailing notion of “saving glut” has raised numerous questions (e.g., Bernanke, 2005). There is a renewed interest among policymakers to better understand saving behaviors and policy implications.

After identifying the overaccumulation status of China, we employ rigorous econometric methods (the GMM estimator) and complete official datasets to examine the determinants of Chinese household savings. This study goes beyond the conventional doctrine that “saving is mostly good” to search for imperative policy prescriptions to curb the current problem of excess saving in China.

This study contributes to the literature in three aspects. First, we confirm a part of important empirical regularities. For instance, the traditional concept of “son preference” is more entrenched in rural China; the rural-urban migration has significantly attenuated the overaccumulation problem; the SOE reform has largely stimulated the saving accumulation in urban regions.

Second, we present novel evidence on saving behaviors. For example, urban and rural residents in China have identical saving inertia, which is relatively small by international standards; this evidence indicates that saving persistence is not responsible for the excess saving in China, nor has it contributed to the discrepancy in urban-rural saving accumulation; rural households tend to

save a large proportion of transfer income, probably due to the Ricardian effect.

Third, we locate the causes of the overaccumulation in China. According to the results, factors that are commonly regarded as beneficial to economic development (e.g., education reform, expansion in bank lending, SOE reform, and income growth) have actually aggravated the problem of excess saving. On the other hand, those ordinarily deemed to be negative factors (e.g., population policies, real estate bubble, expansion in public investment, and the phenomenon of “Rural Hollowing”) have essentially attenuated the surplus saving and served as remedies for the overaccumulation problem.

Although these insights might seem counterintuitive, the key message conveyed in this study is simple: in the past decades, China has achieved substantial economic success through capital-extensive growth models, which rely critically on saving accumulation. However, the capital-extensive growth pattern is pathological and unsustainable since economic growth is achieved at the expense of market efficiency and welfare gains. It will be mostly harmless for Chinese economy to rebalance its growth model and create a more consumption-oriented environment.

The above findings have well reflected the ambiguity in the saving literature and warned of the danger of neglecting the analytical stance in empirical research. This study provides a number of suggestive insights that might be helpful to supplement and reconcile the diverse findings of recent studies. We are looking forward to further explore the topic in future research.

Chapter 4

The resilience of saving behaviors: the case of 2008 Sichuan earthquake*

4.1 Introduction

The economic impact of natural disasters has been attracting considerable attention in the past decade. The ongoing debate centers on how and whether natural catastrophes affect economic growth, whereas no consensus has been reached. Economic theories predict that the growth effects of natural events can be distinct in directions (positive, negative, and neutral) and magnitudes, both in the short and long terms.³⁶ On the other hand, the empirical literature has highlighted diverse insights as well. Early studies reveal the positive correlation between economic growth and the frequency and magnitude of moderate disasters (Albala-Bertrand, 1993; Tol and Leek, 1999; Skidmore and Toya, 2002), while recent studies discover that natural catastrophes lead to negative economic consequences in the short term, especially for underdeveloped countries (Vigdor, 2008; Noy, 2009; Coffman and Noy, 2012; Strobl, 2012). There is also ample evidence indicating the mixed growth impact of natural disasters, for which the overall outcome would depend on the

³⁶ For instance, in the traditional neoclassical models, natural disasters cause only capital losses thus technological progress remains intact. Accordingly, the shock spurts short-term growth but has a neutral long-term effect (in the steady state). On the other hand, endogenous growth theories generally contend that destruction will lead to a permanent growth slowdown, resulting in a deviation from the equilibrium growth path (which can translate into a sluggish growth and even a poverty trap). Furthermore, the “creative destruction” and “build back better” hypotheses suggest that destruction can boost replacement, construction, and innovation, which might foster greater growth and probably a better economic potential in the event aftermath (Aghion and Howitt, 1990; Caballero and Hammour, 1991).

features of disasters (type, intensity, and spatial extent), geographical conditions, and national characteristics (Toya and Skidmore, 2007; Loayza et al., 2009; Noy and Vu, 2010; Cavallo et al., 2013).

Research on disaster impact has long been preoccupied with the growth effect, whereas the characterization of aggregate growth barely provides complete answers. It seems desirable to take a further look into the mechanisms and channels through which the growth effect is formed. In this study, the authors attempt to identify the disaster impact on household saving—a critical and decisive determinant of economic growth. This analytical angle applies very well to the case of the 2008 Sichuan earthquake, as China’s economic development is largely driven by the capital-intensive investment pattern fueled by its extraordinarily high household saving rates.

Saving behavior is a central topic in economics. The common belief on the subject is that people tend to be conservative and save more in the wake of natural disasters, or that victims might become self-indulgent and consume more instead of saving (also due to the “Charity hazard”). In this study, in order to extend the empirical knowledge of saving behaviors, the authors employ the synthetic control method of Abadie et al. (2003) to estimate the short- and long-term effects of the 2008 Sichuan earthquake on household saving. According to the results, the earthquake has caused substantial declines in Sichuan’s household saving rates—from 24% to 7% for the rural population and from 23% to 21% for the urban population—as the manifestation of direct economic losses from the disaster. However, both the rural and urban saving rates have rebounded to the “counterfactual” levels shortly after the slump. Accordingly, the earthquake has resulted in short-

term adverse effects but has no perceivable long-term effect on saving propensity. This finding is confirmed by a “placebo test” and a series of robustness checks employing alternative predictors.

The structure of this study is as follows. Section 4.2 reviews related literature and summarizes the mechanisms of disaster impact. Section 4.3 gives a brief overview of the 2008 Sichuan earthquake; what follows covers the introduction of empirical strategy, data source, and variable definition. Section 4.4 presents the estimates, placebo test, and robustness checks. Section 4.5 closes the study with concluding remarks and implications.

4.2 Natural disasters and saving behaviors

Disaster impact on saving behaviors has seldom been explicitly examined so far. As a notable exception, Japan—as a disaster-prone country—has offered numerous valuable studies and fairly rich data sources on the topic of household decisions against natural events. In a literature survey, Horioka (1990) mentions that the high frequency and enormous damages of natural events occurring in Japan have contributed to its high saving persistence in the postwar periods. To the best of our knowledge, Skidmore (2001) is the first empirical attempt in English academic circles to look into the correlation between disasters and saving accumulation. Employing a cross-country estimation based on a sample of 14 developed nations, the analyst finds that disaster loss is positively correlated with household saving rate, in support of the precautionary saving hypothesis. In a subsequent study (Skidmore and Toya, 2002), the authors reveal a growth impact of climatic disasters on national capital accumulation. In a similar vein, Leiter et al. (2009) estimate that firms that were flood victims in Europe tend to pursue a higher growth in asset accumulation.

On the other hand, recent empirical studies have presented different insights. Dercon (2004) discovers that rainfall shocks have significantly stimulated the consumption of rural residents in Ethiopia. Sawada and Shimizutani (2008) investigate how local residents insured themselves against the 1995 Kobe earthquake. Their analysis indicates that homeowners have dis-saved and borrowed extensively after the shock, implying that the formal and informal insurance systems were essentially ineffective and that the complete risk-sharing hypothesis can be rejected. Gignoux

and Menéndez (2016) find that individuals who have experienced short-term economic losses from the Indonesian earthquakes, recovered in the medium-run, and even exhibited welfare gains (consumption growth) in the long term. Berlemann et al. (2015) study the effect of the 2002 European flood on saving behaviors. They conclude that mostly owing to the generous government compensation, the flood turns out to have depressed the victims' motive to save. Their finding lends support to the much-debated hypotheses of "Samaritan's Dilemma" and "Charity hazard." In a study similar to the present one, Filipinski et al. (2015) investigate the impact of the 2008 Sichuan earthquake on consumer behaviors. They find that households who lived closer to the epicenter, tend to save less, spend more on alcohol and cigarettes, and pursue more leisure activities after the shock.

The existing literature has provided diverse evidence concerning the disaster impact on saving behaviors, yet the sign and magnitude of the overall effect remain ambiguous. To be clear, the disaster impact is a multi-dimensional issue that is rather complicated to quantify, since the destructive nature of disasters not only generates economic costs but also triggers changes in consumer behaviors and influences people's attitude towards the future³⁷. Matters are aggravated when it comes to empirical assessments because the statistical inference will be disturbed to a

³⁷ Saving propensity generally increases with risk aversion (attitude towards risk) and decreases with time preference (the strategy to "discount" future outcomes). In behavioral economics, there is ample evidence suggesting that individuals respond to natural disasters by becoming more risk averse towards uncertainty (e.g., Van Den Berg et al., 2009; Cameron and Shah, 2015; Cassar et al., 2017). However, some support the contrary, that disaster victims tend to be risk tolerant and reckless, gamble more, and spend more on consumer goods (e.g., Eckel et al., 2009; Li et al., 2011; Page et al., 2014; Hanaoka et al., 2015; Filipinski et al., 2015). In the context of time preference, Callen (2015) argues that consumers become less impatient after catastrophic events, whereas Cassar et al. (2017) advocate the opposite. Beyond economics, the impact known as post-traumatic stress disorder (PTSD) has been exclusively studied in medical fields with a consensus that extreme shocks usually depress saving motives.

certain extent by the existing transfer mechanisms (e.g., disaster relief and donations). Here we briefly summarize the mechanisms and channels through which saving behavior is potentially driven.

