

BOFIT Discussion Papers
12 • 2018

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The credit risk of Chinese households
– A micro-level assessment



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BOFIT Discussion Papers
Editor-in-Chief Zuzana Fungáčová

BOFIT Discussion Papers 12/2018
7.5.2018

Michael Funke, Rongrong Sun and Linxu Zhu: The credit risk of Chinese households – A micro-level assessment

ISBN 978-952-323-229-7, online
ISSN 1456-5889, online

The views expressed in this paper are those of the authors and do not necessarily represent the views of the Bank of Finland.

Suomen Pankki
Helsinki 2018

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Abstract

Household borrowing in China has increased considerably in recent years, raising concerns about the household sector's vulnerability and implications for the stability of the financial system. We construct a number of granular debt-burden indicators at the level of individual Chinese households and calculate the share of households that are financially vulnerable using the three available waves (2011, 2013 and 2015) of China's Household Finance Survey. Overall loan-to-value (LTV) ratios appear safe and sound at first glance, but closer scrutiny reveals that Chinese households in the lowest income quintile face high vulnerability and struggle to meet their debt commitments. Our stress tests suggest that Chinese households in higher quintiles, despite the huge increase in household indebtedness, are not particularly vulnerable to declining incomes or falling house prices.

Keywords: Household debt; household financial vulnerability; financial stability.

JEL Classification: D10, D14, G21.

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1 Introduction

Concerns over rising household debt in China have intensified in recent years. Rapid urbanization and a mortgage lending boom have resulted in soaring Chinese household debt. Indeed, household debt corresponded to 46.8% of GDP in June 2017, a quadrupling from its March 2006 level.¹ The concurrence of a housing boom and climbing debt levels has led to worries that China could experience a financial meltdown similar to that of the US in 2008–2009. The US crisis was triggered by a housing market collapse on the heels of dramatic mortgage expansion.² For policymakers, the takeaway from US subprime mortgage crisis was that a household debt crisis can precipitate a large systemic financial crisis with global implications.

According to Mian and Sufi (2018) and Mian et al. (2017), household debt expansions unconditionally predict declines in real GDP growth. Household debt also foreshadows recession severity conditional on a recession. The precise mechanism involves mutual reinforcement and amplification of credit supply shocks and the household demand channel. Martin and Philippon (2017) demonstrate that household debt expansion is a precursor of economic downturns across geographical areas. In their Eurozone example, a mortgage-to-GDP ratio increase of 6.2 percentage points over three years led to a decline of 2.1 percentage points in GDP growth over the subsequent three years. More recently in China, we see the ratio mid- and long-term household loans over nominal GDP increasing from 17.5% in 2013 to 27.1% in 2016.³

Before asking whether household debt problems threaten China's economic prospects, we should ask if a blanket answer overlooks important nuances. We know, for example, that the aggregate debt-to-GDP numbers may well hide significant differences among household types. We therefore delve into the three waves of the China Household Finance Survey (CHFS) conducted in 2011, 2013 and 2015 to shed light on how Chinese micro-level household indebtedness and financial vulnerability have evolved. The CHFS aims to understand the financial choices and decisions of households, as well as their relation to household financial objectives. The CHFS, which primarily seeks to study household balance sheets, contains questions on topical policy issues unavailable from other

¹ See <https://www.ceicdata.com/en/indicator/china/household-debt--of-nominal-gdp>.

² <https://www.bloomberg.com/news/articles/2017-11-21/china-s-debt-surge-may-increase-risk-of-financial-crisis>. Many central banks and international financial institutions supplement their analyses of household debt at the macro-level with analyses of micro-level data. For more discussion of the economic growth and financial stability implications of the rise in household debt across advanced and emerging market economies in recent decades, see IMF (2017a), pp. 53-89.

³ The People's Bank of China series for mid- and long-term loans above one year include household loans for the purchase of housing, housing decoration, tourism, education and consumer durables. There are no separate data for mortgage loans.

sources. Moreover, the CHFS aspires to a deeper understanding of household finances that hopefully allows policymakers to improve market practices and develop policy.

Survey participation in the CHFS is randomized. To date, the results of three rounds of comprehensive biannual surveys have been published. Conducted as computer-assisted personal interviews, the CHFS is a cross-sectional survey, i.e. the sample of households interviewed in a given wave is not necessarily the same as that interviewed in other waves. This must be kept in mind when interpreting changes in the data and calculated key figures. The wide range of validation and plausibility checks carried out strongly suggest that the CHFS data are fit for the intended vulnerability assessment.⁴

An important advantage of examining debt on the household level is that individuals in a household often have joint responsibility for outstanding debts. Consequently, an analysis on the household level provides a more accurate picture of indebtedness than debt at the personal or community level. Additionally, analysis of household debt sustainability requires the use of micro-level data as aggregate data cannot account for differences in distributions.

Under the traditional view, household debt and access to credit help boost demand and allow households to make large investments in housing and education, as well as smooth consumption over time. Debt allows households to acquire goods and services immediately and repay gradually (often in anticipation of higher future income). By extension, higher private sector credit supports long-run economic growth. Much of the empirical literature on the finance and growth nexus (cross-country, time-series, panel data, or industry- and firm-level studies) by and large supports the existence of a positive relationship between financial market development and economic growth.

This all changed, however, with the global financial crisis. Recent empirical studies examine the *vanishing effect of financial development* (e.g. Law and Singh, 2014). These studies suggest that the positive effect of finance on economic growth is more nuanced. In particular, the relationship between financial development and growth depends on a country's *income level, policy regime and institutional quality*.

Under certain circumstances, excessive financial development actually impedes growth. This contractionary impact emerges when households borrow primarily for non-productive purposes or experience inadequate returns on their investment. Higher indebtedness can also be a source

⁴ For detailed documentation of the nationally representative China Household Finance Survey (CHFS) conducted by the Southwestern University of Finance and Economics, see the survey website <http://www.chfsdata.org>. As summarized in Gan et al. (2014), due to its *low non-response rate*, the overall representativeness of the CHFS is excellent.

of financial vulnerability and household over-borrowing may cause significant debt overhang problems when a country unexpectedly faces extreme negative shocks. At a deep level, this leads to a greater likelihood of a banking crisis. The 2008–2009 global financial crisis is a prime example of how high household debt and household defaults can trigger recessions and undermine macro-financial stability.⁵

The roadmap to the remainder of the paper is as follows. Section 2 provides a bird’s-eye view of the data. Section 3 contains our analysis of financial vulnerability of Chinese households using various measures of distress to account for the liquidity and solvency of households. We apply stress tests to analyze the impact of adverse shocks to the economy in Section 4, and thereby determine the proportion of at-risk households. Section 5 concludes with comparisons between the micro- and macro-empirical vulnerability approaches, provides a brief critical assessment on how to interpret the empirical results and gives some suggestions on avenues for further research.

2 Household characteristics and the distribution of income and debt

We first describe the household characteristics according to various socio-demographic and economic variables and the distribution of income for 2011, 2013 and 2015. The 2015 (3rd wave) data are the most recent available. The sampling design for the CHFS consists of an overall sampling scheme and an onsite sampling scheme based on mapping.

A well-known challenge for any micro-level survey is that the income distribution is highly skewed, i.e. a small fraction of the population has very high income and large asset holdings. The coverage of such households in the surveys may be incomplete as such households may be inaccessible or refuse to participate. In such case, the survey would underestimate the income of the wealthiest households. To address this issue, observations from relatively wealthy regions are over-sampled.

