Financial Cycles in China

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Abstract

This paper is a comprehensive study of the financial cycles in China. By adopting a trend-cycle approach, the study finds a short-term 2-3 year cycle in major financial variables, whose turning points typically lead the turning points of the real business cycle for 1-3 quarters. Different kinds of financial shocks have heterogeneous effects on the macroeconomy. A credit shock boosts the output gap as much as 0.6 percent and peaks in 4-6 quarters, while the impact of increasing leverage is much more sustaining. House prices, which are more sensitive to growth and interest rates, usually signal the turning points in business cycle movements. Credit expansion fueled by high asset prices is a particularly strong propulsion for output growth. However, it also presages more severe downturns. The evidence is consistent with the financial accelerator effect and the financial instability hypothesis.

Keywords: financial cycle, business cycle, credit, debt, house price, leverage

1 Introduction

Economics studies the efficient allocation of real goods and services through the market mechanism. Economists have learned to look through the "veil of money" and reveal

the *real* aspects of economic truth. However, unless we live in a barter economy, economic activities also involve *financial* aspects associated with transaction mediation, debt issuance, and asset accumulation.

Economic views about the role of money and finance in macroeconomics has involved over time. The zeitgeist through history swings between "neutral money" and "nonneutral money," nominal-real "dichotomy" and integrated views.

Classical theories hold the view that "money is a veil" and financial institutions are just intermediaries which alter no substance in the real economy. The onset of the Great Depression in the 1930s gave birth to the Keynesian school, which recognizes the possibility of massive market failures and advocates government interventions. Reflections on the Great Depression also bred the school of monetarism, which recognizes monetary aspects as possible disruptive factors to the economy. The relatively stable economic growth in the postwar period saw a revival of classical dichotomy, featured by the Real Business Cycle theory and the rational expectation school, in which monetary factors become again irrelevant. However, the recent Global Financial Crisis posed a serious challenge to the neoclassical thinking, and triggered another round of rethink of the role of money and finance in macroeconomics.

After the GFC, growing efforts have been devoted to study how financial factors affect macroeconomic performance (Gertler and Kiyotaki 2010; Brunnermeier and Sannikov 2014; Reinhart and Rogoff 2011; Schularick and Taylor 2012). Both theoretical models and empirical evidence suggest growing asset prices and leverage ratios lead to economic instability, therefore justify the adoption of macro-prudential regulations.

This paper studies financial macroeconomic dynamics from China's perspective. The study is important for three reasons. First, most of the literature in the field are based on the experience of developed economies, relevant few attentions are given to developing economies. Despite China being the second-largest economy that accounts for nearly a third of global growth, the research on how China's financial situations affect its macroeconomic performance is scant (Lodge and Soudan 2019; Shen et al. 2018). Second, the fact that China has a drastically different financial system from most developed coun-

tries poses an interesting challenge to the prevailing theories in the field. China is a rare chance of testing the generality of relevant economic theories. Third, many believe China's socialist system is immune to financial crises because the State tightly controls the financial system. A study of China's financial macroeconomics provides an empirical test of the validity of such claims.

In this paper, I try to answer the following questions: what are the basic characteristics of China's financial cycles? Are they similar or different to the financial cycles in developed economies? How do financial cycles interact with real business cycles? Which financial variable helps to predict changes in real economic activities? And what are the possible mechanism that transmits financial shocks to real economic outcomes?

I adopt a new approach to separate cyclical components from the growth trend. By applying the Boosted HP filter (Phillips and Shi 2019), boom and bust cycles are extracted as up and down movements around the long-term growth trend. I find financial cycles in China have much shorter duration than in developed countries and it does not seem to cause permanent output losses.

I specifically focus on three financial variables: credit growth, house price, and leverage ratio. I conduct three exercises to investigate how they interact with the real business cycle. First, a simple event study suggests all of the three variables lead the peaks and troughs of real output for 1-3 quarters. China's real GDP is particularly sensitive to house prices. Second, VAR analysis suggests an initial shock to any of these variables triggers an upward movement of real output, with house price having the most durable and substantial impact. Finally, including any of the three variables improves the predictive power for upcoming recessions (defined as periods with negative output gaps). Credit growth is particularly helpful in predicting recessions.

I also explore the possible mechanism of how financial shocks are transmitted to affect real economic activities. I find credit expansion fueled with high asset prices drives the economy higher than usual but also ends it up in an even worse recession. The evidence is consistent with the "financial accelerator effect," suggested by most theoretical works, that there exists a positive feedback loop among asset prices, credit expansion, and output

growth, which amplifies and propagates financial shocks to large impacts. These findings cast doubt on the claim that China's state-controlled economy is immune to financial crises. The impact from financial shocks are alive, though the tight monitoring from the regulatory authority and the ability to promptly resolve insolvencies might mitigate the probability of an full-blown crisis.

The remainder of the paper is organized as follows. Section 2 briefly review the important theories regarding finance and macroeconomics. Section 3 introduces the data series and the cycle extraction method. Section 4 characterizes the basic features of China's financial cycles and business cycles. Section 5 presents the empirical results on the interactions between financial variables and real business cycles. Section 6 explores the possible mechanism that transmits financial conditions to real outcomes. Section 7 concludes.

2 Literature review

The debate over the role of money and finance in macroeconomics is almost as old as the discipline of economics itself. Though it is not possible to give an exhausting review of all the theories, this section briefly summarizes the relevant ideas in the history timeline.[1]

Classical dichotomy Early discussions of "nonneutral money" date back to the early 18th century, when French economist Richard Cantillon discovered that increasing quantity of money does not raise the price level uniformly, but incurs redistribution effect: those who are close to money creation benefit from an earlier rise in price and income. Therefore, they can enjoy a higher standard of living at the expense of those far away from money creation.

However, Cantillon's nonneutral monetary theory was more than overwhelmed by the influential classic writers such as Adam Smith, who popularized the profound economic thought that "money is a veil." Smith wrote:

[1]The readers are also referred to Detzer and Herr (2014) which provides a great overview of the theories of financial crises.

> It would be too ridiculous to go about seriously to prove, that wealth does not consist in money, or in gold and silver; but in what money purchases, and is valueable only for purchasing... To attempt to increase the wealth of any country, either by introducing or by detaining in it an unnecessary quantity of gold and silver, is as absurd as it would be to attempt to increase the good cheer of private families by obliging them to keep an unnecessary number of kitchen utensils. (Smith 1776, 406)

The idea of the "money veil" dominated throughout the Smith-Ricardo tradition. The precise job of economists is to look through the veil and reveal the "real" economic relations behind it. Smith recognized that banking operations might improve economic performance, but banking was not regarded as anything essential to the wealth of a nation.

The Currency School and the Banking School The development in the 19th century gave birth to the controversy between the Currency School, who adhered to the Quantity Theory and believed paper money should function as if they were gold, and the Banking School, who noticed deposits played an important role in money creation and the money supply was driven by market demand. In the context of a modern monetary system, which is free of "hard money" like gold or silver, the relevance of the Currency school thoughts is in question. The picture painted by the Banking school is more close to the actual working of modern finance.

Knut Wicksell extended the thinking of the Banking School and proposed a framework of analyzing the interaction of money and real output – via the relationship between the money rate of interest and the natural rate of interest – that is still influential today. Wicksell differentiates a "pure cash economy" from a "credit economy." In the latter case, "the necessary quantity of money can be infinitely small, and its velocity of circulation to be infinitely great" (Wicksell 1898, 65). With organized credit channeling (i.e. banking), money does not even have to circulate at all to facilitate transactions, since "all domestic payments are effected by means of the *Giro* system and bookkeeping transfers" (Wicksell

1898, 70). In such a system, the supply of money is totally elastic, which makes deducting price level from the quantity of money insensible. Wicksell, therefore, diverts the focus of monetary control from reserve quantities to the rate of interest, claiming that the linkage between financial operations and the real economy is through the difference between the money rate of interest and the "natural rate of interest" (real return on capital). Whenever the money rate of interest is lower than the natural rate of interest, a surplus is generated as entrepreneur profits, which encourages business expansion. Therefore, excessive credit facilitates overly expansion. The inevitable speculative behavior developed during expansion presage a future economic downturn as a correction.