First, natural disasters cause direct physical destruction. Households exposed to natural events confront the increases in expenditures (e.g., home, contents, and medical services). That is, those severely affected might have required available resources to cope with the adverse consequences, and they might encounter a higher risk of unemployment and negative income shocks (Vigdor, 2007; Deryugina et al., 2014). In this sense, individuals usually earn less and expend more after the event. In the short-run, the “volume effect” of natural disasters (e.g., destruction, income loss, losses of domestic and foreign investments) can lead to higher consumption and lower saving both in household and aggregate levels.

Second, through rational expectation, natural events influence the preference and behavioral responses of victims, which in turn induce a reallocation of time resources (Eckel et al., 2009; Cameron and Shah, 2015; Cassar et al., 2017). In summary, there are roughly two kinds of uncertainties that exogenous shocks might bring about. One concerns uncertainty on future earnings, the other one concerns uncertainty on life expectancy. (1) After the 2008 earthquake, there was widespread awareness that Sichuan is located in the vicinity of dense faults, making it particularly vulnerable and susceptible to seismic activity. Saving is regarded as a tool to smooth the life-time consumption. To fend off the potential property damage, unemployment, and income loss, individuals living in disaster-prone regions react to the corresponding uncertainty by saving and other methods of self-insurance. (2) On the other hand, in the context of extreme natural

catastrophes that can cause a large number of casualties and human toll, rational agents might anticipate an increase in mortality and thus a decrease in their life expectancy. They will update their evaluation of the future by adjusting their time preferences, all of which in turn shape the patterns of consumption and saving³⁸. In this case, extreme events are likely to cause a concentration on consumption other than on saving accumulation in the long-run. In summary, effects of risk perception offset each other. One promotes savings in preparation for potential economic losses, and the other one reduces savings in response to the perceived lower life expectancy. It is unclear how these effects would balance out on net.

Third, the follow-on saving behaviors rely crucially on the objective factors. For instance, disaster consequences are often less severe in nations with higher insurance penetration, better institutions, greater openness, and better economic status (Kunreuther, 1996; Toya and Skidmore, 2007). In fact, private insurance usually does a poor job in the face of severe natural events, even in advanced economies with high take-up rates of insurance³⁹. On the other side, in the wake of natural disasters, external elements—such as government compensation, disaster relief, adaptation policies, external aid, private donations, and transfers—have proven profound influences on consumer behaviors (Raschky and Weck-Hannemann, 2007; Cavallo et al., 2013; Berlemann et al., 2015; Gignoux and Menéndez, 2016). These factors have no doubt helped to relieve the direct

³⁸ As a typical example, Kinugasa and Mason (2007) theoretically and empirically study the effect of changing mortality on national saving rates.

³⁹ See Skidmore and Toya (2001) for a comprehensive survey of the insufficiency of private insurance against extreme catastrophic events. See Sawada and Shimizutani (2008) and Horwich (2000) for the performance of Japanese self-insurance mechanisms in coping with the 1995 Kobe earthquake.

disaster consequences, but will more or less blunt the statistical inference derived from empirical assessments.

Theoretical models and previous findings will only take us so far. To sum up, natural disasters generally have negative impacts on savings in the short run, whereas the long-term impact remains unclear due to the interaction of different mechanisms. There is an urgent need to extend the empirical knowledge of the overall disaster impact on saving behaviors. In the current study, the authors pay careful attention to the validity of empirical strategies and focus on assessing the extent and direction of long-term disaster impacts.

4.3 Background, empirical strategy, and data

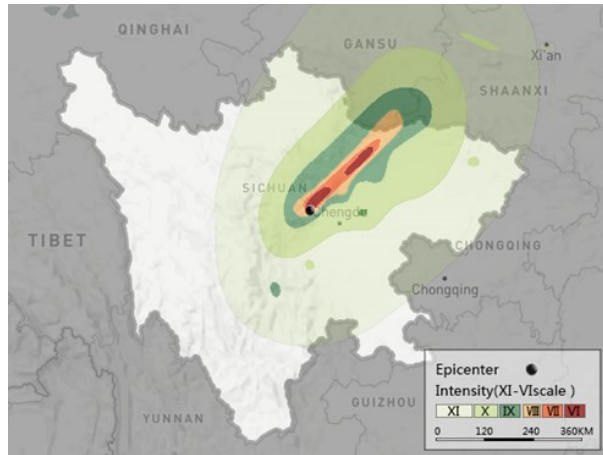
4.3.1 2008 Sichuan earthquake

On May 12, 2008, an earthquake measuring 8.0 on the Richter scale hit the Sichuan province of China (see Figure 4.1). The earthquake is recorded as one of the strongest natural disasters in human history, resulting in 69,268 deaths, 17,923 persons listed as missing, 374,643 injured, 5 million homeless, and 46 million people affected⁴⁰. The direct economic loss is estimated at over US\$ 120 billion, of which 27.4% was for housing destructions, 20.4% for non-residential destructions, and 21.9% for infrastructure damages. Sichuan province constituted 99% of the overall human toll and 91.3% of the total economic losses from the catastrophe (Gansu province represented 5.8%, and the Shaanxi province 2.8%)⁴¹. The earthquake was felt even by people living 2,000 km away from the epicenter. Between May 12 and June 23, the mainshock was followed by hundreds of aftershocks, five of which reached the magnitude of MS 6.0. In April 2013, another severe earthquake of 7.0 on the Richter scale—also believed one of the aftershocks of the 2008 mainshock—took place in Ya'an city, western Sichuan.

⁴⁰ Borrowing the definition from EM-DAT (Emergency Events Database), “affected” denotes the people in need of immediate assistance during the post-event emergency period.

⁴¹ The indicators in subsection 4.3.1 are directly taken from official figures available in the publications of the National Bureau of Statistics and the National disaster reduction and management council of China.

Figure 4.1: the 2008 Sichuan earthquake



Source: From the National disaster reduction and management council of China.

4.3.2 Empirical strategy

In the following parts, utilizing the earthquake as a natural experiment, we pursue a comparative event study to assess the disaster impact on household saving. Existing empirical literature on the subject tends to be limited in several aspects: First, most studies are oriented to assessing only the short-run effect. As the previous discussion underscores, direct economic costs from natural disasters usually lead to higher household expenditures, unemployment, and income fluctuations. In this sense, the effect is most likely to be identified as negative—an unfruitful inference—as the cross-section and short-panel estimations and micro-based analyses have done so far, yet the medium- and long-term impact remains vague and inconclusive. Second, conventional regression approaches pivot critically on the model-dependent extrapolation; these methods provide a weak safeguard against erroneous statistical inference and thus might jeopardize the transparency and honesty of the estimates (Cavallo et al., 2013; Abadie et al., 2015). Third,

most literature does not fully address the endogeneity concern. On one side, it is apparent that economic indicators—such as disaster losses and fatalities, which are correlated with economic characteristics (the outcome variables), cannot serve as a proper proxy for disaster occurrence. Further, there is a growing literature on disaster vulnerability considering disaster impacts as dependent variables, rather than explanatory variables. On the other side, as Kousky (2014) has suggested, incorporating disaster occurrence or frequency would not satisfy the endogeneity considerations as well, due to the inclusion criteria of databases, by which disaster occurrences in advanced economies are often under-reported. Accordingly, to utilize a natural disaster as a controlled experiment, the most harmless choice seems to be employing particular instrument variables (e.g., a time dummy variable and physical indexes). Fourth, in comparative case studies based on panel data, it is vital to control for time trends and the heterogeneity problem⁴². Inferential techniques like the traditional DID framework (difference-in-difference) might generate bias since the unobserved factors are generally not properly accounted for, and this is exactly the challenge in studying the dynamics of Chinese household behaviors⁴³.