The CHFS project employs a stratified three-stage probability proportional to size (PPS) random sample design. The primary sampling units include counties (including county-level cities)

⁵ The classic study of financial crises by Carmen Reinhart and Ken Rogoff (2009) highlights the attractiveness of the “this time is different” argument. Systemic risk stems from a vulnerable financial system in combination with sufficiently large shocks that can crystallize this vulnerability. Even so, crisis-induced household debt defaults do not necessarily threaten sustainable growth. Debt defaults can facilitate adjustment to lower debt levels and thereby exert positive effects. To simplify a bit, the default increases the resources households have at their disposal to cover non-debt-related expenses and maintain their consumption levels (Elul, 2008). Such a financial decelerator mechanism may explain why debt overhang is costlier in countries where the cost of debt default is comparatively high.

from all Chinese provinces except Tibet, Xinjiang and Inner Mongolia. Hong Kong and Macao are also excluded. The second stage of sampling involves selecting residential villages from the counties/cities selected at the first stage. In the final stage, households are selected from residential villages chosen in the second stage.

As a caveat, the 2011 sample is considerably smaller than the samples for 2013 and 2015. In 2011, the CHFS randomly selected 80 counties out of a total of 2,585 Chinese counties. The 2013 CHFS survey included twice as many households from 1,048 communities in 262 counties. The number of households surveyed was 8,149 in the 1st CHFS wave, 27,570 in the 2nd wave and 36,556 in the 3rd wave.⁶

The descriptive analysis in Table 1 illustrates some key demographic and economic characteristics of households, including household size, age, education and employment status in all three waves. Several interesting facts emerge. First, only a single-digit share of households have an outstanding mortgage (as indicated with the share of owner with mortgage under the housing status). Second, the share of households classifying themselves as self-employed is high in all three waves. The reason is that farmers, who represent a substantial share of the Chinese labor force, are considered self-employed. Third, household members tend to be somewhat older in later waves. Finally, home ownership rates and educational attainment remain broadly stable across waves.

⁶ The original amount of households surveyed in each of the three waves was 8,438, 28,136 and 37,289, respectively. We have excluded households with income reported as zero or value missing.

Table 1 Key features of the China Household Finance Survey

		Percentage of households		
		1 st wave 2011	2 nd wave 2013	3 rd wave 2015
Household size	1	6.5	6.9	8.8
	2	21.1	22.0	25.4
	3	29.6	28.8	27.2
	4	18.8	18.7	17.2
	≥ 5	24.1	23.7	21.4
Housing status	Outright owner	77.0	69.6	77.9
	Owner with mortgage	7.6	7.5	7.3
	Renter	15.4	22.9	14.7
Age	≤ 34	13.5	12.7	10.6
	35-44	24.6	20.9	17.4
	45-54	24.3	24.8	26.4
	55-64	21.7	22.7	23.0
	65-74	11.0	12.3	15.0
	≥ 75	5.0	6.7	7.6
Work status	Employee	32.8	31.9	31.8
	Self-employed	38.9	35.7	40.2
	Retired	14.8	17.0	10.3
	Unemployed	4.2	3.9	2.4
	Other	9.3	11.5	15.3
Human capital	Basic education	30.8	30.6	31.6
	Secondary schooling	53.5	52.7	52.4
	Tertiary schooling	15.7	16.7	16.1

Notes: A household is defined as all persons who reside permanently on the same property and have common house-keeping. The reference person is the main income earner of the household, referred to as the head of household in CHSS surveys. If there is no income earner, the oldest person is defined as the reference person. Age, education and work status apply to the reference person of the household. Farmers are categorized as self-employed.

Table 2 Household characteristics and percentage of households holding debt

		Percentage of households holding debt		
		1 st wave 2011	2 nd wave 2013	3 rd wave 2015
Income quintiles	1 st	14.0	12.6	9.9
	2 nd	13.7	12.3	12.2
	3 rd	14.3	15.3	15.2
	4 th	20.3	21.1	21.5
	5 th	37.6	38.4	41.3
Household size	1	4.6	4.4	6.2
	2	11.8	13.3	15.4
	3	37.3	37.7	35.9
	4	20.4	21.0	21.2
	≥ 5	25.9	23.6	21.3
Age	≤ 34	24.8	25.6	24.0
	35-44	33.6	29.9	29.4
	45-54	23.9	27.4	28.5
	55-64	13.2	13.3	12.7
	65-74	3.6	3.0	4.0
	≥ 75	0.7	0.9	1.4
Work status	Employee	44.6	47.4	58.7
	Self-employed	39.5	36.7	27.5
	Retired	5.7	6.4	4.1
	Unemployed	3.4	2.7	2.0
	Other	6.9	6.9	7.8

Note: The percentage reported in the table is the distribution of indebted households according to their household characteristics. Work status “other” includes students and persons performing unpaid housework.

Table 2 presents a bird’s-eye view of household participation in the debt market in relation to a selected economic, social or demographic variable. Households not holding debt are excluded from the analysis, i.e. we only consider indebted households within each income category. The categories are income quintiles defined at the points that divide income into five equal groups of total households. Indebted households are those with outstanding loans from financial institutions. Informal debt from relatives and friends is not considered as there is no available data on servicing such debt. Table 2 summarizes the main characteristics of households holding formal debt.

Only a minority of Chinese households participate in formal debt markets. The number of indebted households was 1,401 in the 1st wave, 3,813 in the 2nd wave and 5,190 in the 3rd wave (17.2%, 13.8% and 14.2% of the whole sample, respectively).

As expected, the percentage of indebted households increases with household income: about 14.0% in 2011 (9.9% in 2015) in the low-end 1st quintile and 37.6 % (41.3 %) in the high-end 5th quintile. The probable reason for such a heavily skewed distribution of debt is the positive correlation of current and expected future income.

The percentage of indebted households is hump-shaped across age groups, so it decreases with the age of the reference person beyond a certain age. Most debt is held by households within the primary first-time home buyer and second-stepper households, i.e. 35-44 and 45-54 age groups. The greater uncertainty concerning future income in the case of young households under 34 leads reduces demand for mortgages, even though 34 is older than the age traditionally associated with acquisition of a first residence.

Notably, the distribution of debt across age groups changes over time from younger to older households, with the 45-54 age group increasing its share of total debt.

Households where the reference person is self-employed have the highest participation in the debt market. Households with employed work status have also experienced a significant increase in debt from 2013 to 2015. A slightly lower share of households with an employed reference person held debt. In households where the reference person is unemployed or retired, the percentage of households with debt is significantly lower.

Participation in the debt market also correlates with household size and required floor space. The results of the CHFS indicate that the households with the highest participation in the debt market are those with at least three household members. Single-person households have the lowest participation.

In summary, the lowest percentages of indebted households are found in the lowest income quintile, in single households, in households with a retired reference person and in households where the reference person is not part of the active population.

3 Debt burden indicators and measures of risk

We now arrive at the salient question of whether Chinese household debt poses abnormal risks to financial, or even systemic, stability. To investigate various aspects of the household debt burden, we consider indicators that highlight certain aspects of debt and risk. These indicators are calculated

for every indebted household, i.e. households with outstanding loans from financial institutions (mortgage, consumer, personal, installment, etc.).

The debt-to-asset (DA) ratio is perhaps the best-known leverage measure. DA looks at how debt is backed by assets and measures household vulnerability to indebtedness. Debt-to-income is another frequently used ratio in measuring credit risk in the household sector. Here, we use its refined cousin, the debt-to-disposable-income ratio (DI). Disposable income, i.e. after-tax income less interest expenses, indicates household income available for consumption and saving. Another alternative is the debt-servicing-to-disposable-income ratio (DSI).⁷ DA, DI and DSI are all consensual measures of debt vulnerability reflecting the ability of a household to repay debt without resorting to selling liquid assets.