> Under special conditions simple credit may itself be capable of a significant degree of expansion, for instance at times of speculation as a result of the attractiveness of higher profits, or of the offer of ever higher prices or of a higher rate of interest. But as soon as this incentive disappears, the contraction is correspondingly catastrophic, as is revealed in the period of crisis that ensues. Everybody now hastens to fortify his balances, which appear much too small in relation to the new level of prices. The demand for goods contracts, their supply increases, and prices fall, for a time possibly far below their normal level—particularly if confidence has been strained and general mistrust prevails. (Wicksell 1898, 62)

Monetary theory of development Wicksell's contribution inspired many money theorists in the 20th century. Joseph Schumpeter is one of them. Schumpeter's theory of money and banking is a unique strand in its own that deserves special attention. Schumpeter incorporates money and banking in its economic development theory and regards it as an indispensable feature of the capitalist economy. Schumpeter considers economic development as "different employment of existing services of labor and land," and banking credit is essential to achieve the re-employment.

> The essential function of credit in our sense consists in enabling the entrepreneur to withdraw the producers' goods which he needs from their pre-

> vious employments, by excercising a demand for them, and thereby to force the economic system into new channels... the nature of the process, which consists in creating a new demand for, without simultaneously creating, a new supply of goods. (Schumpeter 1911, 106)

The peculiar of the banking business is precisely, contrary to the common belief, that banks do not lend depositors' money, but create purchasing power on their own. Banks identify profitable businesses and grand them purchasing power so that productive resources can be drawn from other employment and reallocated into the new business. In this regard, banks play a central role in resource allocation in a capitalist economy, which is considered by Schumpeter the key difference between a capitalist economy and a command or planned economy. Money is never a veil in a capitalist setting, "...the essential features of the capitalist process may depend upon the 'veil' and that the 'face behind it' is incomplete without it." In Schumpeter's "creative destruction" paradigm, recessions or crises can be viewed as "credit booms gone wrong." "This loss always occurs if the entrepreneur does not succeed in producing commodities at least equal in value to the credit plus interest." (Schumpeter 1911, 114)

Debt deflation and Monetarism The Great Depression in the early 20th century sparked various economic thoughts attempting to explain how financial stress transmitted to economic crises. One of the most notable theories among them is Fisher's "debt deflation" theory (Fisher 1933). According to Fisher, when an economy is heavily indebted, debt liquidation and deflation triggers a downward spiral that sends the economy into deep crises.

> Assuming, accordingly, that, at some point of time, a state of over- indebtedness exists, this will tend to lead to liquidation, through the alarm either of debtors or creditors or both. Then we may deduce the following chain of consequences in nine links: (1) Debt liquidation leads to distress selling and to (2) Contraction of deposit currency, as bank loans are paid off, and to a slowing down of velocity of circulation. This contraction of deposits and of

> their velocity, precipitated by distress selling, causes (3) A fall in the level of prices, in other words, a swelling of the dollar. Assuming, as above stated, that this fall of prices is not interfered with by reflation or otherwise, there must be (4) A still greater fall in the net worths of business, precipitating bankruptcies and (5) A like fall in profits, which in a "capitalistic," that is, a private- profit society, leads the concerns which are running at a loss to make (6) A reduction in output, in trade and in employment of labor. These losses, bankruptcies, and unemployment, lead to (7) Pessimism and loss of confidence, which in turn lead to (8) Hoarding and slowing down still more the velocity of circulation. The above eight changes cause (9) Complicated disturbances in the rates of interest, in particular, a fall in the nominal, or money, rates and a rise in the real, or commodity, rates of interest. (Fisher 1933)

Another influential school of thoughts spawned by the Great Depression is Monetarism, largely thanks to the work of Friedman and Schwartz (1963). Friedman and Schwartz, through a careful study of the monetary history of the United States, found that

> Changes in money income and prices have, in every case, been accompanied by a change in the rate of growth of the money stock, in the same direction and of appreciate magnitude, and there are no comparable disturbances in the rate of growth of the money stock unaccompanied by changes in money income and prices. (Friedman and Schwartz 1965)

The quantity of money, therefore, is an independent source of economic fluctuations, not merely a reflection of cyclical behavior of the real economy.

> The reflex influence of business on money... would then become part of the partly self-generating mechanism whereby monetary disturbances are transmitted. (Friedman and Schwartz 1965)

The central mechanism transmitting monetary shocks to economic fluctuations, identified by Friedman and Schwartz, is through portfolio adjustments. For example, an initial impulse on money stocks disturbs money holders' portfolio of money and securities, thus triggers a portfolio rebalance toward more security holdings. As they seek to purchase these assets, they will bid up the prices of financial assets. As a result, an imbalance of the portfolio with financial wealth and real income will emerge, which leads to more purchasing of real goods and services, therefore raise the general price level. Friedman and Schwartz also argue the portfolio adjustment movement always has a tendency to overshoot because of adaptive expectations and feedback effects. The dynamic process of overshooting and adjustment fulfills a "monetary theory of partly self-generating cyclical fluctuations."

Although the effect of changing stocks of money on economic activities is undeniable, nowadays we believe that the monetary theory of business cycles is inadequate. First of all, in present times with the increasing complexity of financial markets, a whole range of quasi-money assets are created and compete with traditional banking deposits. It becomes less justified to exclusively focus on banking deposits which are the only financial assets regarded as money. Money is inadequate in the modern context in the sense that money fails to account for a hefty amount of intermediary flows. Empirical studies also identified a decoupling of credit and money in postwar period, that money becomes a less credible predictor for business cycles (Schularick and Taylor 2012). Secondly, exclusively focusing on money will miss important mechanism that finance interacts with the real economy. As pointed out by Schumpeter (1911) and Fisher (1933), financial forces affect real economic activities not only through the quantity of money, but the quality of credit and the level of indebtedness is also critical. In other words, in terms of financial and economic stability, what matters is the overall debt structure, not only the narrowly defined stock of money. For the above reason, throughout this paper, I focus on the total credit generated by the financial system (including both banks and non-bank institutions), not the stock of money.

Theorizing financial institutions Gurley and Shaw (1960) is a remarkable work on theorizing financial markets and institutions. Gurley and Shaw realized that narrowly focusing on money was no longer appropriate in the post-war United States. They "attempt to develop a theory of finance that encompasses the theory of money." Gurley and Shaw (1960) developed a general equilibrium framework for financial assets and debt. They emphasize how financial development alters the equilibrium growth path even without price stickiness or money illusion.

> We have played the game according to the ground rules of neo-classical economics in order to show that even here money is not a veil, that it may have an important role to play in determining the level and position of output. (Gurley and Shaw 1960, 10)

The reason is briefly as follows: suppose there is more debt issuance, given the spending units' portfolio preference, their demand for liquidity grows as debt accumulates. If the supply of money stays constant, it will entail a higher interest rate in the new equilibrium, which will no long be the same as the previous one. Therefore, to maintain a balanced growth path, monetary policy must expand proportional to rising debt to satisfy the portfolio diversification demand of spending units. This is true even in neo-classical settings with perfect price flexibility.

The development of nonmonetary intermediaries alters the equilibrium too. The presence of money substitutes tends to offset central banks' effort to control the money supply, which renders monetary policy less effective. Therefore, what matters, to both economic growth and monetary policy concerns, is the "financial capacity," which is the capacity to absorb debt without restrain the current spending (Gertler 1988). Financial intermediaries are important because they enrich the channels of financial resources and make it possible for certain borrowing and lending that would be infeasible otherwise.

However, before the theories of Gurley and Shaw gained influence, the stagflation experience of the 1970s gave rise to the school of rational expectations. Money irrelevance view gained popularity and culminated in the Real Business Cycle (RBC) theory (Kydland and Prescott 1982). The RBC theory projects business cycles as efficient responses

to real exogenous shocks and denies any endogenously generated fluctuations. The RBC theory is a revival of the classical dichotomy: money becomes a veil again. More comments on the RBC theory are unnecessary. The correctness of the theory is irrelevant here because RBC provides no explanation for the financial aspects of the economy, which is the main concern of this paper. As Borio (2014) remarked: "since shocks can be regarded as a measure of our ignorance, rather than of our understanding, this approach leaves much of the behaviour of the economy unexplained."