We contribute to the literature by employing the methodological innovation formalized in Abadie et al. (2003, 2010, 2015), which is immune to the above limitations. The core concept of the methodology is to construct a comparable counterfactual scenario that demonstrates what the

⁴² In Abadie et al. (2010, 2015), the authors prove that when the length of pre-intervention periods is sufficient, the synthetic control method controls for the un-observed effects and mitigates the heterogeneity problem. The rationale is simple: only units that resemble in both the observed and unobserved characteristics *over sizable periods* are able to precisely produce the “counterfactual” estimates.

⁴³ Household saving rates of China vary over time and across space. Official statistics indicate that the average saving rate of rural households by prefecture has been declining from 45% to 18%, whereas its urban counterpart has been rising from 18% to 30% in the past 20 years, demonstrated by the descriptive statistics (Table 4.1). To address the problem, the synthetic control method allows the unobserved effects to vary with time, rather than holding them constant in time as fixed effects.

outcome trajectory the affected group would have experienced in the absence of the specific event of interest. The synthetic control method does not rely on statistical extrapolation; instead, it produces a reasonable “donor pool” in a data-driven manner by incorporating control groups comprised of unaffected units. The comparability of the treated group to the control group—supported by the visible similarities between the groups prior to the shock—facilitates us in displaying more explicit pictures and more accurate estimates of the disaster impact. Accordingly, the causal effect can be derived from the comparison between the actual trajectory we observed and its counterfactual counterpart.

Following the enlightening works by Abadie et al. (2003, 2010, 2015), the part below briefly illustrates the theoretical underpinnings of the synthetic control method, combined with the case to be investigated in the study. Assume that there is a number of $J+1$ districts, and the first district ($j=1$) is exposed to a specific event, whereas others are not. The first district ($j=1$) is the “treated unit,” and the remaining J districts serve as the potential “donor pool.” Let $S_{i,t}$ be the recorded value of the outcome variable, or we can name it as the saving rate. The earthquake occurred in 2008; thus, the pre-intervention period covers the initial year to 2007— k years in total.

Let $A_{1,t} = S_{1,t} - CS_{1,t}$ be the causal effect of the earthquake on the saving rate, where $S_{1,t}$ is the observed saving rate in district 1 (Sichuan province) at time t , $CS_{1,t}$ is the predicted counterfactual saving rate in district 1 at time t . As Abadie et al. (2015) put it, “*a combination of comparison units often does a better job of reproducing the characteristics of the treated unit than any single comparison unit alone or an equally weighted combination of several control units.*”

The strategy is to make explicit the contribution of each comparison unit to the counterfactual

outcome, with proper weights that sum to unity⁴⁴. This enables us to focus more on the similarity and divergence between the treated and control groups, which helps to cautiously select comparison units in order to reduce bias and discretion in observational case studies.

The method considers a $J \times 1$ vector W of weights, and each particular vector W represents a potential synthetic control, that is, a specific weighted average of control units. In general, the optimal vector W is chosen to minimize $\|X_1 - X_{other}W\|_V = \sqrt{(X_1 - X_{other}W)'V(X_1 - X_{other}W)}$ ⁴⁵, where X_1 is the $k \times 1$ vector of the observed pre-intervention characteristics (in the study, these can be the saving rate and its determinants) of the treated unit over k years. X_{other} is a $(k \times j)$ matrix of the same variables in the comparison units (J units in total). The method gauges whether the characteristics of the treated unit are efficiently matched by those of the synthetic controls. In other words, the synthetic control method is intended to employ a systematic algorithm—in common with the conventional least-squares estimation—to derive the optimal weights by which the comparison units best resemble the treated one.

Notice that there are two matrices to be solved: The algorithm-derived weights W , and the $K \times K$ positive semidefinite matrix V —meant to sketch the relative importance of each predictor⁴⁶. The choice of V influences the mean-square error of the estimators, but the estimated results are

⁴⁴ That is, $w_2 + w_3 + \dots + w_{j+1} = 1$, with $0 \leq w_j \leq 1$, where $j = 2, 3 \dots j + 1$.

⁴⁵ The process is to minimize the Euclidean distance between the pre-event values of the treated unit and those of its synthetic version. The equation can also be written as $\sum_{k=1}^k v_k (X_{1,k} - X_{other,k} W)^2$, where $X_{1,k}$ is the recorded value of the k -th variable for the treated unit; $X_{other,k}$ is the recorded values of the k -th variable for the comparison units. In this regard, $X_{other,k} W$ is the predicted value of k -th variable for the treated unit as the weighted average of the variables in the control units.

⁴⁶ Variables with a larger explanatory power in predicting the outcome variable can be assigned larger weights.

generally robust to different approaches for choosing V ⁴⁷. For instance, it can be subjectively assessed under scrutiny, or it can be derived from cross-validation (Abadie et al., 2015) by “nested” optimization (Kaul et al., 2015), or by regression approaches (Bohn et al., 2014). A common practice is to select the optimal matrix V among all positive and diagonal matrices that minimize the mean-square error of the synthetic control estimators over the pre-intervention period. Once the matrix V is obtained, the vector W becomes derivable; then, the causal effect can be assessed as $A_{1,t} = S_{1,t} - \sum_{j=2}^{j+1} w_j S_{j,t}$, for the treated unit at time t in the post-intervention period.

Although the synthetic control method has never put the long debate on “the best overall approach” to rest, there does appear to exist a consensus among academicians that this method offers superiorities over other approaches in many ways (Saunders et al., 2015; Gobillon and Magnac, 2016; Athey and Imbens, 2017; Gardeazabal and Vega-Bayo, 2017). The methodology is deemed to be a bridge—which is theoretically sound as well as empirically feasible—between quantitative and qualitative approaches in comparative case studies, and its application is becoming increasingly popular in diverse research topics⁴⁸.

⁴⁷ For a detailed discussion on different procedures for computing “ V ,” see Abadie et al. (2003, 2010, 2015), Kaul et al. (2015), and Klößner et al. (2017).

⁴⁸ The interested reader can consult Kaul et al. (2015) for a comprehensive survey of the empirical applications of the synthetic control method.

4.3.3 Data and variables

The research purpose is to capture the short- and long-term effects of the 2008 Sichuan earthquake on household saving. The analysis will focus primarily on the rural household saving rate for several considerations. First, the epicenter (Wenchuan County) is located in rural districts surrounded by dozens of other villages, which subsequently became the worst devastated regions. According to the official statistics and anecdotal evidence, mountainous and underdeveloped areas in Sichuan province suffered the most in terms of both economic losses and casualties during the shock. Second, due to the lack of insurance systems as well as the fluctuation in agricultural income, rural residents rely more on household saving as a self-insurance mechanism and have a greater need for precautionary saving. On the other hand, urban residents have highly subsidized social securities and alternative financial approaches, which makes it challenging to capture the disaster impact only by specifying the disaster impact on urban household saving. The rural saving rate suits the research purpose better in assessing the precautionary motive as well as the adverse impact of the earthquake.

The outcome variable of interest, household saving rate, is calculated in a traditional manner as the average ratio of household savings to household disposable income by prefecture. The estimation also includes several standard determinants of saving behaviors as predictors (i.e., the contents in matrix X), including the share of housing and education expenditures, sex ratio (the ratio of males to females), transfer income ratio (share of inter-family and government transfers in total disposable income), level (logged) and growth rate of disposable income, bank lending

(proportion of total bank lending in prefectural nominal GDP), and the lag terms of the outcome variable.⁴⁹ These variables are selected due to their outstanding explanatory power on Chinese household saving rates.⁵⁰ More importantly, control variables are needed to account for the effects of external aid and post-earthquake reconstruction (which can lead to the underestimation of the disaster impact; see section 4.2). For instance, housing expenditure is incorporated to account for housing reconstruction; transfer income accounts for victims' receipt of donation and government compensation; the level and growth of income account for the fluctuation in household income due to the earthquake.

The analysis is based on China's provincial datasets comprised of 30 units (i.e., provinces, autonomous regions, or municipalities) covering the period 1995-2015; the datasets are separate for rural, urban, and provincial economies (due to data limitation, several indicators are recorded only at the provincial level and have been employed in different parts). The datasets provide a pre-event period of 13 years (from 1995 to 2007) and an after-event period of 8 years (from 2008 to 2015). In the robustness tests, the observation period is extended to 1990 by employing alternative outcome indicators. All variables are taken and constructed directly from statistics available in the Chinese statistics yearbook, population and employment statistics yearbook, and finance and banking yearbook, published by the National Bureau of Statistics of China (see Table 4.1). The

⁴⁹ Interested readers can refer to Luo and Kinugasa (2018) for the comparison between explanatory power of different saving determinants (see Kevin Luo and Tomoko Kinugasa. *Counterintuitive facts regarding household saving in China: the saving glut*. No. 1815. 2018.)