Financially vulnerable households are identified as those for which the debt burden indicators exceed the thresholds $DA > 1$, $DI > 4$ and $DSI > 0.4$. We also perform a sensitivity analysis and consider the thresholds $DA > 0.75$, $DI > 3$ and $DSI > 0.3$ in order to avoid basing our analysis on a single set of thresholds. We use rule-of-thumb thresholds common in the existing literature on household financial vulnerability, e.g. Bricker et al. (2015) for the US and ECB (2013) for the Euro Zone. These threshold levels are based on convenience, but recognize that an excessively high threshold likely misses many distressed borrowers and an excessively low threshold likely captures borrowers who can afford debt.

The shares of Chinese debtors exceeding our three thresholds, as reported in Table 3, are rather high compared to other countries. For example, around 3.5% of all British households reported an outstanding mortgage debt in excess of four times their current household income (see e.g. Baracke and Sethi, 2017). In Canada, Djoudad (2012) estimated the share of vulnerable households in indebted households at 5.7% using the baseline debt service-to income $DSI > 0.40$ vulnerability measure. In Spain, the IMF (2012) estimated this share at 16.5% for 2008. Moreover, the Chinese shares, independent of which indicator we refer to, remain constantly high over the 2011–2015 period. In particular, households in the 1st quintile relatively carry very large debt burdens. A less-threatening explanation is that the surveys underestimate household disposable income in

⁷ See Juselius and Drehmann (2015) and Drehmann et al. (2017) on the role of the debt service ratio as a leading indicator of household consumption. Drehmann and Juselius (2012) show that the household debt service ratio provides a reliable early warning signal for systemic banking crises and that the level of the ratio is related to the size of subsequent output losses.

this quintile as they may also take in earnings from the informal sector. Nevertheless, these households must be considered to have a high probability of insolvency and thereby pose a threat to financial stability.

Table 3 Percentage of households exceeding critical debt burden thresholds

			Income quintiles				
			1 st	2 nd	3 rd	4 th	5 th
1 st wave 2011	Baseline thresholds	% DA > 1	8.6	7.8	4.5	3.5	2.1
		% DI > 4	36.5	15.1	12.0	11.6	9.2
		% DSI > 0.4	17.3	4.7	3.5	2.1	2.3
	Stricter thresholds	% DA > 0.75	14.2	10.4	5.5	7.0	8.0
		% DI > 3	40.1	19.3	16.0	13.7	14.0
		% DSI > 0.3	18.8	6.8	5.0	4.2	3.8
2 nd wave 2013	Baseline thresholds	% DA > 1	4.8	3.6	2.2	0.4	0.8
		% DI > 4	38.2	19.7	14.9	9.2	5.4
		% DSI > 0.4	37.5	21.6	7.7	7.6	2.2
	Stricter thresholds	% DA > 0.75	8.1	5.6	2.9	1.4	1.0
		% DI > 3	44.0	25.8	21.6	15.1	9.8
		% DSI > 0.3	41.5	25.5	13.7	12.2	5.2
3 rd wave 2015	Baseline thresholds	% DA > 1	6.8	4.7	3.2	2.4	1.1
		% DI > 4	51.1	31.3	19.8	11.1	6.7
		% DSI > 0.4	55.2	59.8	41.5	21.1	8.3
	Stricter thresholds	% DA > 0.75	8.9	7.4	5.2	3.2	2.0
		% DI > 3	54.7	37.2	27.8	18.5	11.2
		% DSI > 0.3	56.5	64.7	57.2	38.0	15.7

Notes: The indicators below are all calculated over the entire population of indebted households. The household post-tax income includes labor income, profits, pensions, remittances and net capital gains. DA gives total outstanding debt divided by household assets. DI is defined as total outstanding debt divided by annual household gross income. DSI is defined as annual debt service divided by annual disposable income. Debt service comprises the sum of interest payments. Due to lack of data, repayment of principal is not included.

While financial burden indicators in Table 3 are useful for forming a general impression of Chinese households under financial stress, they can hide important aspects of the problem. For example, while a household with a very high *DSI* may face difficulties covering its debt installment from the current income stream, it may own semi-liquid liquid assets that can be sold to continue servicing debt without ever being at risk of missing a payment. In a similar vein, an underwater household

may have sufficient income such that it never defaults in the absence of a negative income shock. Thus, more elaborated vulnerability measures are needed.

As a first step, we consider the financial margin.⁸ The financial margin FM of a household is defined as

$$FM = Y - C - DS, \quad (1)$$

where Y is disposable household income, C is basic consumption and DS is debt service. For Y and C , we use total monthly net income and total monthly consumption as recorded by the household. For DS , we use the sum of interest payments for mortgages (mortgages on the main residence and on other real estate properties) and interest payments for non-collateralized loans. In other words, the financial margin FM is a continuous measure of how well a household is able to make ends meet.

To focus on potentially vulnerable households and see whether they might pose a threat to financial market stability, we further define a household as vulnerable if it has a negative financial margin ($FM < 0$), and not vulnerable otherwise ($FM \geq 0$). This approach implicitly assumes that ordinary living expenses have priority over interest payments. Table 4 provides the percentage of households with $FM < 0$ by quintiles of the income distribution. Such granularity has long been sought, but was out of the question due to the paucity of data prior to publication of the CHFS.

Table 4 Share of vulnerable indebted households with $FM < 0$ by income quintiles (%)

	Income quintiles				
	1 st	2 nd	3 rd	4 th	5 th
1 st wave 2011	84.7	42.2	25.5	12.3	4.6
2 nd wave 2013	91.1	55.7	29.2	10.9	3.5
3 rd wave 2015	92.8	66.1	39.5	21.0	6.6

Notes: The total number of vulnerable households with $FM < 0$ is 358 in the 1st wave, 1,013 in the 2nd wave and 1,582 in the 3rd wave. The percentage reported in the table is this number divided by the total number of indebted households in each income quintile.

The percent values in Table 4 list the proportion of indebted households *below* the critical financial margin, i.e. vulnerable households. At least technically, these households run a risk of cancelling

⁸ For earlier papers on alternative risk measures and stress tests, see e.g. Albacete et al. (2014) and Ampudia et al. (2016).

their debt servicing. A striking detail here is that the risk profile of households is quite different across income quintiles, with debt servicing ability heavily skewed. Not only does this evidence underscore the usefulness of micro-level data, but, from the risk management perspective, it shows that curbing the extension of loans to overly-indebted households in the low-income quintiles is an enduring task.⁹ Since the vulnerability has increased over time, this unevenly distributed debt servicing capacity is a distinctive hidden danger to the financial stability of China.