The credit view The end of the Bretton Woods system in early 1970s decoupled the Dollar from the gold, since then money lost its peg and could expand without limits. The new environment brewed a monetary thought called the "credit view" as opposed to the "money view" represented by Milton Friedman. The controversy more or less resembled the 19th-century debate between the Banking School and the Currency School. Mishkin (1978) found that the household balance sheet was an important transmission mechanism during the Great Depression causing the decline of aggregate demand. Bernanke (1983) found money was not enough to explain the severity of the Great Depression; the collapse of the financial system, choking off credit to the economy, was an important determinant of the depth of the depression. Bernanke (1986) showed that credit explained a much larger proportion of money- income correlation than commonly assumed. These researches divert the money-focus explanation of economic fluctuation to credit creation and balance sheet analysis.

Also the development of modeling techniques, and the discovery of information asymmetry, enabled economists to incorporate financial factors in economic models with the same level of rigor as Real Business Cycle models. Bernanke and Gertler (1986) showed that with information asymmetry, financial arrangement between borrowers and lenders entails an agent cost. Only entrepreneurs with a net worth above a certain level can borrow. Therefore, the capital supply curve depends on entrepreneurs' net worth. After a productivity shock that raises the entrepreneurs' net worth, the expansion persists because higher net worth enables more borrowing and capital accumulation which in turn raise the entrepreneurs' net worth even higher. This is called the "financial accelerator

effect." Kiyotaki and Moore (1997) also showed collateral requirements in borrowing tend to amplify business cycle fluctuations. Because borrowers' credit limits are constrained by the price of the collateral assets, while the prices of these assets are also affected by the credit limits. Therefore, there is a self-reinforcing interaction between credit and asset prices that generate business cycles endogenously.

After the GFC The idea of endogenous business cycles generated by the financial system is also propounded by schools of thought outside of the mainstream, such as Hyman Minsky's "financial stability hypothesis," which was largely ignored for decades until the Global Financial Crisis reigniting the interest of the theory. Unlike the neoclassical approach of assuming perfect competition, Minsky analyzed a capitalist economy with monopolistic power. The function of price is not only to clear the market and allocate resources, but must also be able to support the debt structure of the economy.

> ... the normal functioning of a modern capitalist economy depends upon capital income (and thus investment) reaching and sustaining a level at which capital assets earn sufficient income to validate past debts. If this situation does not prevail, the prices of capital assets and debts fall, and such a decline adversely affects investment demand.(Minsky 1986, 195)

Therefore, the financial arrangement, or the debt structure, is never a simple veil, but determines relative prices, income, and output. The capitalist economy is "a system of borrowing and lending based upon margins of safety" (Minsky 1986, 90), which means the margins of cash receipts relative to payment commitments on liabilities. The higher the ratio of liabilities to cash flow, or the ratio of external to internal financing, the narrower the margins of safety. Minsky (1986) proposed that the financial system is inherently unstable. Sustained growth does not only induce more investment, but also a change in the financing structure, from internal financing to external financing ("speculative financing" or "Ponzi financing"), which means the erosion of margins of safety. If such a financing structure is encountered with a negative shock so that cash income can no longer validate the financing structure, the system breaks down and heads toward a financial

crisis.

In the wake of the GFC, a large body of research is dedicated to understanding how financial shocks are transmitted to real consequences. The experience of the GFC has brought fresh ideas into the literature. Earlier literature mainly focuses on borrowing constraints and leverage dynamics of the non-financial business sector. Theorists after the GFC start to incorporate household and bank balance sheets into their models (Gertler and Kiyotaki 2010; Brunnermeier and Sannikov 2014; Eggertsson and Krugman 2012). Empirical researchers, by utilizing long-run time series over a century, show that there are repeated patterns that credit expansion and household leverage lead to economic instability and recessions (Reinhart and Rogoff 2011; Schularick and Taylor 2012; Mian, Sufi, and Verner 2017).

Summary To briefly summarize, we believe the relationship between finance and real economic activities is not simply captured by saving-investment dynamics or the quantity theory of money. "The banking system does not simply transfer real resources... it generates (nominal) purchasing power." (Borio 2014) Because the existence of a positive feedback loop between credit creation and asset prices, financial expansion and contraction tends to be self- reinforcing and generates economic fluctuations internally. Lasting booms result in low risk perception, excessive indebtedness, and vulnerable financing structure, which erodes the safety margin of the system and is internally destabilizing. In other words, there are externalities associated with leverage choice: individual household or enterprise may fail to internalize the vulnerabilities their borrowing behavior may impose on the whole economy. This rationale justifies government regulations on overall leverage choice.

3 Data and methodology

In the light of the theories in Section 2, the rest of the paper is to explore the evidence in the context of China. It is of particular interest whether the financial macroeconomic relationships predicted by the theories above still hold in a drastically different institutional

setting.

Broadly speaking, there are two approaches to study financial cycles in the literature. One is to compile the relevant variables into an index (English et al. 2005; Levanon et al. 2015; Ma, Feng, and Tian 2016). The other is to study each critical variable separately (Claessens, Kose, and Terrones 2012; Yi and Zhang 2016). I follow the second approach in this paper. Not only because using a single index conceals the heterogeneity of the response of the economy to each individual variable; but also because treating the variables separately allows us to study the interaction effect among them, which is tremendously helpful to uncover the transmission mechanism of financial shocks.

I start by describing the major variables used in the study, namely, credit, house price, and leverage ratios. These variables are widely used as proxies for observing financial cycles. For the purpose of studying boom and bust cycles, cyclical fluctuations need to be separated from the long-term growth trend. I adopted the boosted HP filter to accomplish this task. Then I characterize the basic features of the financial and business cycles including their duration, amplitude, correlation. A special event study is conducted to explore the interactions between the turning points of financial variables and the real business cycle.

3.1 Choice of variables

I choose three indicators to characterize the financial cycles: credit, house price, leverage ratio. Credit reflects the aggregate claims created by the financial system, which is a natural choice to represent financial cycles. Credit is also regarded by some as the single most powerful indicator for financial crisis (Schularick and Taylor 2012). In this paper, I use the Total Credit to the Non-Financial Sector from the BIS credit statistics.[2]

[2]BIS total credit comprises financing from all sources, including domestic banks, other domestic financial corporations, non-financial corporations, and non-residents. The financial instruments covered comprise currency and deposits, loans, and debt securities. Debt securities include bonds and short-term papers; equities, insurance, pension funds are not included. In the literature on China, the Aggregate Financing to the Real Economy (AFRE) is more widely used to measure total credit. However, the AFRE statistics are only available yearly after 2002, and monthly after 2014. While BIS total credit is quarterly data back to 1995. The coverage of BIS total credit and AFRE largely overlap. The correlation between BIS total credit and AFRE after 2014 is 0.9944. To preserve consistency in data, BIS total credit is used throughout this paper.

House price is another important indicator of financial cycles. Housing properties, though being real assets, have many similar characteristics as financial assets. As the most commonly accepted collateral for credit, house prices capture the endogenous relationship between entities' net worth, borrowing constraints, and credit creation. Strong evidence suggests household leverage (mainly through mortgage loans) influences business cycles through credit supply channels (Mian, Sufi, and Verner 2017). In this paper, I use the Average Price of Commercial Residential Buildings from the National Bureau of Statistics as a measure of average house prices.[3]

The leverage ratio, defined as the overall non-financial debt to GDP, is also considered as a key indicator. It is argued that indebtedness is not a problem as long as income flows are sufficient to meet the payment requirement. Therefore, the debt to GDP ratio captures the overall fragility of the economy. I include the Non-financial Sector Leverage Ratio from the National Institution for Finance and Development (NIFD). Theoretically, total credit to the non-financial sector is equivalent to the total debt bearing of the sector. But including leverage ratio as a separate variable is not trivial. First, credit expansion does not necessarily mean rising leverage ratios if real output grows proportionally. Therefore, credit growth and leverage ratio do not measure the same thing. Second, data from the BIS and NIFD are not identical. Including another source of measures as a robustness check improves the credibility of the results.