⁵⁰ According to Kaul et al. (2015), in the application of the synthetic control method, the introduction of *all* outcome lags as separate predictors might generate bias and lead to invalid implications. For conservativeness, the estimations have incorporated less than three lags—a reasonable setting adopted in Abadie et al. (2003, 2010).

authors have also tested other potential saving predictors, such as the dependency ratio, urbanization ratio, life expectancy, inflation rate, FDI, and CPI indexes. Different model specifications have reached similar conclusions thus the results are not reported due to space limitation. In the robustness tests, the authors exploit the level and growth of cash deposits and total retail sales of consumer goods as alternative outcome indicators. Table 4.1 displays the descriptive statistics on the incorporated variables.

Table 4.1: Descriptive statistics

Variable	N	Mean	SD	Min	Max	Variation decomposition	
						Cross provinces	Over time
(Part 1: rural household saving behaviours)							
Saving	630	0.309	0.149	-0.162	0.656	39%	61%
Education	630	0.072	0.023	0.005	0.160	47%	53%
Housing	630	0.121	0.041	0.018	0.255	38%	62%
Sex-ratio	630	1.046	0.036	0.923	1.204	47%	53%
Income	630	3.576	0.304	2.945	4.366	49%	51%
Transfer	630	0.068	0.050	0.010	0.292	30%	70%
Income-G	630	0.115	0.074	-0.117	0.507	20%	80%
Investment	630	2.115	0.844	2.037	0.851	68%	32%
Bank lending	651	1.120	0.615	1.008	0.091	54%	46%
(Part 2: urban household saving behaviours)							
Saving	609	0.248	0.059	0.129	0.402	35%	65%
Education	609	0.090	0.017	0.047	0.145	37%	63%
Housing	609	0.079	0.028	0.031	0.238	21%	79%
Sex-ratio	609	1.046	0.036	0.923	1.204	50%	50%
Income	609	4.024	0.287	3.457	4.724	27%	73%
Transfer	609	0.236	0.057	0.091	0.375	45%	55%
Income-G	609	0.109	0.047	-0.023	0.313	15%	85%
Investment	630	2.115	0.844	2.037	0.851	68%	32%
Bank lending	651	1.120	0.615	1.008	0.091	54%	46%
(Part 3: robustness tests)							
Deposit (Level)	754	0.657	0.208	0.144	1.781	51%	49%
Deposit (Growth)	609	0.098	0.059	-0.268	0.645	31%	69%
Consumption	754	0.368	0.071	0.124	0.727	45%	55%
Income	754	3.455	0.383	2.633	4.366	31%	69%
Investment	630	2.115	0.844	2.037	0.851	68%	32%
Bank lending	754	1.101	0.570	0.091	4.893	60%	40%
Income-G	754	0.123	0.088	-0.173	0.635	6%	94%

Source: All variables are taken and constructed directly from statistics available in the Chinese statistics yearbook, population and employment statistics yearbook, and finance and banking yearbook, published by the National Bureau of Statistics of China.

One drawback of the dataset is that several indicators are not available for specific administrative units over particular periods. For instance, the unit “Tibet” is eliminated in the robustness tests due to the problem of missing values; Chongqing city became independent from Sichuan province in 1997 thus some figures were not recorded until 1997. Moreover, the synthetic

control group has to be constructed as a weighted average of the *unaffected* units. Accordingly, Chongqing city and Gansu province, which have also been significantly affected by the earthquake, are not likely to serve as suitable comparison units (see Figure 4.1). Accordingly, researchers need to make sure that the weights of the affected regions are sufficiently small or remove them from the donor pool.

As a primary concern, the datasets appear highly inconsistent across the observation period, due to systematic changes in statistical approaches—the revisions of China’s statistical systems in 1992, 2002, and 2012. To address this problem, one might be tempted to smooth the data trends instead of trying to retain all the time-series information. However, the inconsistency in statistical standards does not lead to biased estimates, since the revisions are in essence “exogenous shocks” that took place simultaneously. In other words, as long as the revisions lead to indiscriminate overstatements or understatements on the economic indicators, the structural processes will be eliminated through the DID procedure in the application of the SCM (to be confirmed in the next section).

4.4 Results

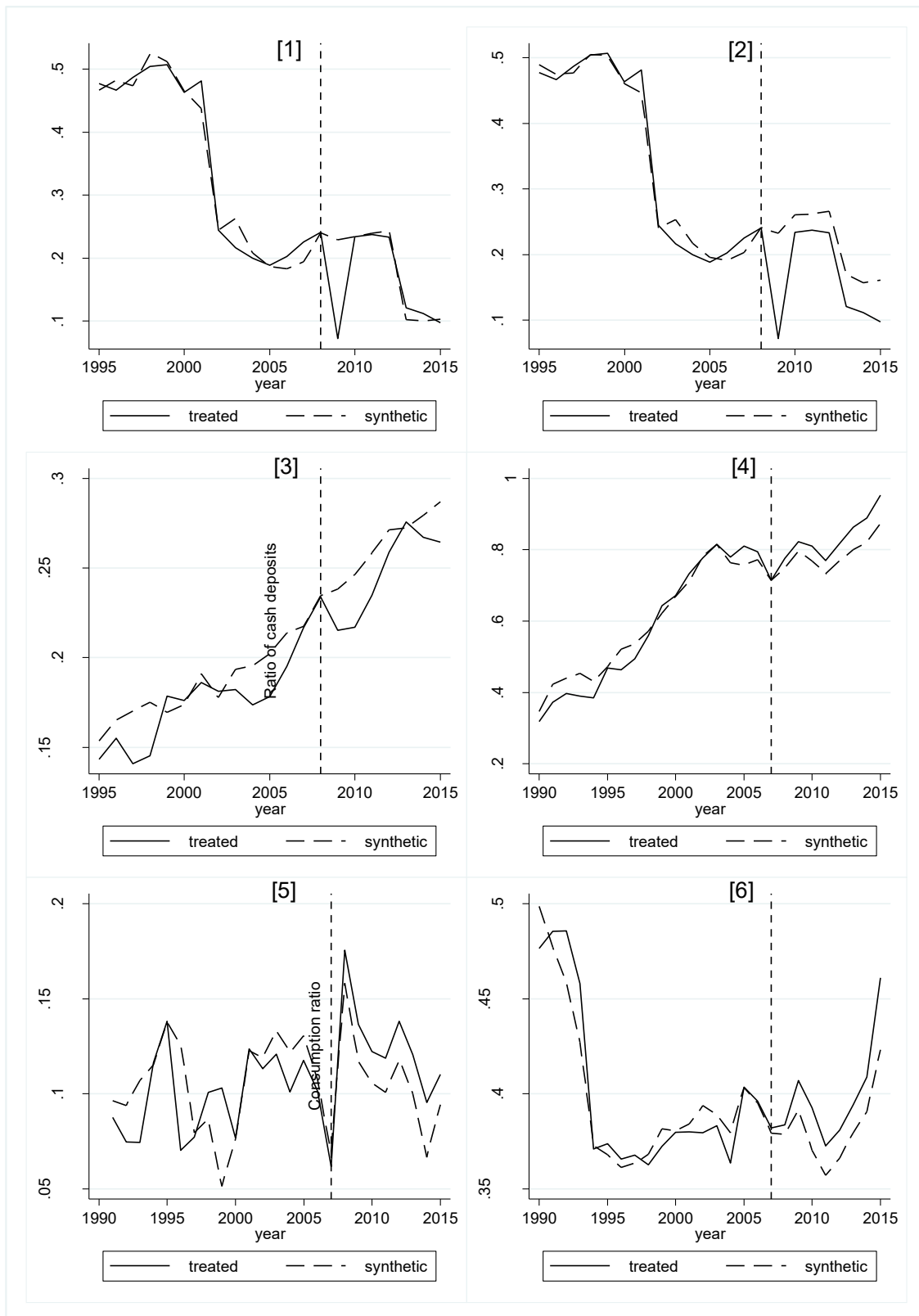
The 2008 Sichuan earthquake is one of the most economically significant disasters in human history; it is arguably the least predictable type of natural event, and it has caused grave consequences in a relatively short time. From an economic point of view, the earthquake provides a feasible natural experiment to study the otherwise unquantifiable disaster impact. To estimate the disaster impact, the authors use the synthetic control method to construct the “synthetic Sichuan” that closely reproduces the characteristics of the treated unit preceding the event. For compactness, all the obtained results are summarized in Table 4.2 and Figure 4.2.