An immediate concern is that a household with $FM < 0$ could still service its debt if it has sufficient semi-liquid liquid assets to sell to cover the payments. Unlike real assets, financial assets are relatively easy to realize and thus serve as a short-term buffer against unexpected reductions in disposable income. Therefore, we introduce an extended financial margin condition related to the ability to cover the negative financial margin with liquid assets (LA). The narrow definition of liquid asset comprises cash, demand deposits, time deposits, and cash on stock accounts. As a robustness check we also consider a broader definition of liquid and semi-liquid asset which additionally includes the market value of securities (stocks, derivatives), the face value of bonds, money market funds, as well as the market value of wealth management products. It states that a household is considered to be in distress if the household's negative financial margin for a determined number of months M is greater than the household's liquid assets. In other words, this extended condition says that a household is not in distress even if it has a negative FM if it can cover a given number of months of the flow of negative financial margin from its liquid assets. A formal account of the description is

$$FM < 0 \wedge |FM| \cdot M > LA. \quad (2)$$

For M , we alternatively assume 6 and 12 months, respectively. To what extent have Chinese households accumulated buffers that can help smooth unexpected income shocks? The results for the various definitions and calculation methods are disclosed in Table 5. The empirical evidence in Table 5 shows that amid the accelerated pace of increase in Chinese household debt since 2011, the various negative financial margin measures have risen steeply. This particularly applies to the low-income quintiles. The upshot here is that focusing solely on the average statistics may be insufficient to identify all the vulnerabilities emerging in the system. This is particularly important as a debt

⁹ The evidence supports our suspicion that the households, especially in the 1st (lowest) income quintile, have income not recorded in the survey.

crisis or mortgage crisis is likely to first emerge in low- or medium-income families. Based on the recent experience of the global financial crisis, the US subprime mortgage crisis, which originated in a household debt crisis affecting low- and middle-class groups, was enough to trigger a systemic financial crisis.

Table 5 Percentage of households with negative extended financial margin by income quintiles over time

			Income quintiles				
			1 st	2 nd	3 rd	4 th	5 th
1 st wave 2011	LA^{Narrow}	$M = 6$	59.9	28.6	12.5	4.2	1.7
		$M = 12$	69.5	31.8	13.5	6.7	2.1
	LA^{Broad}	$M = 6$	57.9	28.1	12.0	3.1	1.7
		$M = 12$	68.0	30.7	13.5	4.9	2.1
2 nd wave 2013	LA^{Narrow}	$M = 6$	74.3	29.6	13.2	4.5	1.3
		$M = 12$	81.5	37.6	17.0	5.7	1.8
	LA^{Broad}	$M = 6$	72.6	29.0	12.3	4.3	1.2
		$M = 12$	80.1	36.1	16.1	5.3	1.5
3 rd wave 2015	LA^{Narrow}	$M = 6$	68.7	37.3	18.2	7.4	2.1
		$M = 12$	80.2	45.7	23.9	9.3	2.8
	LA^{Broad}	$M = 6$	67.1	36.2	17.7	6.8	1.9
		$M = 12$	77.6	44.5	22.7	8.5	2.4

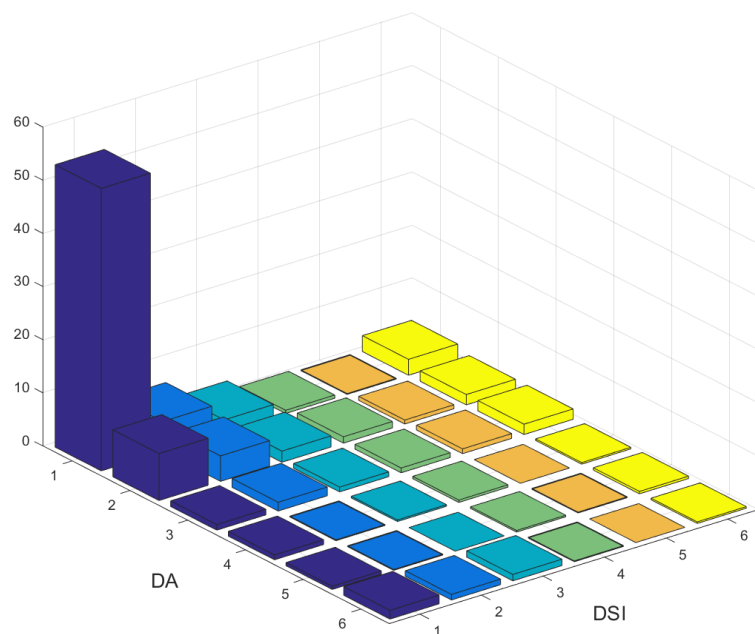
Notes: The narrow definition of liquid asset LA comprises cash, demand deposits, time deposits and cash on stock accounts. As a robustness check we consider a broader definition of liquid and semi-liquid assets that also includes the market value of securities (stocks, derivatives), the face value of bonds, money market funds, as well as the market value of wealth management products.

For monitoring purposes, clear presentation and easily interpretation are useful. In this spirit, we identify vulnerable households by combining the indicators presented above. Our aim here is to focus on vulnerable households most likely to run into serious problems and cause losses to the lender. Looking at the joint distribution of the vulnerability indicators gives us a good picture of households that can be considered “at risk.” To this end, we divide the DA and DSI ratios into six classes. The first class stands for a DA ratio between 0 and 0.2, and a DSI ratio between 0 and 0.10. Accordingly, the last class corresponds to a DA ratio above 1 and a DSI ratio above 0.5. The height of the bars represents the share of households with corresponding DA and DSI ratios. The resulting (6×6) matrices form the basis for the 3-dimensional vulnerability bar graph. The graph is color coded

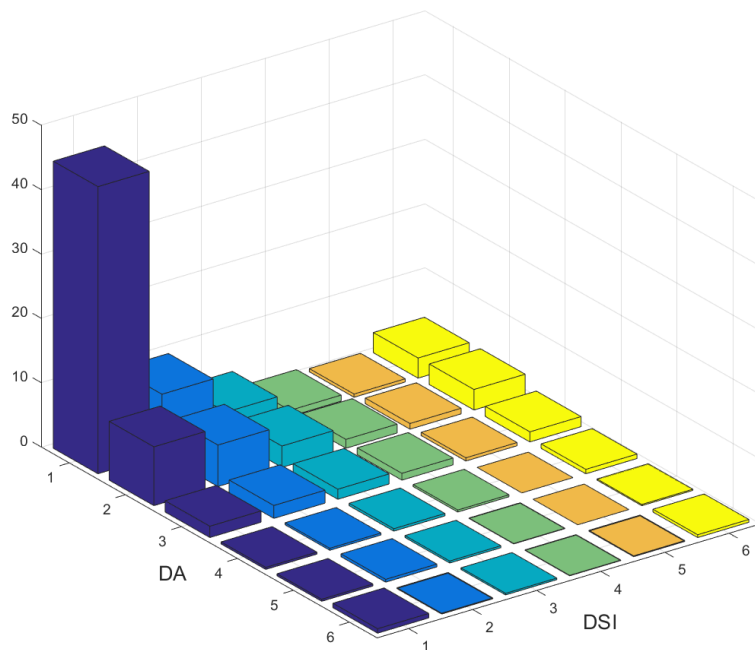
to differentiate varying risk levels. The dark blue bars represent, broadly speaking, high joint vulnerability clusters. Light blue clusters are less vulnerable, while the green, orange and yellow clusters represent increasingly less problematic households.