I do not include equity price in the study, despite researches have found strong correlations between credit growth, equity price, and economic performance (Baron and Xiong 2017; Baron, Verner, and Xiong 2021). The reasons is twofold. First, the equity market in China is still immature relative to developed economies. Fluctuations in equity prices are more likely driven by speculations rather than economic fundamentals. Therefore, even if we find a correlation between equity price and real economic performance, it more likely captures market sentiment effects rather than the "financial accelerator effect" we

[3]This only includes a portion of the total residential properties in China, indemnification housing and other types of public-built private-owned housing are not included in this statistic. But narrowing down to privately traded residential properties is a better choice to reflect market conditions. Other indicators, such as the average house price of 70 major cities, are more widely used in the literature. However, these indicators are only available for recent years. The indicator chosen in this paper traced the house prices back to 1998, the beginning of China's housing market reform.

are after. Second, equity financing accounts for only 1.36% of the total financing of non-financial firms as of 2019. The vicissitude of the equity market is the least representative for the overall financial conditions.

I also include inflation and interest rates as control variables. The Consumer Price Index is used as the proxy for inflation, detrended with the bHP filter as other variables. I choose the seven-day repo rate (R007) as the proxy for interest rates. China does not explicitly target money market rates for its monetary policy. The benchmark lending rate is controlled by the monetary authority. However, it is not adjusted frequent enough to reflect market conditions. The repo rate is an ideal proxy for interbank money market conditions.

The data are of quarterly frequency, ranging from 1999 to 2019. The data starts from 1999, firstly due to the data availability; secondly, considering China took a major reform in the housing market in July 1998 – since then residential properties can be freely traded in the market – the house prices before 1999 have little value for the purpose of this paper. The time series are seasonally adjusted whenever necessary.

3.2 Cycle extraction

There are many methodologies to identify cycles in macroeconomic variables. The classical method tracks the absolute increase or decrease of economic activities. For example, a recession is identified by two consecutive quarters of declines of real GDP. However, this "classical" business cycle definition is not suitable for fast-growing economies, in which macroeconomic variables are constantly in upward movement. For fast-growing economies, the "growth cycle methodology" is more appropriate, which identifies cycles as fluctuations around a trend.

In this paper, I apply the Boosted Hodrick-Prescott (bHP) filter (Phillips and Shi 2019) to extract the cyclical components from the time series. BHP filter is an enhanced version of the classical HP filter (Hodrick and Prescott 1997), which applies HP filter iteratively and is proven to asymptotically recover the true trend mechanism. A comparison between bHP and other cycle extraction methods suggests cycles identified by

bHP are more stable and economically sensible.[4] To the best of my knowledge, this work is the first to apply the bHP technique to identify business cycles among the relevant literature. Log-transformation is applied to variables that grow proportionately to their sizes such as GDP, credit, and house prices. By taking logarithms, the extracted cycles have a very nice interpretation – the percentage deviation from the trend. For example, the cyclical components of real GDP can be interpreted as GDP gaps, whose values are percentage deviations from the long-term growth trend.

Harding and Pagan (2002)'s turning-point algorithm is then applied to identify peaks and troughs. The algorithm involves three steps: (1) identifying local maxima and minima over a window of minimal 5 quarters; (2) imposing censoring rules that the minimum length of each phase of upturn or downturn is 2 quarters; (3) peaks and troughs must appear alternately, that is there must be one and only one peaks (troughs) between two troughs (peaks). Figure 1 plots the extracted cycles of the variables together with the identified turning points.

4 Basic features of financial cycles in China

4.1 Duration and amplitude

Table 1 reports the duration and amplitude of the cycles for each major series based on the turning points identified in Section 3.2. The duration of an upturn (downturn) is defined as the quarters from a trough (peak) to a peak (trough). The amplitude is the absolute difference between the value of the peak and the value of the trough.

To summarize the findings in Table 1: (1) Most variables have a full cycle length of

[4]See Nilsson and Gyomai (2011) for a technical comparison of various cycle extraction methods. The Phase-Average-Trend (PAT) method, used by OECD, is outperformed by the HP filter and the CF filter. The Christiano-Fitzgerald (CF) filter is used in various literature such as Drehmann, Borio, and Tsatsaronis (2012) and Zhu and Huang (2018). However, the CF filter pre-imposes the length of the cycle to be within a certain band. According to Drehmann, Borio, and Tsatsaronis (2012), the short-term cycles are between 1 and 8 years, and mid-term cycles are between 8 to 30 years. Since China's data is available for only 20 years, applying the CF filter may bear the risk of losing too much information. Another approach is simply taking year-over-year percentage change, as most of economic statistics in China are released as YoY growth. However, directly using growth rate to identify business cycles is problematic. First, the growth rate itself has trends. Second, it does not inform whether a level is above or below the trend.

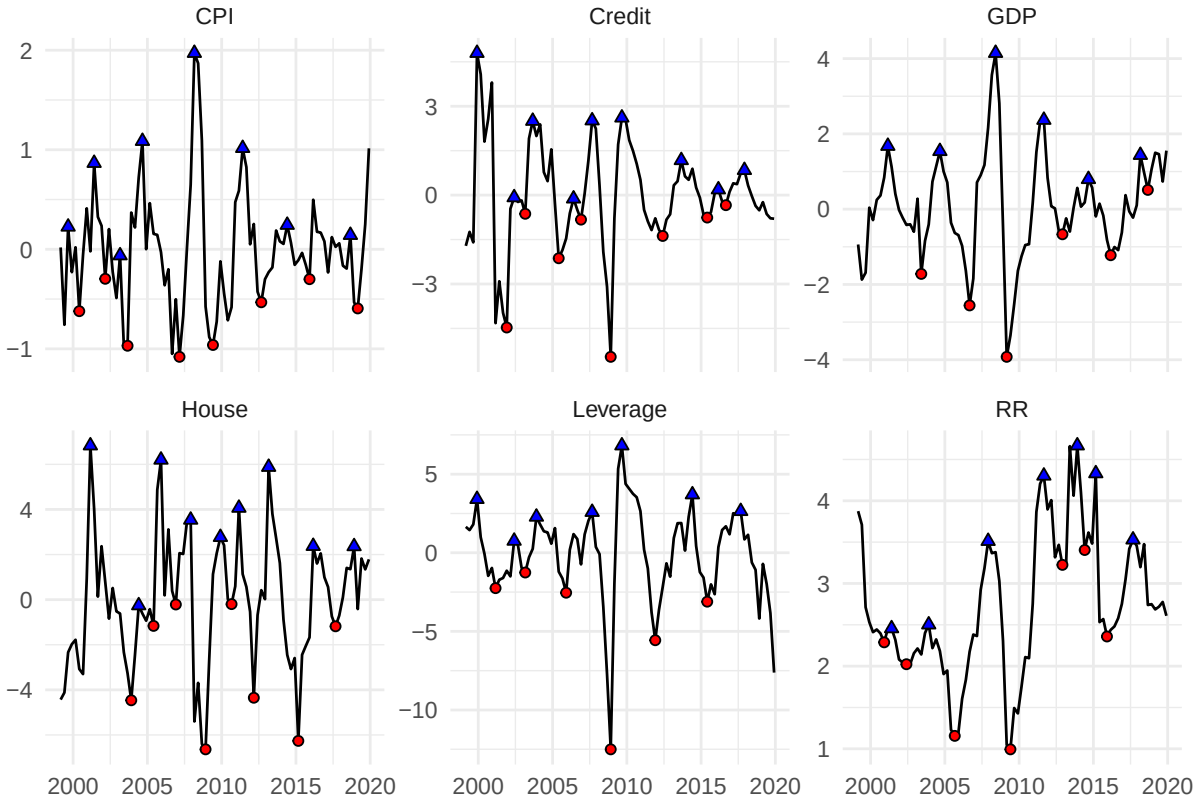

Figure 1: Business cycles and turning points

Table 1: Basic cyclical features of main variables

Indicator	Measure	Upturn	Downturn	Full Cycle
GDP	Amplitude %	4.07	3.59	
	Duration	7.40	5.50	12.90
CPI	Amplitude	1.43	1.36	
	Duration	6.00	4.50	10.50
Credit	Amplitude %	3.20	3.70	
	Duration	3.38	5.62	9.00
Leverage	Amplitude	7.67	7.80	
	Duration	6.17	5.67	11.83
House Price	Amplitude %	6.42	6.98	
	Duration	3.38	5.50	8.88
Interest Rate	Amplitude	1.41	1.43	
	Duration	5.71	4.50	10.21

8-12 quarters. Real GDP and leverage ratio have longer cycles than others, while the house price has the shortest cycle length. (2) Real variables tend to have longer upturns than downturns. For example, real GDP has an average of 7.4 quarters of upturns and 5.5 quarters of downturns. While financial variables tend to have longer downturns than upturns. For example, credit has an average of 3.4 quarters of upturns and 5.6 quarters of downturns. (3) In terms of the amplitudes, all variables exhibit roughly even amplitudes of upturns and downturns. For variables whose amplitudes have a percentage interpretation, the magnitude of an upturn or downturn is roughly 4-6% relative to the trend.