Table 4.2: Overview of predictor means

	Sichuan province		Average of control groups
Variables	Observed	Synthetic	
<i>(Panel 1: Rural household saving rate)</i>			
Education	0.075	0.075	0.072
Housing	0.091	0.091	0.121
Sex-ratio	1.049	1.038	1.046
Income	3.315	3.323	3.576
Transfer	0.046	0.046	0.068
Income-growth	0.109	0.109	0.115
<i>(Panel 2: Rural household saving rate; controlled for external aid)</i>			
Education	0.075	0.075	0.072
Housing	0.091	0.096	0.121
Sex-ratio	1.049	1.048	1.046
Income	3.315	3.329	3.576
Transfer	0.046	0.041	0.068
Income-growth	0.109	0.107	0.115
Investment	1.875	2.115	2.165
Bank lending	0.924	0.833	1.115
<i>(Panel 3: Urban household saving rate; controlled for external aid)</i>			
Education	0.104	0.104	0.090
Housing	0.075	0.084	0.079
Sex-ratio	1.049	1.019	1.046
Income	3.804	3.865	4.024
Transfer	0.226	0.223	0.236
Income-growth	0.099	0.101	0.109
Investment	1.875	1.903	2.165
Bank lending	0.924	0.941	1.115
S(2007)	0.217	0.220	0.274
<i>(Panel 4: Ratio of cash deposits)</i>			
Income	3.158	3.170	3.455
Investment	1.886	1.923	2.165
Bank lending	0.868	0.864	1.101
Income-growth	0.115	0.115	0.123
Deposit(1995)	0.469	0.473	0.539
Deposit(2000)	0.672	0.669	0.686
Deposit(2006)	0.816	0.815	0.731
<i>(Panel 5: Ratio of growth in cash deposits)</i>			
Income	3.184	3.188	3.364
Investment	1.886	1.843	2.165
Bank lending	0.880	0.908	1.068
Income-growth	0.114	0.114	0.098
Deposits growth(1995)	0.138	0.138	0.145
Deposits growth(2000)	0.077	0.076	0.063
Deposits growth(2005)	0.124	0.123	0.093
<i>(Panel 6: Consumption ratio)</i>			
Income	3.279	3.355	3.364
Investment	1.887	2.081	2.165
Bank lending	0.928	0.917	1.068
Income-growth	0.106	0.103	0.098
Consumption(1995)	0.374	0.368	0.355
Consumption(2000)	0.380	0.381	0.368
Consumption(2006)	0.404	0.403	0.328

Note: All variables are averaged over the period 1995-2007 by prefecture and group. The last column presents the national average (excluding Sichuan) over 1995-2007. S (2007) denotes the average provincial household saving rate, and so on. The ratio of cash deposits is calculated as the proportion of total cash deposits in the annual GDP by prefecture; the ratio of deposits growth is calculated as the proportion of the growth in total cash deposits in the annual GDP by prefecture; the consumption ratio is calculated as the proportion of total retail sales of consumer goods in nominal GDP by prefecture.

Figure 4.2: Overview of model fitness



The analysis begins with the disaster impact on Sichuan's rural household saving rate. Before proceeding, it is important to scrutinize the similarity between the treated and synthetic control groups. Panel 1 in Table 4.2 demonstrates the pre-intervention characteristics of rural Sichuan, national rural average (rural Sichuan excluded), and the synthetic control group. The comparison between rural Sichuan and the national average indicates that an equally weighted combination of all the rural regions cannot serve as a proper control group for the treated unit. For instance, rural residents in Sichuan have a considerably lower share of housing expenditure and a lower proportion of transfer income than the national average.

On the other hand, the synthetic Sichuan accurately replicates the pre-event characteristics of rural Sichuan (the “inner optimization”), which verifies the validity and consistency of the synthetic control method. For instance, four predicted values of saving determinants are identical to the actual observations. The estimated weights of the control units (i.e., the vector W) show that the pre-intervention trajectory of Sichuan's rural household saving rate is best reproduced by Inner Mongolia (58.1%), Tibet (22.9%), Fujian (11.8%), and Ningxia (6.7%). These regions have not been directly exposed to the earthquake, nor have they experienced significant shocks over the post-intervention period. These features have satisfied the restrictions of the synthetic control method.

Subfigure 1 in Figure 4.2 plots Sichuan's rural household saving rate over 1995-2015 against the synthetic counterpart. The synthetic version closely tracks the actual trajectory over the

pre-event period; in particular, it matches the recorded saving rate in 2008,⁵¹ which implies a sensible approximation to the counterfactual that represents the outcome in the absence of the event (the “outer optimization”). Immediately after the earthquake, the recorded saving rate dropped noticeably from 24% to 7% within one year (a decline of 71% the saving propensity), whereas the synthetic trajectory appears to maintain the same level after the shock. The discrepancy between two trajectories indicates a pronounced negative impact on saving accumulation, due to the direct economic losses from the disaster. This finding is broadly in line with historical experience and previous evidence on the short-term saving impacts of natural disasters (e.g., Sawada and Shimizutani, 2008; Berlemann et al., 2015; Filipinski et al., 2015).

According to Subfigure 1, however, the saving rate has rapidly recovered to its synthetic state value in the second year of the catastrophe, and the outcome almost exactly matches its synthetic counterpart in the period ahead. This evidence is somewhat in support of the “target saving” hypothesis,⁵² which indicates that households tend to retain specific saving rates as a buffer stock against risk (Chamon and Prasad, 2010; Nabar, 2011). It also lends support to the prediction of traditional neoclassical models that exogenous shock is neutral to the steady-state growth, and the temporary loss would be recovered in the future. In summary, the above findings imply that the

⁵¹ In the estimation, 2008 is set as the end of the pre-intervention period because there is no significant change in the saving rate in 2008 but in 2009. Probably due to the interruption of household surveys, the statistical offices have no choice but to rely on pre-intervention observations to complete their work. In this sense, the survey data are inclined to understate the short-term disaster impact. However, the main conclusion remains intact since even the underestimated effect suffices to verify its statistical significance (to be explored below).

⁵² The “target saving” hypothesis also refers to the “habit persistence,” “habit formation,” and “stickiness of consumption” hypotheses, proposed by Modigliani, Duesenberry, and other researchers.

earthquake has not significantly influenced the long-term saving propensity of the affected population.

However, the insignificant long-run disaster impact might be due to the effect of external aid (e.g., government compensation, disaster relief, and adaptation policies). After the Sichuan earthquake and the global financial crisis in 2008, the Chinese government launched the “four-trillion-*yuan* stimulus package” on 9 November 2008, a quarter of which was allocated to the program of Sichuan post-earthquake reconstruction.⁵³ According to the official statistics, the receipt of transfer income, government investment, and bank lending in Sichuan have increased sharply after the 2008 earthquake. The emergency fiscal support might have relieved the disaster impact and led to the underestimation of the direct economic losses from the earthquake. To test this hypothesis, based on the same econometric settings, the model further incorporates the indicators of government investment and bank lending to control for the effect of external aid.⁵⁴

According to the results in Subfigure 2 and Panel 2, the synthetic control has successfully replicated the pre-event characteristics of Sichuan after controlling for external aid, which suggests the good fitness of the model. As expected, the actual trajectory is slightly below the counterfactual counterpart over the after-event period, which indicates the potential underestimation of disaster impact due to the lack of proper controls. However, the bias-adjusted estimate of the long-term

⁵³ < <http://en.ndrc.gov.cn/policyrelease/> > [10 March October]. Also see Ouyang and Peng (2015) for the short-term effects of the “four-trillion-*yuan* stimulus package.”

⁵⁴ Government investment is expressed as the ratio of public investment to financial revenue by prefecture; bank lending is expressed as the proportion of total bank lending in prefectural nominal GDP.

impact remains muted in comparison with the pronounced short-term effect. Overall, the results point towards a neutral long-term effect of the earthquake on household saving.

Are these findings empirically relevant? As supportive evidence, according to the official statistics, the growth rate of Sichuan's nominal GDP has been increasing steadily from 8.5% to 14.5% during the period 2000-2007; the growth rate then dropped to 11.0% in 2008, quickly rebounded to 14.5% in 2009, and maintained the value around 15% until 2012. Household saving accumulation has long been the primary engine behind China's economic success. The aggregate growth of Sichuan evolves in a direction consistent with its saving cycle, which displays an acute "V-shaped pattern" over the turbulent period.

Looking at the results in Figure 4.2, one might be curious about the drastic declines in the recorded saving rates and wonder whether this problem impairs the result reliability. As discussed in section 4.3, this inconsistency (triggered by the revisions of statistical systems) does not disturb the statistical inference, since the structural process is identical across space and will be eliminated in the DID process. The synthetic trajectory has adequately reflected the abnormal fluctuations over the transition periods (the revisions in 1992, 2002 and 2012).