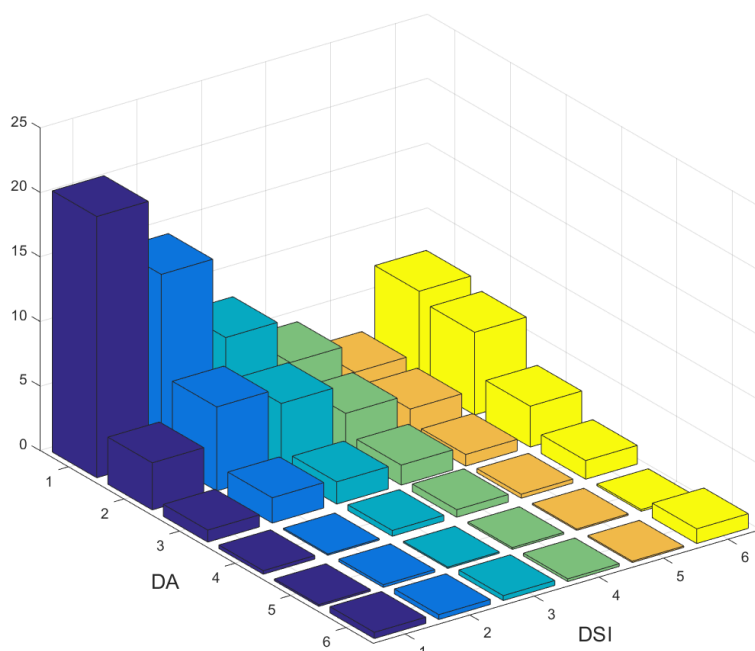
Figure 1 Joint distribution of DA and DSI ratios over time

1st wave 2011



2nd wave 2013



3rd wave 2015

The results enable us to identify pockets of credit risk over time. The data show that the financial standing of households in 2015 deteriorated significantly in comparison to 2011 and 2013. This result matches the conclusions of the previous sections. Overall, some low-income households appear to be so heavily indebted that they find it difficult to manage their debt with their own income. This is important because household-level spending adjustments are more likely to be amplified if debt is concentrated among households with limited access to credit or with less scope for self-insurance (see Zabai, 2017). By way of qualification, it must be conceded that, according to the survey, low-income quintile households should default more frequently on their debts than they actually do. This supports our suspicion that households, especially in the first quintile, have unreported income or assets not recorded in the survey.

In recent decades, real property has become the *de facto* store of wealth in China and the ultimate choice for investors given its high return. In view of the importance of housing in the balance sheets of households and credit institutions, the final step in this section involves the calculation of loan-to-value (LTV) ratios.¹⁰ While various mortgage debt LTV measures are monitored, we focus on *initial* and *current* LTV ratios. We also distinguish between main residence, second residence and third residence. The initial LTV ratio is defined by the initial mortgage loan divided by

¹⁰ The high growth rate of mortgage debt in China in recent years has captured headlines around the world. For example, Bloomberg ran in 2014 a provocatively titled article “Is China Building a Mortgage Bomb?” (<https://www.bloomberg.com/view/articles/2014-11-21/is-china-building-a-mortgage-bomb>).

the value of the property at the time the mortgage was taken out. In other words, “L” and “V” are calculated as of loan origination, and not updated afterwards.

Limits on the initial LTV ratio are a popular macroprudential tool to make financial institutions and households more resilient to house price, income and interest rate shocks.¹¹ By contrast, the current LTV ratio in the CHFS is defined as the currently outstanding amount of “L” divided by the self-assessed and updated “V.”¹² The LTV is both an indicator of default risk (when calculated at loan origination) and an indicator of expected loss (when the “V” is updated). Since the updated “V” gives the estimated foreclosure value, the current LTV ratio is the preferred measure to assess the current financial stability implication of Chinese household mortgages. The initial LTV ratio is of interest to macroprudential regulators because it is a predictor of default.¹³ A high initial LTV ratio implies higher leverage, and therefore higher risk, i.e. the borrower has been obliged to borrow more as he or she otherwise could not afford the property. Also, the amount of equity invested in the house can be used as an indicator of willingness to pay.

From the macroprudential perspective, an LTV ratio tightening may reduce demand for mortgages as homebuyers are forced out of the property market. An LTV cap tightening may also reduce credit supply because it may lead banks to lend less than they otherwise would. The focus upon macroprudential policies reflects the increasing skepticism towards standard monetary policy in tempering housing booms in support of financial stability. For example, Svensson (2014) argues the costs of higher interest rates in terms of higher unemployment in Sweden exceed the benefits of reducing financial stability risks. This implies a costly trade-off of using standard monetary policy to temper house prices when macroeconomic and financial stability goals are in conflict. While we cannot do justice to the complete literature, one can point to the work of Arslan et al. (2015), who show that macroprudential policies help moderate fluctuations in house prices and mortgage default

¹¹ House price growth should be a focus for monitoring and regulatory vigilance. The IMF “Global Housing Watch” (<http://www.imf.org/external/research/housing/>) traces the evolution and dynamics of house prices in China from an international perspective. A growing literature has documented the use of macroprudential policies including capped LTV ratios across countries and analyzed their effects. Galati and Moessler (2012) provide a review of China’s macroprudential housing-finance toolkit. Cerutti et al. (2017) document the use of macroprudential policies for 119 countries over the period 2000–2013 that covers many instruments. Recent work on macroprudential policy includes Bianchi et al. (2012, 2016) and Farhi and Werning (2016).

¹² LTV ratios may be calculated in several ways. For instance, the market value “V” in LTV may be left unchanged after the loan issuance. This results in conservative LTV estimates when prices rise after loan origination, but can be misleading if house prices decrease. The ratings agency Standard and Poor’s typically uses the lower of the updated price and the original valuation of the property. See https://www.standardandpoors.com/en_US/web/guest/ratings/ratings-criteria/-/articles/criteria/structured-finance/filter/rmbs. Given their subjective nature, the self-assessed current market value “V” in the CHFS implies that precise current LTV ratios should be interpreted with caution.

¹³ The recent literature on the global financial crisis provides ample evidence that the boom was to a large extent driven by an increased willingness by lenders to extend loans to a riskier category of borrowers (Demyanyk and Van Hemert, 2011, Mayer et al., 2009, Mian and Sufi, 2009, Dell’Ariccia et al., 2012).

rates. It is well-known that policymakers can only target marginal lending in principle. However, the intention is that the macroprudential policies should have an effect over the entire life of the mortgage contract. Therefore, we look at all borrowers, not only those taking new loans.

Table 6 shows the mean initial and current LTV ratios for all three waves and thus monitors vulnerabilities related to the residential real estate sector in a simple and informative way. In addition, the LTV ratios for multiple housing owners who have expanded their borrowings in line with the buoyancy of the Chinese housing market are given.

Table 6 Mean household LTV ratios by income quintiles over time

			Income quintiles				
			1 st	2 nd	3 rd	4 th	5 th
1 st wave 2011	Initial LTV ratio in %	Main residence	0.53	0.44	0.49	0.53	0.57
		2 nd residence	0.75	0.56	0.58	0.55	0.61
		3 rd residence	NA	NA	NA	NA	0.69
	Current LTV ratio in %	Main residence	0.13	0.12	0.16	0.17	0.20
		2 nd residence	0.34	0.18	0.24	0.20	0.28
		3 rd residence	NA	NA	NA	NA	0.32
2 nd wave 2013	Initial LTV ratio in %	Main residence	0.42	0.45	0.46	0.49	0.53
		2 nd residence	0.69	0.59	0.66	0.57	0.63
		3 rd residence	NA	NA	NA	NA	0.58
	Current LTV ratio in %	Main residence	0.35	0.31	0.29	0.28	0.39
		2 nd residence	0.34	0.26	0.35	0.34	0.33
		3 rd residence	NA	NA	NA	NA	0.28
3 rd wave 2015	Initial LTV ratio in %	Main residence	0.63	0.54	0.55	0.54	0.56
		2 nd residence	NA	NA	NA	NA	NA
		3 rd residence	NA	NA	NA	NA	NA
	Current LTV ratio in %	Main residence	0.48	0.57	0.35	0.37	0.40
		2 nd residence	NA	NA	NA	NA	NA
		3 rd residence	NA	NA	NA	NA	NA

Notes: The main residence is owner-occupied housing. The 2nd and 3rd residences are other properties owned by the household. The table reports the average LTV ratio in each income quintile. NA indicates that the number of observations in that category is less than 5. Please note that in the 3rd wave, mortgage loans are not reported for each individual residence. Rather, total household mortgage loans are reported. Thus, we have only calculated the LTV ratios for those households with one residence. Due to this fact, the data for 2015 are only marginally comparable with earlier figures.