Note the numbers reported here are remarkably shorter than the duration of financial or business cycles reported from developed economies (Claessens, Kose, and Terrones 2011; Claessens, Kose, and Terrones 2012; Borio 2014). In the latter case, the duration of a full cycle typically lasts 15-20 quarters. The difference may be partially attributed to the different cycle extraction methods. Institutional factors may also affect the behavior of macroeconomic variables. For example, China used to take strong counter-cyclical fiscal policies during downturns, which usually resulted in fast recovery but also protracted readjustment afterward. However, the results here are consistent with conclusions from the Chinese literature (Yi and Zhang 2016; Zhu and Huang 2018).

4.2 Correlation and concordance

Figure 2 shows the correlation between the series. It is not surprising real GDP is positively correlated with CPI and the interest rate (proxied by the repo rate, RR), which is consistent with the predictions from the ISLM model and the Phillips curve. Real GDP is negatively correlated with credit, house price, and leverage ratio, indicating that the financial cycle is not synchronized with the real business cycle. The interaction between the financial cycle and the real business cycle will be explored in detail in the following sections. It is interesting that none of the three financial variables has a significant correlation with the interest rate, though the coefficient is negative as expected. The leverage ratio is positively correlated with credit growth, but the correlation is not as

strong as one may expect. It confirms the assertion in Section3.1 that they convey different information about the financial conditions. More interestingly, the house price is positively correlated with the leverage ratio, but has no correlation with credit.

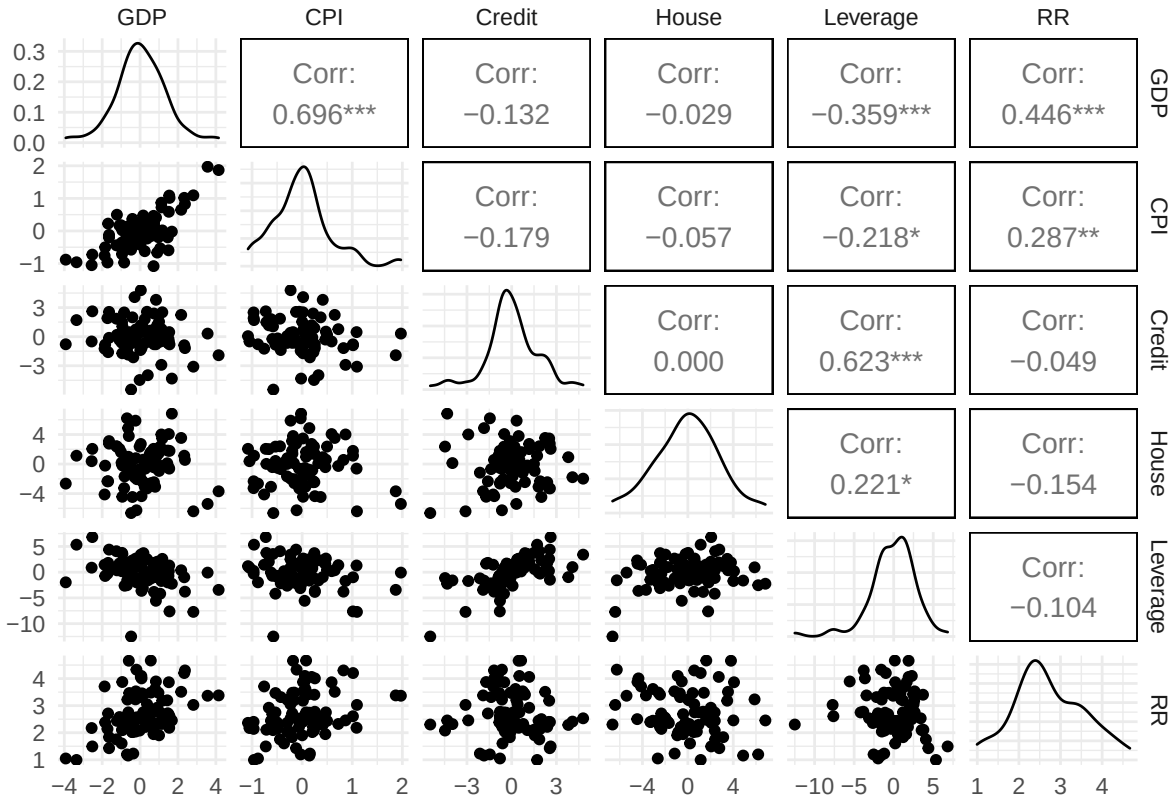

Figure 2: Correlation between series

To further shed some light on the concordance of the cycles of different series, I calculate the concordance score between the variables following Drehmann, Borio, and Tsatsaronis (2012). Concordance measures the percentage of time for which two series are in the same phase (upturn or downturn). The concordance score is defined as

$$\rho_{XY} = \frac{1}{T}\sum_{t=1}^{T}[\rho_t^X \rho_t^Y + (1-\rho_t^X)(1-\rho_t^Y)]$$

where

$$\rho_t^X = \begin{cases} 0, \text{if X is in downturn} \\ 1, \text{if X is in upturn} \end{cases}, \quad \rho_t^Y = \begin{cases} 0, \text{if Y is in downturn} \\ 1, \text{if Y is in upturn} \end{cases}.$$

Table 2: Concordance between variables

Variables	GDP	CPI	Credit	House	Leverage	RR
GDP	1.00	0.75	0.45	0.54	0.48	0.58
CPI	0.75	1.00	0.46	0.52	0.49	0.62
Credit	0.45	0.46	1.00	0.65	0.81	0.56
House	0.54	0.52	0.65	1.00	0.49	0.38
Leverage	0.48	0.49	0.81	0.49	1.00	0.58
RR	0.58	0.62	0.56	0.38	0.58	1.00

The concordance scores are reported in Table 2. Real GDP has 75% of the ups and downs overlapped with CPI, but only 45% overlapped with credit, 54% with house price, and 48% with leverage ratio, indicating real business cycle variables are more synchronized with each other than with financial variables. Meanwhile, financial variables are more likely in concordance with other financial variables. Credit has a concordance score of 65% with house prices and 81% with leverage ratio, which is obviously higher than with real GDP or CPI. Interest rate cycles are highly concordant with inflation cycles, which is expected, but only moderately concordant with other variables.

4.3 Event study around peaks and troughs

It is of particular interest how macroeconomic variables behave around the peaks and troughs of financial cycles. This section conducts a simple event study based on the peaks and troughs identified in Section 3.2.

Figure 3 traces the average real GDP gaps after a peak or trough in each of the three financial cycle indicators. For comparison, Figure 3 also shows a reference trend after a "placebo" event (the average of some random draws of 6 consecutive quarters from the dataset). In every scenario, the dynamics of real GDP is visibly different from the "placebo" reference.