4.4.1 Placebo test

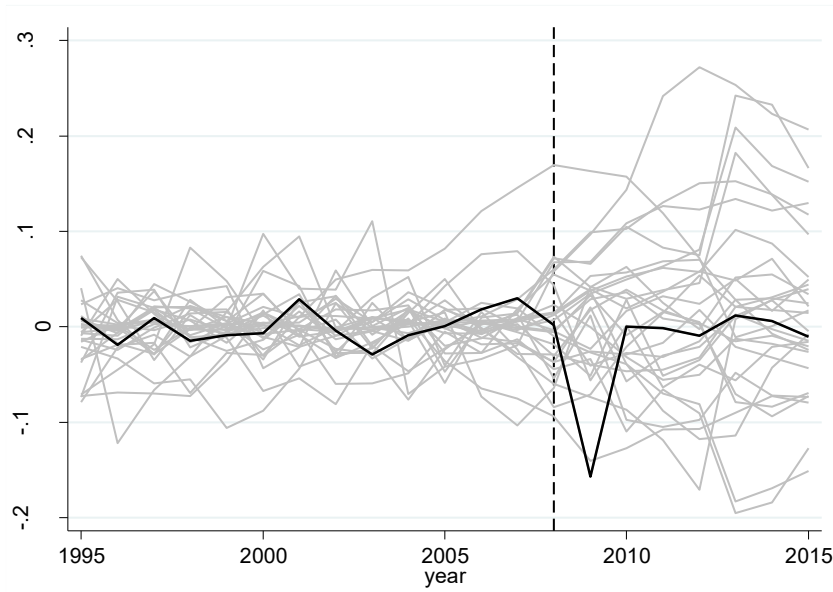
To derive the statistical significance of the estimate, the authors conduct an "in-space placebo test" frequently used in comparative case studies (e.g., Abadie et al., 2003, 2010, 2015; Bertrand et al., 2004). The strategy is to find out whether other regions (the control units) have

experienced even greater shocks relative to the treated unit, due to unclear mechanisms.⁵⁵ The placebo experiment applies the synthetic control method to every unit in the donor pool. That is, in each exercise the intervention is artificially *re-assigned* to one of the control units, with the treated unit (Sichuan) shifted to the donor pool. Figure 4.3 displays the results, in which the grey line represents the divergence between the recorded value of saving rate and its synthetic counterpart for each region; the black line is the estimate for Sichuan, the one obtained in Subfigure 1.

The divergence over the pre-intervention period can be interpreted as “prediction error” in the context of comparative case studies. If the deviation is negligible, then the synthetic control is considered to have precisely reproduced the pre-intervention outcome for the treated unit, and the divergence over the post-intervention period closely approximates the disaster impact. As Figure 4.3 makes apparent, the prediction error in the estimate for Sichuan is minor, which verifies the validity of the methodology. The slump in Sichuan’s rural household saving rate in 2009 is by far the largest one-year shock among all the estimates. Similarly, the resilience in 2010 is the most rapid recovery in the overall observations, let alone the fact that the deviations (prediction errors) in some estimates are sufficiently large before the intervention.

⁵⁵ The earthquake might have non-negligible short-term effects on the saving rates of other regions, because some of them were directly exposed, although modestly, to the event (e.g., Shaanxi and Gansu). Moreover, the adverse disaster impact might not be restricted to Sichuan and its surrounding areas, since most of the administrative units have been devoting their efforts in the post-earthquake reconstruction, which has cost enormous resources and human capital. In this regard, the estimated result might be contaminated if the affected regions are identified as the synthetic control units.

Figure 4.3: Prediction error of the SCM



Note: The numbers represent the difference between the recorded saving rate and its synthetic counterpart for each region.

The analysis follows the method proposed by Abadie et al. (2003, 2010, 2015) and Rosenbaum (2005) to obtain the statistical significance of the result. Given that the experiment has generated 29 placebo runs for control units, under the random permutation, the probability of receiving an adverse effect or a recovery effect—of the magnitude greater than those for Sichuan in 2009 and 2010—is considered to be less than 3.3% (1/30) for each instance (a sufficient significance in the statistical sense). The placebo test confirms the significant short-term effect and the negligible long-term effect identified in the benchmark analysis.

4.4.2 Robustness test

As Hayashi (1986) has proposed, in studying saving issues, the relevant concept to be considered is not only the household saving rate, but also other prominent features, reflections, and

manifestations of “saving.” To test the result robustness, the authors exploit alternative outcome variables to replace the rural household saving rate. Robustness tests help to evaluate to what extent the main conclusion is limited to particular outcome specifications. Overall, the estimated results in Table 4.2 and Figure 4.2 indicate that the main conclusion is robust to the selection of outcome indicators.⁵⁶ As the analytical angle changes from “the most affected” to “the less affected” and from “the micro” to “the macro,” the adverse disaster impact diminishes, and the estimates do not exhibit much of a long-run impact on the saving and consumption patterns.

Urban household saving rate

To test the result robustness, a basic solution is to study urban household savings as well. The authors estimate the disaster impact on Sichuan’s urban household saving rate using the same econometric settings as in subsection 4.4.1. However, it is noteworthy that urban Sichuan is remarkably different from other urban regions in many aspects. According to the official statistics, urban residents in Sichuan have the lowest household saving rate and the highest share of leisure expenditure among all the urban regions (except Tibet). Moreover, Sichuan’s urban population has long been known for its high proclivity to consumption and an epicurean lifestyle. Since the synthetic control method is designed to replicate certain outcome variables for the treated unit through exploiting available information in the control units, it is crucial to make sure that the economic indicators of the treated unit are in the middle of the convex hull derived from the control

⁵⁶ In each robustness test, placebo tests were also conducted but the results are not reported here in the interest of space, and because they will only strengthen the main conclusion that the earthquake has no long-term impact on saving accumulation.

units. However, the saving predictors for Sichuan's urban population are either in the low end or high end among the overall observations. This feature makes it rather challenging to precisely track down the saving rate since there is no combination of control units that could accurately reproduce an outlier (except by the saving rate itself or by allowing for negative weights; see footnote 44).

Panel 3 in Table 4.2 displays the similarity across the groups of urban saving indicators. As expected, the results imply that the synthetic control has not efficiently approximated the characteristics of urban Sichuan. For several variables, the discrepancy between the actual value and the synthetic scenario turns out even larger than that between the actual value and national average. Moreover, Subfigure 3 suggests that the prediction error is non-negligible. However, the results clearly point out that the urban saving rate has also declined immediately after the shock and then ascended to the synthetic state before long. The evolution of the urban saving rate has a lot in common with the findings in the rural part, in which the earthquake has significant short-term but insignificant long-term effects on household saving.

Cash deposits and consumer goods

Previous analyses have employed household saving rates as the outcome variables. In general, subjective measures of household surveys are often plagued by the problems of non-randomization, reporting bias, and sample attrition. In comparison, macroeconomic indicators are generally more reliable and can be instructive in mirroring the objective reality of saving behaviors. The following analysis looks into the disaster impacts on the saving and consumption patterns of Sichuan. For provincial economies, the gross domestic product and the cash deposits can be

interpreted as “income” and “saving,” respectively. The analysis employs two measures of provincial cash deposits ratio: the proportion of total cash deposits to annual GDP (the “stock”), and the proportion of growth in total cash deposits to annual GDP (the “flow”). The “flow” is more consistent with the conventional notion of household saving, which is a residual concept representing the income flow. In a similar vein, the consumption ratio can be measured as the proportion of total retail sales of consumer goods in nominal GDP, which captures the consumption propensity at the provincial level.

Panels 4-6 in Table 4.2 suggest that, under different outcome variables, the synthetic control units have effectively reproduced the pre-event characteristics of Sichuan, in which the discrepancy between the actual value and the synthetic version is only marginal. According to Subfigures 4 and 5, the earthquake appears to have slightly promoted the stock and flow of provincial cash deposits, inferring that the dis-saving effect was more than compensated by the growth effect at the aggregate level (see footnote 36). The net growth in cash deposits is likely a reflection of the post-earthquake reconstruction and disaster relief, in which the funds were primarily operated through the banking systems. Overall, the disaster impacts appear insignificant in consideration of the highly volatile nature of cash deposits. In Subfigure 6, again, despite a seemingly large inconsistency in the provincial consumption propensity (due to the 1992 and 2002 revisions of statistical systems), the synthetic control closely tracks the actual trajectory and perfectly matches the post-intervention trend. In summary, the results imply that the earthquake has not significantly influenced the saving and consumption patterns at the aggregate level.