What emerges from this regarding mortgage soundness? In the first instance, the initial LTV ratios are relatively low compared to other countries (see e.g. Thebault, 2017). Two opposing trends are

visible. On one hand, the comparison of the initial and current LTV ratios reveals that rising house prices and the amortization requirement (minus newly-raised debt) have produced the desired macroprudential effect, i.e. households decreasing their LTV ratios over the contractual period is a positive development. This is counteracted, however, by the trend shown in Table 6 that the LTV ratios are increasing in the 3rd wave. Note that the household risk profile by quantiles of the income distribution in Table 6 differs substantially from the risk profiles in Table 4 and 5. This underscores the usefulness of LTV-based measures and can be explained to some extent by self-regulation in the banking sector related to mortgage credit risk.

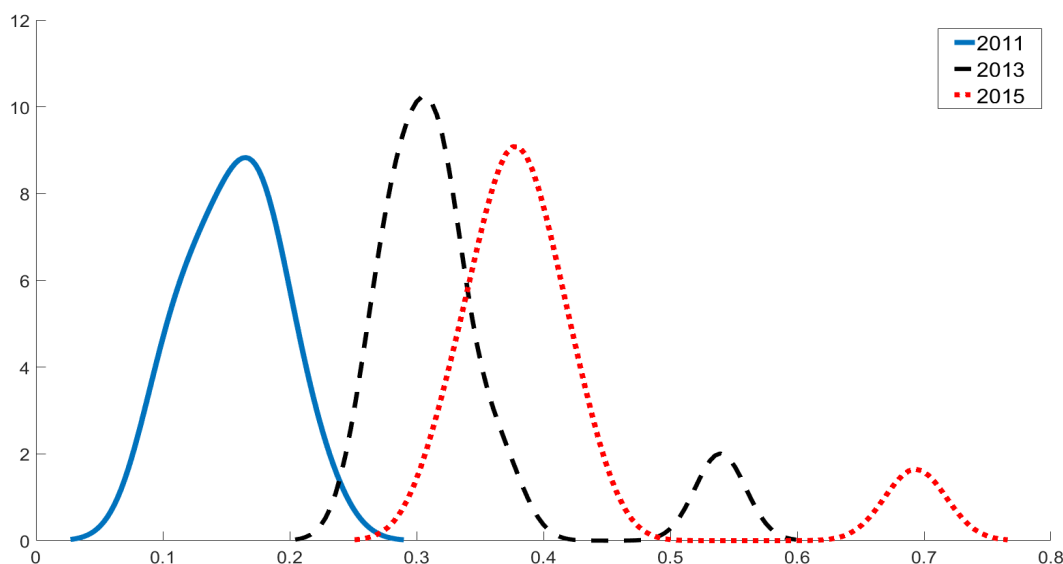
Overall, the LTV ratios do not give cause for concern.¹⁴ This applies especially to current LTV ratios. However, asset valuations are procyclical and could fall sharply when the boom ends. There is also a mismatch in the structure of liabilities and assets. Household liabilities are mostly financial liabilities, while a significant portion of assets are nonfinancial fixed assets (e.g. housing) that are illiquid and subject to sharp valuation changes. In addition, more vulnerable households such as those with lower debt-servicing capacity tend to hold fewer liquid assets, suggesting they have lower buffers in times of stress.

In concluding this section, we take a closer look at the shift of the current LTV ratio over time. A convenient way to illustrate the LTV ratio distributions is to calculate univariate kernel smoothing estimates.

Figure 2 tracks the distribution of LTV ratios over time, and shows that the LTV distribution has evolved. From 2011 to 2013, the residential mortgage loan LTV ratios increased modestly. From 2013 to 2015, the data show a surge in the LTV ratios. Nonetheless, it should be emphasized that appreciating Chinese house prices in the observation period were not accompanied by an exceptionally rapid increase in current LTV ratios. This finding contrasts with the situation in many advanced economies prior to the global financial crisis.

¹⁴ Chinese savings behavior could also be a factor. Chinese households save more at every income decile than in other countries, but the gap is largest for the poor (see IMF, 2017c, pp. 7-11). The exceptional consumption-saving pattern in China is influenced by precautionary saving motives to a considerable extent (Chamon and Prasad, 2010, and Chamon et al., 2013). It should also be noted that informal borrowing among friends and relatives is prevalent in China. In the second wave of the CHFS in 2013, over 30% of homebuyers in China informally borrowed from friend and relatives. The average amount borrowed from friends and family was RMB 70,000, and the average reported interest rate of informal borrowing was 0.4%.

Figure 3 Distributions of current LTV ratios for main residence over time



4 Stress tests

As a first step, we present and explain the methodology that underpins the stress index. Stress tests raise two questions: where do the adverse shocks occur and what is their magnitude? Below we conduct micro-simulations with income and house price changes and assess the associated picture of vulnerabilities.¹⁵ In doing so, we assume that both shocks are independent from each other. The guiding principle underpinning the stress tests is that future shocks hitting the Chinese economy are inherently unpredictable.¹⁶ But if and when shocks materialize, their impact should vary according to exposures and leverage built up in the system. Unlike actual shocks, these vulnerabilities can be assessed and monitored. To this end, we conduct stress tests reflecting different risk factors.

We start by monitoring the resilience of households under adverse income shocks employing the $FM < 0$ cut-off in equation (1). The results are given in Table 7. The income shock is modelled via a uniform reduction of income Y of all households. We calculate the static impact effects

¹⁵ The predominant mortgage contract in China is an adjustable-rate mortgage (Zabai, 2017, p. 42). As a result, one might assume an interest rate shock. In practice, however, Chinese policymakers are most likely to leave the benchmark interest rate unchanged amid reasonable CPI inflation rises and a stable renminbi – even with the current likelihood of rising US interest rates. The People’s Bank of China intends to keep its monetary policy independent and the current CPI inflation provides no incentive to take further steps. Thus, our stress test design seems appropriate for the questions posed here.

¹⁶ The focus on unexpected shocks prevents a rigorous assessment of anticipated macroeconomic shocks or economic policy changes. This drawback cannot be ignored.

keeping all other variables unchanged. The recalculation of *FM* for all indebted households assuming income declines of 5% and 10%, respectively, reveals that even the sharper drop in income does not greatly affect the proportion of households below the financial margin.

Table 7 Share of vulnerable households with $FM < 0$ by income quintiles under alternative income stress scenarios over time (%)

		Income quintiles				
		1 st	2 nd	3 rd	4 th	5 th
1 st wave 2011	5 % income decline	85.2 (0.5)	44.3 (2.1)	28.1 (2.6)	14.0 (1.7)	5.3 (0.7)
	10 % income decline	88.3 (3.6)	44.8 (2.6)	30.5 (5.0)	15.4 (3.1)	5.3 (0.7)
2 nd wave 2013	5 % income decline	92.7 (1.6)	57.6 (1.9)	32.1 (2.9)	12.7 (1.8)	4.0 (0.5)
	10 % income decline	93.8 (2.7)	60.1 (4.4)	35.3 (6.1)	14.3 (3.4)	5.1 (1.6)
3 rd wave 2015	5 % income decline	93.4 (0.6)	67.4 (1.3)	42.1 (2.6)	23.3 (2.3)	7.8 (1.2)
	10 % income decline	93.4 (0.6)	68.8 (2.7)	45.2 (5.7)	25.9 (4.9)	8.9 (2.3)

Notes: The numbers in brackets are the percentage point changes of the share of vulnerable households with $FM < 0$ compared to the baseline in Table 4.