Several observations are worth to remark. (1) Real GDP on average peaks in 3-4 quarters after credit cycle peaks, and bottoms out 1 quarter after credit cycle troughs. (2) The real economy responds more promptly to house price cycles. Real GDP peaks in just 2 quarters after house price peaks, and starts to recover almost immediately after

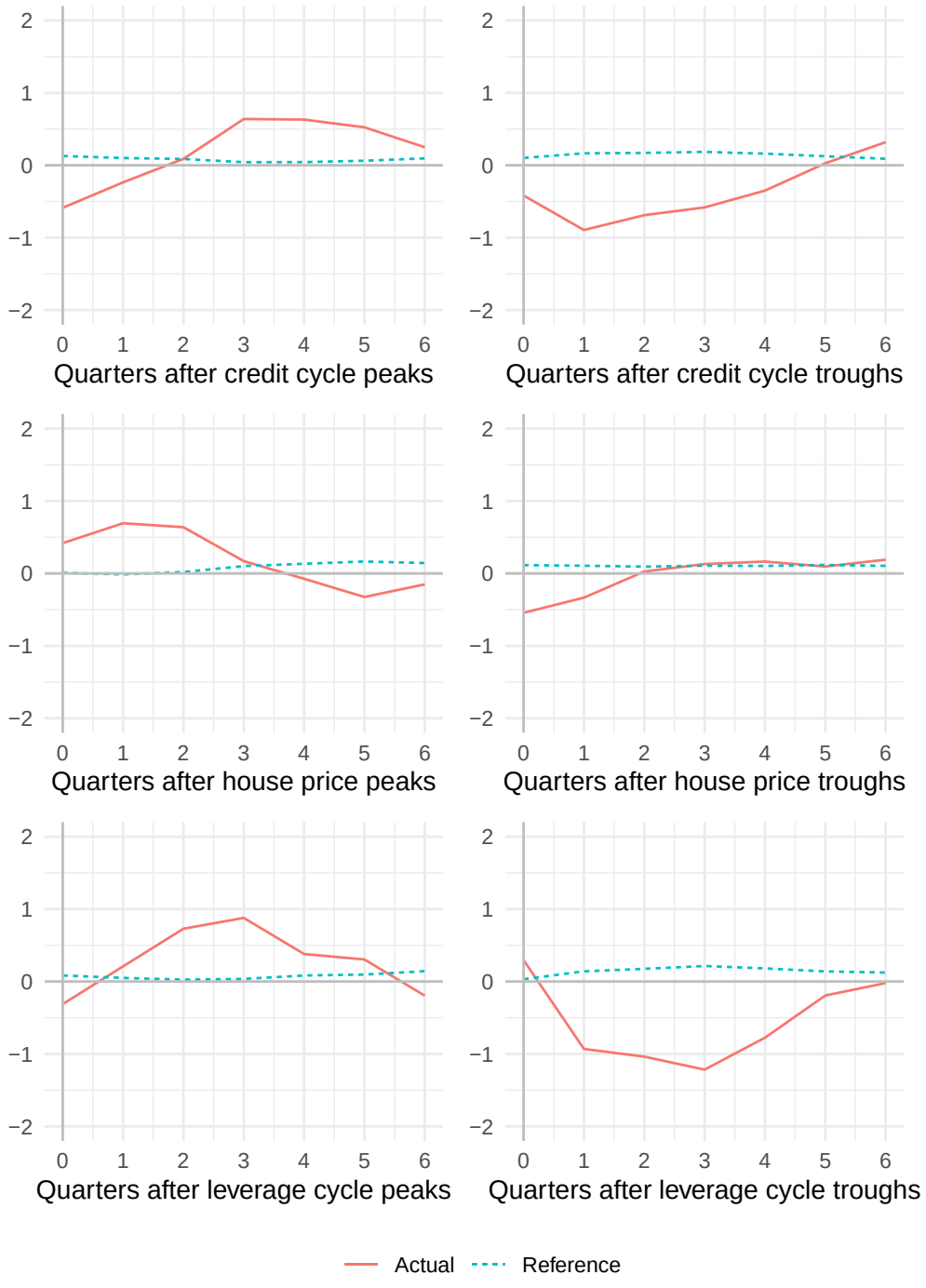

Figure 3: Real GDP after financial cycle peaks and troughs

house price troughs. (3) The response of real GDP to leverage cycles has a slightly larger magnitude than the response to credit or house price cycles. The peak follows 3 quarters after leverage ratio peaks. But output recovers slowly following leverage ratio troughs. However, these results only compare the unconditional means. The next section will explore the dynamics in a more rigorous manner.

5 Financial cycles and business cycles

This section explores the relationships between financial cycles and business cycles in formal empirical frameworks. First, I extend the event study in Section 4.3 and explore the output dynamics after financial cycle peaks and troughs in more detail. Then I conduct a VAR analysis to investigate the response of real output to financial shocks. Finally, I will show that, in a forecasting framework, financial variables help predict future economic recessions, defined as negative output gaps. In short, the evidence shows all the three financial variables – credit, house price, and leverage ratio – are leading indicators for real output movements. Financial expansions foresee upcoming prosperity, but also presage subsequent recessions.

5.1 Aftermath of peaks and troughs

To formally examine the output response after financial cycle peaks and troughs, I estimate a Jordà (2005) local projection, which allows flexibly including controls into model.

$$y_{t+h} = \alpha_h + \beta_h X_t + \gamma_h^P \mathbb{1}[\text{PEAK}(X_t)] + \delta_h^P X_t \times \mathbb{1}[\text{PEAK}(X_t)] + \Phi(L) Z_t + \epsilon_{t+h} \quad (1)$$

$$y_{t+h} = \alpha_h + \beta_h X_t + \gamma_h^T \mathbb{1}[\text{TROF}(X_t)] + \delta_h^T X_t \times \mathbb{1}[\text{TROF}(X_t)] + \Phi(L) Z_t + \epsilon_{t+h} \quad (2)$$

where y_{t+h} is the real output gap h-period ahead. X_t is one of the three financial variables, namely, credit, house price, or leverage ratio. $\text{PEAK}(X_t)$ and $\text{TROF}(X_t)$ indicate whether

X_t is at its peak or trough at time t. Z_t controls for several macroeconomic variables including two lags of real output, inflation, and interest rates.

The parameter β_h captures the response of output gaps h-period after an initial shock in X_t. γ_h captures the alteration of the expected output gaps following a peak or trough of X_t. δ_h captures the possible difference in the response of output gaps to X_t after the peaks or troughs.

Note that the linkage between financial cycles and real business cycles could come from two sources. First, it is possible that a contraction of financial cycles starves financing resources from the real economy, and thus causes a downturn in the real business cycle. Second, it is also possible that financial agents anticipate a real economic downturn in the future and withdraw financial resources beforehand, thus financial indicators, both credit and asset prices, usually exhibit forward-looking characters. Therefore, the estimation in this section does not have a causal interpretation, but provides an average predicted path of subsequent real output gaps following a peak or trough of the financial cycle.

Table 3 reports the results estimated from Equation 1 and 2 for horizons $h = 1, \ldots, 6$. Standard errors are in Newey-West.[5] To summarize the results, they are broadly consistent with the findings in Section 4.3. Peaking financial cycles presage an upcoming slowdown of the real output; and financial troughs indicate the economy is about to recover.

A shock to credit initially boosts the output, but the trend reverses after 5-6 quarters. When the credit cycle peaks, there is immediate downward pressure on the output, demonstrated by the negative coefficients after the peak. However, there is no clear pattern for output after credit troughs. It seems the output moves higher than usual shortly after the credit bottoms out but drops lower after two quarters, though none of the coefficients are statistically significant.

The peaks and troughs of house prices have strong implications for the real output. After the peak, output gaps remain higher than usual, but the euphoria exhausts after

[5]Equation 1 and 2 both include lags of dependent variables. As suggested by Olea and Plagborg-Møller (2020), it is sufficient to use heteroskedasticity consistent standard errors in lag-augmented local projections. This paper still use heteroskedasticity and autocorrelation consistent standard errors as most local projection literatures do.

5 quarters and the output gaps drop significantly below its usual level by 1.4 percentage points. The negative interaction terms indicate after the peak house prices contribute negatively to output growth. On the other hand, output responds quickly and strongly to house price troughs. The projected output gap is roughly 1 percentage point higher than usual after the house price troughs, and the positive effect remains for at least 6 quarters. The interaction terms turn positive after house price troughs, suggesting there is positive feedback between house price and output growth. The result is consistent with the "financial accelerator effect" that will be explored in more detail in Section 6.