4.5 Conclusion

In the current study, exploiting the synthetic control method formalized in Abadie et al. (2003, 2010, 2015), the authors estimate the short- and long-term impacts of the 2008 Sichuan earthquake on the saving behaviors of local residents. The results suggest that the earthquake has a significant short-term adverse impact on household saving rates, due to the direct economic losses from the disaster. However, the findings also reveal that the earthquake has not influenced the saving and consumption patterns of the affected population in the long run, at both the household and aggregate levels. The main conclusion is confirmed by a “placebo test” and a series of robustness tests employing alternative outcome variables and saving predictors.

The insignificant long-term disaster impact is somewhat in support of the “target saving” hypothesis that households tend to adhere to specific saving plans as a buffer stock against risk, contrary to the precautionary saving hypothesis that people will become more conservative and save more after extreme shocks. The findings also lend support to the prediction of traditional neoclassical models that exogenous shock is neutral to the steady-state growth, and the temporary disaster loss would be recovered in the future, other than a permanent growth slowdown predicted by the endogenous growth theories. Moreover, there are visible signs of saving accumulation and consumption growth at the aggregate level, consistent with the “creative destruction” and “build back better” hypotheses that destruction can boost replacement, construction, and innovation in the event aftermath.

This study explores a new angle to investigate the growth impact of natural disasters and presents suggestive evidence on the short- and long-run disaster impacts on saving behaviors. Some of the findings might be helpful to reconcile the diverse conclusions of recent studies. On the other hand, the authors would like to caution that there is only indirect evidence on the neutral disaster impact and the saving resilience to extreme shocks. Instead, it might well be that some victims suffered devastating losses whereas others moved ahead, with the overall effects canceling out on net.

More importantly, the statistical inferences can be contaminated by several aforementioned mechanisms, and the quick recovery in saving rates might be attributable to the generous disaster relief as a combination of government compensation, external aid, and income transfers.⁵⁷ The saving resilience also indicates the necessity for household precautionary saving, which points towards the underdevelopment of insurance mechanisms in China's rural regions. It is also likely that Sichuan has experienced rapid transitions in industrial and population structures after the earthquake, which contaminates the assessment of disaster impacts. Overall, perhaps the most important concern in this regard is the unprecedented scale of charitable donations as well as the immediate emergency responses by the Chinese governments at all costs, irrespective of ideology and affiliation. The warm-hearted and cool-headed assistance has unquestionably succeeded in lessening the adverse impacts of the earthquake.

⁵⁷ The interested reader can refer to the literature concerning the effectiveness of insurance markets and government compensation in coping with natural events (such as Raschky and Weck-Hannemann, 2007; Berlemann et al., 2015; Gignoux and Menéndez, 2016). This line of research presents comprehensive background surveys that help to draw an initial impression on the mechanisms of disaster relief in real-world economies.

In the current study, the estimations have controlled for the potential downward bias and ruled out the confounding effects such as income fluctuation, enlarging housing expenses, receipt of income transfers, and the expansion in government investment and bank lending. However, due to the data limitation, drawing a definitive conclusion on the subject is beyond the scope of this study. The authors are looking forward to further exploration of the topic.

Chapter 5

Conclusion

This study aims to detect the status of overaccumulation, look into the impact of overaccumulation, reveal the determinants of overaccumulation, and investigate the pattern of overaccumulation. In Chapter 2, we apply, examine, and improve the AMSZ (1989) criterion for assessing dynamic efficiency. Section 2.1 briefly reviews the theoretical background and previous literature on the subject of dynamic efficiency. In section 2.2, employing the largest dataset assembled to date, we estimate dynamic efficiency for major economies based on the cash-flow criterion. The estimated results show that the nations exhibit a similar “U-shaped order” in their evolution of capital accumulation; that is, in the early stage, dynamic efficiency swings from high-to-low, holds for some time, then rebounds from low-to-high in the late stage of capital accumulation.

In section 2.3, we provide a summary of the literature concerning empirical biases in conducting the criterion, followed by the presentation of bias-corrected estimates. Contrary to AMSZ (1989), the results imply that France, the US, and Japan have not been consistently dynamically efficient, especially in their early phases of capital accumulation and during the golden periods of economic development. It is important to note that the adjustments made to the estimates are empirically relevant, and we took no extreme stance in the computation. The following analysis suggests that China today is, at any rate, in a severe state of dynamic inefficiency. The level of excess capital is exceptionally high, and there is an apparent downward trend that infers an

efficiency deterioration in the future. We further demonstrate the superiorities of the efficiency criteria over conventional methods in studying the subject of capital accumulation.

Last but not least, we look into unsolved data problems and the theoretical limitations of AMSZ (1989) (see the Appendix). We argue that the shortcomings do not devalue its versatility, and the advantages of the approach vastly exceed its limitations. We look forward to breakthroughs in the efficiency criterion and the improvement of statistical methods. This research explores a brand-new angle for investigating the evolution of capital accumulation worldwide; some of our findings might be helpful to reconcile the diverse conclusions of recent studies.

In Chapter 3, employing a superior econometric method (the GMM estimator) based on the most complete dataset assembled to date, this study goes beyond the conventional doctrine that “saving is mostly good” to provide imperative policy measures to curb saving and lift consumption for the overaccumulated economy. This study contributes to the literature in three aspects. First, we confirm a part of important empirical regularities. For instance, the traditional concept of “son preference” is more entrenched in rural China; the rural-urban migration has significantly attenuated the overaccumulation problem; the SOE reform has largely stimulated the saving accumulation in urban regions.

Second, we present novel evidence on saving behaviors. For example, urban and rural residents in China have identical saving inertia, which is relatively small by international standards; this evidence indicates that saving persistence is not responsible for the excess saving in China, nor has it contributed to the discrepancy in urban-rural saving accumulation; rural households tend to save a large proportion of transfer income, probably due to the Ricardian effect.

Third, we locate the causes of the overaccumulation in China. According to the results, factors that are commonly regarded as beneficial to economic development (e.g., education reform, expansion in bank lending, SOE reform, and income growth) have actually aggravated the problem of excess saving. On the other hand, those ordinarily deemed to be negative factors (e.g., population policies, real estate bubble, expansion in public investment, and the phenomenon of “Rural Hollowing”) have essentially attenuated the surplus saving and served as remedies for the overaccumulation problem. These findings well reflect the ambiguity in the literature to date and warn of the danger of overlooking the objective reality and analytical stance in diverse research topics. This study provides a number of suggestive insights that might be helpful to supplement the existing literature and reconcile the diverse conclusions of recent studies.

In Chapter 4, exploiting the synthetic control method formalized in Abadie et al. (2003, 2010, 2015), we estimate the impact of the 2008 Sichuan earthquake on the saving behaviors of the local residents. The findings suggest that the earthquake has a significant short-term adverse impact on household saving rates, as a reflection of the direct economic losses from the event. However, contrary to the popular belief that people will become more conservative and save more after extreme shocks or that they might abandon themselves with irrational consumption, we reveal that the earthquake has not influenced the patterns of saving and consumption of the affected population in the long-run. The main conclusion is confirmed by a “placebo test,” and the inference is proven robust across a series of experiments employing alternative outcome predictors and explanatory variables. This study explores a brand new angle to investigate the growth impact of natural disasters; it presents new evidence on the short- and long-run disaster effects on saving behaviors.

Although these insights might seem counterintuitive, the key message conveyed in this study is simple: in the past decades, China and other developing economies have achieved substantial economic success through capital-extensive growth models, which rely critically on saving accumulation. However, the capital-extensive growth pattern is pathological and unsustainable since economic growth is achieved at the expense of market efficiency and welfare gains. It will be mostly harmless for overaccumulated economies, especially China, to rebalance their growth model and create a more consumption-oriented environment.

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Appendix

A.1 Unresolved statistical biases

Except for the statistical biases discussed in section 2.3, some causes of biases are of significant importance in the application of efficiency criteria but remain unresolved due to the limitation of statistical systems.

1. **Bias related to monopoly rents:** As noted, the AMSZ criterion pivots on the assumption of perfectly competitive markets, in which capital always obtains its marginal returns. In the real world, there are monopoly rents, decreasing returns, market failures, and other distortions. These factors indicate the potential upward bias in measuring real capital returns. For this problem, Tobin's q (Tobin, 1969)—the ratio of firm's market value to its book value—can be useful in assessing the degree of monopoly rents⁵⁸. Numerous studies suggest that the aggregate-level Tobin's q is greater than unity, which manifests the objective existence of monopoly rents and market distortions in today's world. However, since market ineffectiveness is a complicated multi-dimensional issue that is unlikely to be quantified by any single unidimensional index (e.g., Tobin's q), further research is needed before we can account for the monopoly bias in efficiency estimates.