As complement, we consider the impact of adverse house price shocks on the current LTV ratios of the main residence.

Mispricing of housing can culminate in financial instability or even economic crises. When a housing bubble bursts, highly indebted households often face repayment difficulties, forcing them to curb their consumption. Claessens et al. (2009), Crowe et al (2013) and Jordà et al. (2015, 2016) have found that credit-financed housing bubbles accompanied by credit booms tend to be followed by deeper recessions and slower recoveries. The basic reason is that the bursting of unleveraged bubbles lack subsequent deleveraging feedback loops and hence pose less threat to financial stability. Indeed, several empirical estimates directly examine the underlying macro-finance relationship and find support for this view. Notably, Garcia-Escribano and Han (2015) show that consumer and housing credit growth have had a significant positive effect on real GDP growth in emerging market economies. Ciccarelli et al. (2015) estimates mortgage demand and supply effects, finding that

changes in demand significantly affect GDP growth. In countries where post-crisis deleveraging did not put downward pressure on household loan demand, sustained household consumption expenditure and housing investment act to stabilize economic growth.

On the other hand, international experience suggests that housing booms are dangerous. They increase the risk of a disruptive adjustment, a marked growth slowdown, or both. Forced asset sales (fire sales) can also aggravate financial fragility by depleting the balance sheets of market participants. Fire sales imply discounts below fundamental values, with market conditions and the urgency of the sale determining the amount of the fire sale discount. Discounts are larger in thin markets with low demand. Fire sales are more likely under of financial or liquidity constraints.¹⁷ Fire sales also may generate externalities that feedback on asset values, thereby magnifying financial accelerator effects and causing price-default spirals.¹⁸

A separate risk factor is reassessment of the future monetary policy stance. The resulting snapback in bond yields and the initial price correction may be magnified by fire sales. Consequently, the macroprudential authority should as a precaution pay close attention to signs of excessive house prices.

Quantitative plain-vanilla risk metrics are presented in Table 8. As a double check, we look at 10% and 25% house price drops. These house price discounts are meant to account for fire sale risks, property specific features and legal/transaction costs. Again, we calculate the impact effects *ceteris paribus*.

Table 8 suggests that the current LTV ratios were only mildly sensitive to house price shocks in all three waves. Thus, Chinese households facing affordability problems do not seem particularly vulnerable to declining house prices and are unlikely to experience long-term mortgage arrears or sharp contractions in spending. Indeed, even a house price decline of 25% is unlikely to trigger a systemic impact on the Chinese financial sector.

¹⁷ For a review of the literature and possibility of fire sales externalities, see Shleifer and Vishny (2011), Caballero and Simsek (2013) and Choi and Cook (2012).

¹⁸ The collapse of US housing prices in 2007–2010 was followed by a dramatic increase in mortgage defaults that often led to foreclosures. Empirical evidence supports for this feedback loop conjecture. See Campbell et al. (2011), Elul et al. (2010) and Harding et al. (2010).

Table 8 Mean of the current main residence LTV ratios in percent by income quintiles over time under alternative house price decline scenarios

		Income quintiles				
		1 st	2 nd	3 rd	4 th	5 th
1 st wave 2011	10 % house price decline	0.14	0.13	0.18	0.19	0.22
	25 % house price decline	0.17	0.16	0.21	0.23	0.27
2 nd wave 2013	10 % house price decline	0.39	0.34	0.32	0.32	0.44
	25 % house price decline	0.46	0.41	0.39	0.38	0.52
3 rd wave 2015	10 % house price decline	0.46	0.63	0.39	0.41	0.45
	25 % house price decline	0.51	0.76	0.47	0.49	0.54

Note: For convenience, we assume house prices decreased by the same amount at the same time throughout China.

We have not tied up all issues in this section. Notably, the above stress tests are partial equilibrium analyses and do not account for the economic interactions between the various markets in a given economy. This would require a general equilibrium setup where all markets are simultaneously modelled and interact with each other. Even so, due to their robustness to misspecification in other parts of the economy, easy-to-implement partial equilibrium models are well justified. An obvious advantage of partial equilibrium models is that they break the task of figuring out how the world works into manageable pieces. Moreover, besides the wealth of empirical detail, partial equilibrium modelling is often the preferred initial strategy to figure out, piece by piece, the effects of policies and shocks. As a general comment, there are advantages and disadvantages of each modelling approach.¹⁹

5 Conclusions and discussion

The global financial crisis has brought the international analysis of risks and vulnerabilities to the fore. Using a micro-level lens, the objective of this work has been to clarify detail in the evolution

¹⁹ Of course, addressing financial stability challenges with intertemporal implications requires structural models as a next step. It is not enough to rely on micro-level empirical evidence. In his famous critique of the empirical characterization of business cycles of Burns and Mitchell (1946), Koopmans (1947) articulated the limited nature of conclusions that follow measurement without theory. Thus, extension of the present modelling approach with a view to optimizing behavior and policies holds potential as a subject for future research. The development of Heterogeneous Agent New Keynesian (HANK) models have helped (see Ahn et al., 2018 and Kaplan et al., 2018), but we are far from a clear understanding. In the meantime, assessments that meet prudential requirements must rely primarily on careful statistical analysis of the data.

of financial vulnerabilities. Our identification of vulnerabilities employed is in line with the previous, somewhat sparse, micro-level literature on the topic. We add to the literature by looking at a broad set of variables for measuring vulnerabilities, and, to our best knowledge, provide the first such analysis focused exclusively on China.

The three published waves of the China Household Finance Survey fill a void in information on household finances in China. They provide unrivalled insights into household balance sheet data over the entire income distribution and allow us to address topical policy issues under the microscope where information from other sources is less meaningful. The GHFS is also useful, as shown above, in addressing distributional issues. Combining all relevant pieces of information, the empirical monitoring approach presented in this paper enables an accurate diagnostic of the debt vulnerability of households and thus is a useful complement of macroeconomic model-based tools for analyzing the build-up of financial imbalances and vulnerabilities.²⁰

We can offer no overarching key message; our evidence draws a mixed picture on household indebtedness and financial vulnerability. LTV ratios generally are safe and sound, but many Chinese households in the lowest income quintiles face great vulnerability and seem hard-pressed to meet their debt commitments over the short, medium and long term. From the perspective of financial stability, the participation of low income households in the debt market is below average, mitigating the impact of their eventual default on the financial situation of affected banks.