There is a strong pattern between the leverage ratio and the output gaps. Rising leverage ratios initially enhance the output growth, but then it becomes a dragging force after around 3 quarters. Conditioning on peaks and troughs seems to alter little of the pattern. The output gaps remain above the usual level even after the leverage ratio peaks and remain below the usual level even after the leverage ratio troughs. This pattern contrasts with the patterns of both credit and house price cycles. The real output shows sluggish responses to the turning points of leverage ratios. However, the coefficients of the interaction terms show that the response pattern of output gaps to leverage ratios are indeed altered around peaks and troughs. The significant negative coefficients suggest that high leverage is potentially a disruptive force around the peaks, while low leverage can benefit the recovery after the troughs.

In summary, the findings confirm the claim that peaks and troughs of financial variables are leading indicators for real output dynamics. Moreover, the data suggests China's output gaps are specifically sensitive to house prices.

Table 3: Real GDP gaps after financial cycle peaks and troughs, with controls

	Dependent variable: 100 × log GDP gap											
	Quarters after peak						Quarters after trough					
	h=1	h=2	h=3	h=4	h=5	h=6	h=1	h=2	h=3	h=4	h=5	h=6
Credit												
Credit	0.121	0.157 **	0.110	0.026	-0.116	-0.180 *	0.065	0.150 *	0.132 *	0.054	-0.090	-0.230 *
	(0.074)	(0.075)	(0.081)	(0.094)	(0.103)	(0.095)	(0.055)	(0.079)	(0.078)	(0.087)	(0.101)	(0.119)
Peak	-0.249	-0.670 *	-0.045	-0.305	-0.365	0.024						
	(0.547)	(0.386)	(0.338)	(0.502)	(0.410)	(0.448)						
Credit × Peak	0.018	0.156	0.021	0.171	0.232	-0.123						
	(0.214)	(0.137)	(0.145)	(0.227)	(0.226)	(0.204)						
Trough							0.226	0.121	-0.384	-0.473	-0.491	0.438
							(0.738)	(0.743)	(0.609)	(0.367)	(0.553)	(0.482)
Credit × Trough							0.324	0.014	-0.251	-0.258 *	-0.217	0.317
							(0.319)	(0.241)	(0.198)	(0.130)	(0.147)	(0.282)
R^2	0.542	0.58	0.588	0.463	0.489	0.56	0.56	0.569	0.598	0.469	0.49	0.572
House price												
House	0.008	0.050	0.091	0.091	0.035	0.003	-0.012	0.026	0.032	0.036	0.015	0.017
	(0.064)	(0.057)	(0.060)	(0.073)	(0.061)	(0.043)	(0.041)	(0.044)	(0.058)	(0.081)	(0.038)	(0.039)
Peak	0.997 *	0.912	0.387	0.010	-1.412 **	-1.112 ***						
	(0.508)	(0.613)	(0.523)	(0.500)	(0.570)	(0.399)						
House × Peak	-0.158	-0.222 *	-0.247 *	-0.195 *	0.162	0.189 **						
	(0.115)	(0.112)	(0.131)	(0.110)	(0.116)	(0.073)						
Trough							0.759	0.971 **	0.708 *	0.602	0.350	0.754
							(0.686)	(0.442)	(0.366)	(0.455)	(0.628)	(0.629)
House × Trough							0.339 *	0.285 ***	0.208 *	0.128	0.038	0.078
							(0.185)	(0.091)	(0.115)	(0.144)	(0.137)	(0.143)
R^2	0.544	0.566	0.604	0.487	0.505	0.532	0.564	0.577	0.595	0.469	0.476	0.529
Leverage												
Leverage	0.173 **	0.200 ***	0.146 *	-0.009	-0.153 **	-0.250 ***	0.068	0.171 *	0.128 *	-0.038	-0.156 *	-0.303 ***
	(0.082)	(0.073)	(0.077)	(0.093)	(0.076)	(0.076)	(0.074)	(0.088)	(0.075)	(0.098)	(0.093)	(0.114)
Peak	-0.050	0.257	1.020 **	0.430	1.006	0.313						
	(0.333)	(0.430)	(0.511)	(1.402)	(1.363)	(0.756)						
Leverage × Peak	-0.129 *	-0.204 **	-0.408 ***	-0.281	-0.313	-0.154						
	(0.065)	(0.094)	(0.099)	(0.344)	(0.337)	(0.150)						
Trough							0.240	-0.383	-1.152 **	-0.971 *	-0.267	-0.106
							(0.541)	(0.404)	(0.482)	(0.552)	(0.476)	(0.485)
Leverage × Trough							0.240 ***	-0.041	-0.182 **	-0.147	-0.042	0.082
							(0.067)	(0.076)	(0.090)	(0.102)	(0.080)	(0.066)
R^2	0.575	0.611	0.627	0.477	0.522	0.624	0.604	0.602	0.625	0.475	0.511	0.627

Note:

Newey-West standard errors are reported in parentheses. * $p < .10$; ** $p < .05$; *** $p < .01$.

5.2 VAR Analysis

This section explores the inter-relationship between the variables of interest in a VAR framework. The reduced-form VAR model is given by

$$Y_t = c + \sum_{j=1}^{p} \Phi_j Y_{t-j} + u_t \tag{3}$$

where $Y_t = [\text{GDP, CPI, RR}, X]_t$, A set of models is evaluated using this framework. I first estimate a standard model with only output, inflation and interest rate. This captures the baseline relationships between key macroeconomic variables. Then I add the financial variable X – credit, house price, and leverage ratio – one at a time to investigate how each financial variable interacts with the economy.

To obtain the impulse response, the variables are ordered such that the interest rate responds to output gaps and inflation contemporaneously while output gaps and inflation responds to interest rate only with lags, and that credit or house prices respond to interest rate contemporaneously but interest rate responds to credit or house prices with lags. The ordering reflects that fact the monetary authority adjusts interest rates in response to output gaps and inflation, and credit or housing market are affected by interest rates. Though it is quite plausible to argue financial variables are forward-looking and moves ahead of real variables (which is consistent with our evidence), different ordering does not alter the results materially. The lag length in Equation (3) is set to 4.[6]

The exploration starts from characterizing the basic relationships between key macroeconomic variables. Figure 4 shows the accumulated impulse responses estimated from the baseline model. Each subplot shows the responses of different variables to the same shock. The results are mostly consistent with standard economic theories. A positive shock to output gaps induces higher price level and rising interest rates. The upward trend plateaus 4-6 quarters after the initial shock. A inflation shock leads to rising interest rate and dampens subsequent output growth. Inflation is followed by immediate

[6] AIC suggests a lag length of 8-10, while BIC, HQ, SC suggest 1 lag. I think 1 lag is insufficient to capture the dynamics, while 8-10 lags are a waste of the degree of freedom given the limited data. 4 lags are chosen because including any more lags does not seem to change the impulse response materially.

upward movement of output and interest rate. However, the trend reverses after 4 quarters and collapses into large negative output gaps. The output loses following inflation is striking – nearly 2 percent below the trend. The third plot shows the responses to a negative interest rate shock, which simulates easing monetary shocks. It is interesting that easing interest rates does not stimulate the economy, but both output and inflation remain below the trend. This reflects the pro-cyclical nature of interest rate movement in the context of China. Interest rates rise along upward business cycle movements, and low interest rates tend to be followed by negative output gaps and deflation.