2. **Bias related to capital formation and time adjustment:** In assessing dynamic efficiency, gross capital formation represents immediately available capital ("productive capital") in the production sector, including vantage capital and other crucial components. In this sense, the

⁵⁸ Geerolf (2013) has made explicit attempts to correct for the monopoly bias by referring to the estimated values of Tobin's q .

assumption of full depreciation adopted in AMSZ (1989) is empirically irrelevant, and the problem will be aggravated in empirical assessments due to the rough measurement of capital depreciation in statistical systems. Moreover, there is ample evidence indicating the time adjustment and gestation period of capital formation (e.g., Anderson, 1993; Fakin, 1998). In other words, it takes time for the formed capital to be “operative,” which causes a time asymmetry between the recorded and actual capital formation. Accordingly, the year-by-year approach tends to underestimate the efficiency level for economies where the production sector is expanding. On the other hand, immature statistical systems tend to overstate capital formation due to artificial errors⁵⁹. In summary, the upward bias in measuring capital formation can lead to underestimated efficiency levels, especially in the case of emerging economies.

3. Bias related to informal services and tax evasion: The current statistical systems have difficulty in separating informal financial services and intermediations from capital investment. These hard-to-quantify labor income generally accounts for 2%-5% of GDP (Bullard and Russell, 1999; Geerolf, 2013; Piketty, 2014), which could lead to non-negligible upward bias in efficiency estimates. On the other hand, tax evasion and wealth concealment have become significant socio-economic issues in recent years⁶⁰. Zucman (2013) reveals that in 2010 about 8% of global private capital, mostly owned by Europeans and Americans, was held in “tax havens.” The “missing

⁵⁹ According to Xu (2008), statistical systems in China tend to record the capital investment of “big projects,” which are generally operated for more than five years, as capital formation in the starting year of the project. Moreover, due to the understatement of social consumption, statistical systems in China might have substantially overstated capital investment (e.g., Zhang and Zhu, 2015; Liu et al., 2016).

⁶⁰ The core concept of tax evasion is the strategy of “transfer pricing.” A prime example is “tax havens:” large multinational companies report most of their profits as earned by their subsidiaries located in the Cayman Islands (tax havens), instead of their European subsidiaries that actually produce the profits (where tax rates are higher).

income” due to tax evasion can cause downward bias in efficiency estimates, especially for advanced economies.

A.2 Theoretical limitations of AMSZ (1989)

Empirical literature has exhibited the feasibility and versatility of the AMSZ criterion in assessing dynamic efficiency. However, the long debate over “the best overall efficiency criterion” has never been settled, since neither of the AMSZ and rate-of-return criteria is immune to theoretical limitations. As a major critique, the theoretical basis of AMSZ (1989) virtually underlies a sufficient condition for (interim) Pareto optimality, for which the required assumptions seem too strong for assessing dynamic efficiency (e.g., Zilcha, 1990; Barbie et al., 2004). As a result, the AMSZ criterion is inclined to underestimate the actual efficiency⁶¹.

In addition, the AMSZ criterion is frequently challenged because it requires the net dividend to hold positive on all paths (including the future) under efficient environments, which is a demanding and unverifiable assumption. However, it is noteworthy that other efficiency criteria such as the rate-of-return criterion also confront the same limitation—the interest rate is evaluated over the “entire horizon.” The AMSZ criterion is intrinsically equivalent to many others. The only distinction is that the AMSZ criterion bases its judgment on the net dividend, while other criteria focus on marginal product and real interest rates. Overall, the critique on the definition of “future earnings” is a replay of the “Cambridge capital controversy” in the 1960s, and the question is a minor theoretical limitation rather than a reason to turn a blind eye to the advantages and versatilities of the AMSZ criterion.

⁶¹ For instance, Chattopadhyay (2008) found that dynamically efficient economies can be identified as inefficient under the AMSZ criterion.

In the literature, the lack of microeconomic basis is widely perceived as the actual limitation of the AMSZ criterion. In AMSZ (1989), the mathematical proof follows conventional methods in addressing social welfare in a typical planners' problem. An implicit utility function is employed in computing the first-order conditions, whereas the derived propositions do not rely on the conditions because all the allocations and market prices in equilibrium are *assumed* to satisfy individual constraints as well as the first-order conditions. In this sense, the AMSZ criterion does not necessarily obtain essential micro foundations, including the generality of consumer preferences, intergenerational risk sharing, and existing transfer mechanisms (Chattopadhyay, 2008; Weil, 2008; Schoonbroodt and Tertilt, 2010)⁶². Overall, the characterization of aggregate-level efficiency cannot provide complete answers. It is of equal importance to understand the efficiency implication from microeconomic perspectives.

⁶² In fact, many of the shortcomings of the AMSZ criterion (including statistical bias, theoretical limitation, and shortcomings in mathematical proof) were firstly raised by AMSZ (1989).

A.3 Descriptive statistics

Variable	N	Mean	SD	Median	Min	Max	Variation decomposition	
							Cross provinces	Over time
S	649	0.310	0.148	0.294	-0.162	0.656	35%	65%
Sexratio	640	1.046	0.035	1.045	0.923	1.204	53%	47%
Transfer	648	0.069	0.051	0.053	0.010	0.292	36%	64%
Education	649	0.071	0.023	0.071	0.005	0.160	54%	46%
Housing	649	0.120	0.041	0.117	0.018	0.255	42%	58%
Gov-inves	630	2.115	0.844	2.037	0.851	6.745	68%	32%
Urban	651	0.456	0.164	0.435	0.159	0.896	73%	27%
Lending	651	1.120	0.615	1.008	0.091	4.893	54%	46%
Income	649	3.575	0.303	3.545	2.945	4.366	44%	56%
Income-G	648	0.115	0.073	0.107	-0.117	0.507	9%	91%
(Rural sample)								
S	646	0.247	0.062	0.244	0.072	0.402	37%	63%
Sexratio	640	1.046	0.035	1.045	0.923	1.204	53%	47%
Transfer	646	0.231	0.063	0.237	0.016	0.375	53%	47%
Education	646	0.089	0.019	0.088	0.030	0.147	46%	54%
Housing	646	0.079	0.028	0.072	0.027	0.238	42%	58%
Gov-inves	630	2.115	0.844	2.037	0.851	6.745	68%	32%
Urban	651	0.456	0.164	0.435	0.159	0.896	73%	27%
Lending	651	1.120	0.615	1.008	0.091	4.893	54%	46%
Income	646	4.026	0.284	4.007	3.457	4.724	31%	69%
Income-G	643	0.108	0.047	0.104	-0.052	0.313	19%	81%
SOE	649	0.131	0.080	0.111	0.033	0.547	56%	44%
(Urban sample)								

A.4 Pairwise correlation matrix

Variable	S	S(-1)	Sexratio	Transfer	Education	Housing	Gov-inves	Urban	Lending	Income	Income-G	SOE
S	1.00											
S(-1)	0.92	1.00										
Sexratio	0.12	0.11	1.00									
Transfer	-0.51	-0.54	0.02	1.00								
Education	-0.24	-0.18	-0.09	0.10	1.00							
Housing	-0.75	-0.73	-0.07	0.54	0.06	1.00						
Gov-inves	-0.38	-0.33	0.09	0.17	-0.08	0.24	1.00					
Urban	-0.20	-0.23	-0.31	0.33	0.03	0.24	-0.39	1.00				
Lending	-0.03	-0.03	0.23	0.21	-0.03	-0.04	-0.02	0.35	1.00			
Income	-0.45	-0.48	-0.20	0.63	-0.11	0.52	-0.26	0.74	0.23	1.00		
Income-G	-0.26	-0.35	-0.06	0.16	-0.29	0.21	0.06	0.08	-0.04	0.27	1.00	
(Rural sample)												
S	1.00											
S(-1)	0.93	1.00										
Sexratio	-0.13	-0.13	1.00									
Transfer	0.16	0.17	-0.36	1.00								
Education	-0.44	-0.40	-0.11	0.08	1.00							
Housing	0.14	0.14	0.08	-0.23	-0.13	1.00						
Gov-inves	-0.08	-0.06	0.09	0.14	-0.11	0.02	1.00					
Urban	0.30	0.32	-0.31	0.30	0.04	0.19	-0.39	1.00				
Lending	0.05	0.08	0.23	0.06	0.00	0.11	-0.02	0.35	1.00			
Income	0.71	0.72	-0.15	0.16	-0.26	0.38	-0.09	0.63	0.23	1.00		
Income-G	0.23	0.15	-0.19	0.22	-0.10	-0.16	0.08	0.12	-0.05	0.19	1.00	
SOE	-0.40	-0.39	-0.02	0.02	0.13	-0.25	-0.07	0.22	0.14	-0.42	-0.05	1.00
(Urban sample)												