Surveys, of course, take no long-term view and suffer from publication lags. In order to provide a longer-term macroeconomic view to complement this analysis, Figure 3 presents China's household and corporate credit-to-GDP ratios from 2006 to 2017. Historical experience shows that household debt to GDP in China averaged 11.5% of GDP in March 2006 and reached an all-time high of 46.8% of GDP in June 2017. In other words, China's household debt-to-GDP ratio quadrupled between 2006 and 2017. It is this build-up of household debt that has sparked widespread concern about the health and vulnerability of the Chinese economy.²¹

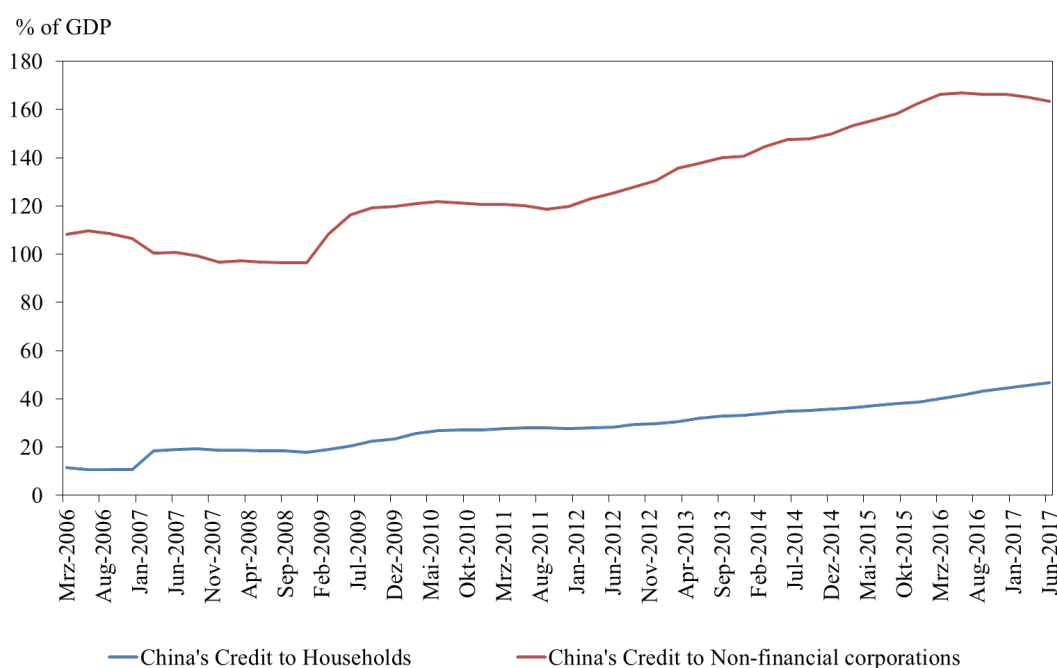
We should keep in mind that Chinese household debt started from an extremely low base. Furthermore, China's big problem is corporate debt. The corporate debt-to-GDP ratio reflects the

²⁰ Aggravating this long-term concomitant effect, Danielsson and Zhou (2016) and Danielsson et al. (2016) have argued that model-based monitoring approaches do not necessarily offer the best guidance during market distress and may not reveal risks which could have been shown by simple metrics.

²¹ See <https://www.bloomberg.com/news/articles/2017-11-21/china-s-debt-surge-may-increase-risk-of-financial-crisis>. Chinese policymakers are well aware of the potential risks of high GDP growth projections in national plans. See <https://www.bloomberg.com/news/articles/2017-10-19/zhou-warns-china-should-defend-against-threat-of-minsky-moment>. Comparison of Table 3 and Figure 4 also shows the extent to which the aggregate macroeconomic household debt ratio underestimates the actual burden of debt of indebted households.

growing role of the financial system in propping up underperforming state-owned firms. Political pressure also continues to keep non-viable “zombie” firms on life support. Such policies may drag down growth in China over the long run. The corporate debt overhang could also negatively impact future productivity growth by reducing the ability of firms to undertake profitable investment projects or crowd out investment in human capital or R&D.²² By the same token, should China manage to rein in debt, the PBoC would have greater leeway in liberalizing financial markets and steering monetary policy.

Figure 3 Household and corporate debt-to-GDP ratios (%)



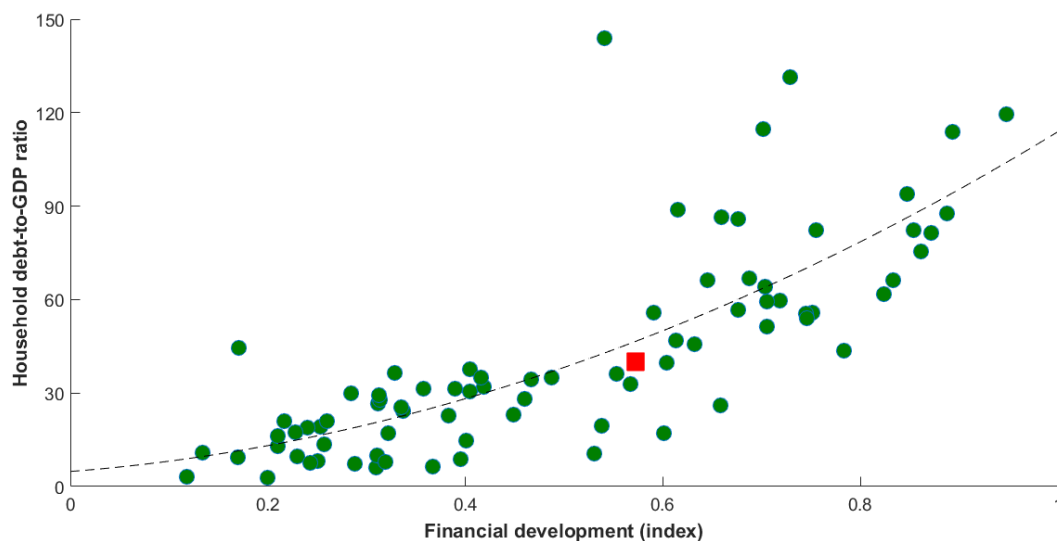
Notes: Credit to households and non-profit institutions serving households at market value in percent of GDP (blue line). Credit to non-financial corporations at market value in percentage of GDP (red line). Both series are adjusted for breaks. The data are from BIS. See <https://www.bis.org/statistics/totcredit.htm>.

The scatterplot in Figure 4 contrasts the household debt-to-GDP ratio and the level of financial development across 80 advanced and emerging market countries for 2013. The figure puts China's household debt problem in an international context (Chinese data point highlighted with a red square icon). As a general rule, the cross-country trend in household debt to GDP in 2013 is positively correlated with the financial development trend. Some of the increase in credit is mere the result of better access to credit. The message for China is clear. Given the level of financial development and

²² See Lam et al. (2017) and Chen and Kang (2018). Drehmann and Tsatsaronis (2014) report that a credit gap above 10% of GDP reliably presages financial distress. The Chinese credit gap last year was the highest in the world, reaching roughly 30% of GDP. https://www.bis.org/statistics/c_gaps.htm.

sophistication, China's household debt in 2013 was not unreasonably high. Thus, the macro-level evidence broadly corroborates the micro-level assessment presented above.

Figure 4 China's household debt problem in a financial development context



Notes: See IMF (2017a), Figure 2.3, p. 60. The financial development index is taken from Svirydzenka (2016). For the list of advanced and emerging market economies included, see IMF (2017a), p. 81.

This paper surveyed potential concerns for financial stability, echoing the increased scrutiny of Chinese household debt in the media and by regulators. But is household debt a ticking time bomb? Based on our household-level analysis, we argue that there exists a substantial margin of safety and thus a strongly pessimistic outlook regarding household debt in China probably misses the mark. Instead, we would argue that policymakers take a nuanced view.

Of course, China's debt situation warrants careful monitoring, particularly with regard to lower income brackets. In addition, further financial reforms are needed to bolster the regulatory and supervisory framework, and increasing transparency of nonbank financial institutions and wealth management products.²³ Good policies, institutions and regulations make a difference. For example, countries with floating exchange rates, and which are financially more developed, are better placed to weather the consequences of high household debt (Dell'Ariccia et al., 2016 and IMF, 2017a). Future work should thus attempt to identify general conditions that might improve financial resilience. We anticipate that therein lies promising potential for future research.

²³ Policymakers may wait to see whether increasing household debt reflects a genuine economic trend or is just a statistical blip. Even when they act, macroprudential tools take time to have an effect.

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