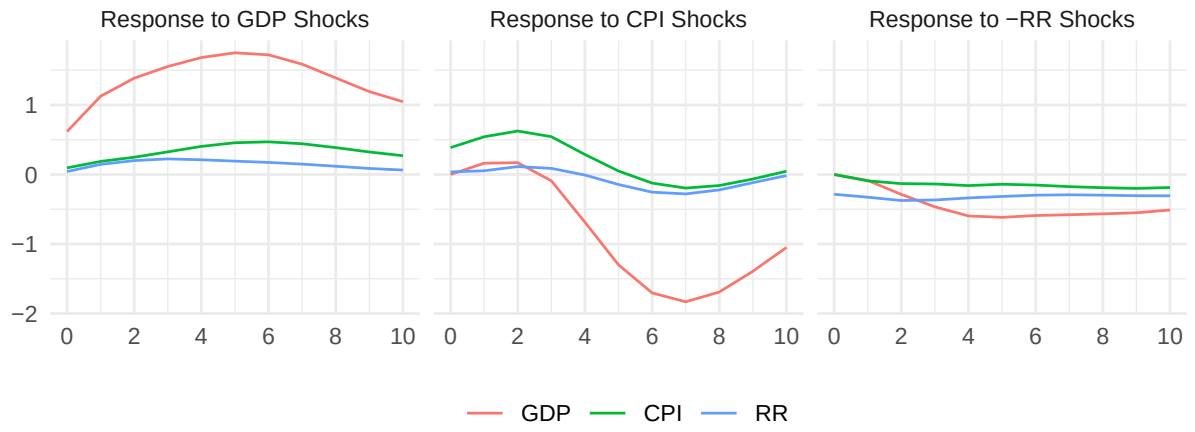

Figure 4: Accumulated impulse response of key variables

It is of particular interest to understand how the financial variables respond to economic shocks. Figure 5 shows the accumulated responses of the three financial variables to output, inflation or interest rate shocks respectively. The heterogeneous response patterns are clearly discernible. After a positive shock to output gaps, credit starts to decline while house prices remain strong. It is not surprising that leverage ratios drop dramatically because strong output growth shrinks the denominator. It maybe a little unusual that strong output is not accompanied by credit expansion. But it is understandable considering credit cycle peaks precedes output by 3-4 quarters (Section 4.3). Inflation shocks, as expected, impose downward pressure to all financial variables. The downward cycle bottoms out in just 4 quarters and a new round of upward movement starts. Compared with the economic response after inflation shocks in Figure 4, it is when the economy slumps into deep recession that the financial variables starts to pick up. Once

again, this result confirms that financial cycles lead real business cycles. In response to easing interest rate shocks, we observe no significant movement in credit and leverage ratios, but a remarkable rise of house prices. Therefore, house prices are sensitive to both output growth and interest rates. The result may be also driven by the government's counter-cyclical polices. The Chinese government typically relax the restrictive policies on home purchase to counter economic downturn pressure. For example, during the economic downturn in 2014, most cities remove the limits on the number of homes one can buy. Such easing policies coupled with low interest rates create strong propulsion for house prices.

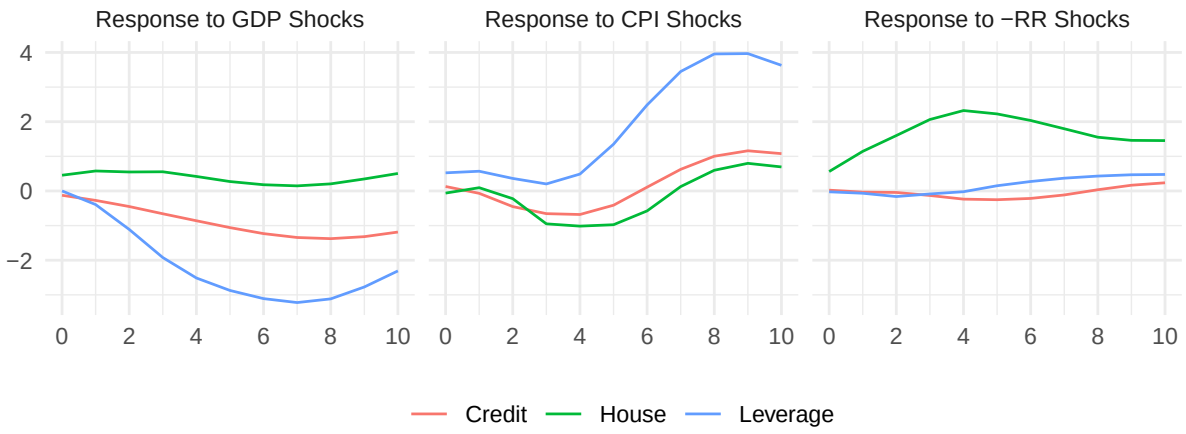

Figure 5: Accumulated response of financial variables to shocks

Since financial cycles lead real business cycles, it is natural to ask how real variables respond to financial shocks. Such a question is even more important in the spirit of Minsky (1986), and in regard to recession forecasting. Figure 6 investigates this issue. I show the accumulated response of real output, inflation and interest rates to various financial shocks. The general pattern is clear: positive financial shocks boost the economy. However, different financial shocks have heterogeneous effects. A credit shock boosts both output and inflation, accompanied by rising interest rates. The boom peaks in 4-6 quarters with a maximal output gap 0.6 percent above the trend. Then the cycle reverses and output and inflation gradually declines to the initial levels. It is a typical pattern that we expect to see as credit expansion leads economic booms. The response to a leverage ratio shock is similar to that of credit shocks, though the impact seems

stronger and more persistent. The output boom peaks as high as 0.8 percent above the trend, and the large positive gap persists even after 10 quarters. The responses to house price shocks exhibit different patterns from credit and leverage shocks. The output gap remains slightly negative after the initial shock then embarks a remarkable increase onward. While inflation remains moderate during the output growth. Combined with the results in Figure 5, we might recover the whole process of house price movements. During economic downturns, the government stimulates the economy by easing real estate policies. House prices start to pick up before the economy recovers, therefore interest rates are still accommodating. Then the real economy starts a new phase of upturn, credit expands, inflation picks up, and interest rates increase as well. As the output grows stronger, it further stimulates the housing market, house prices rise even higher until the rising interest rate inevitably ends the boom.

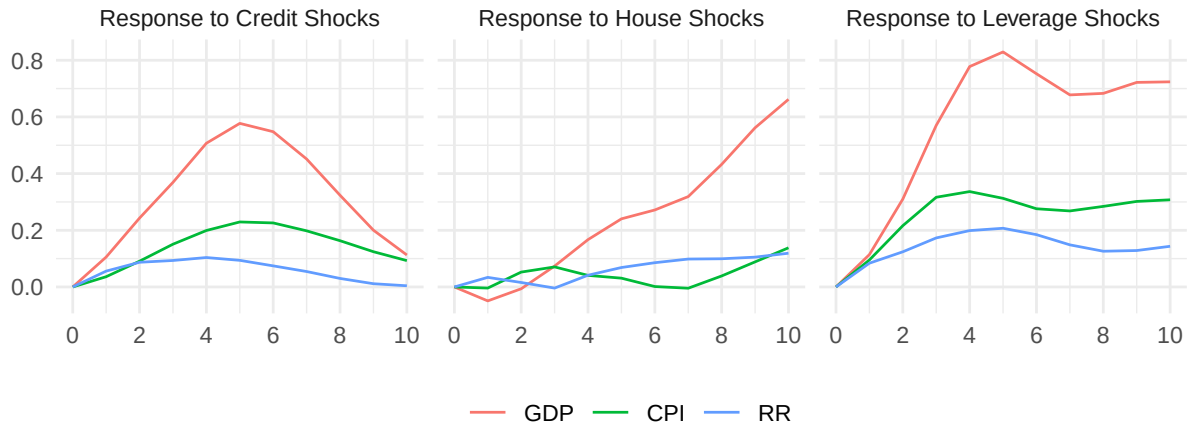

Figure 6: Accumulated response of business cycle to financial shocks

To summarize, the results here is consistent with the findings in Reinhart and Rogoff (2011), Schularick and Taylor (2012) and Mian, Sufi, and Verner (2017), despite the analysis here does not focus on crisis prediction (I will simulate a recession forecasting experiment in the next section). I also uncover the heterogeneous effects of different financial variables on the economy, notably the difference between credit and house price shocks. Such heterogeneous effects are concealed in the researches that study compiled financial condition indexes. The study is not free of shortcomings. One of them is that the study primarily focuses on short-run dynamics. Cerra and Saxena (2008) and Romer

and Romer (2017) have documented the long-lasting impact of financial busts. Such long-term consequences are ignored in this study.

5.3 Recession prediction

The last experiment is to test the predictive power of financial cycles for recessions. Financial indicators have been found to have strong predictive power for economic recessions in developed economies and are widely adopted in various economic leading indicators. I try to mimic the study in the context of China.

There is no severe recession in our dataset thanks to the extraordinary growth performance over the decades. And there is no official classification of recessions in China. Still we can simulate a recession simply by a period of downturns. In this section, I use the OECD based recession indicator for China.[7] The OECD CLI system is based on "growth cycle" approach, and a recession is defined as the period following the peak through the trough.[8]

The forecasting framework is as follows:

$$p_t = \alpha + \beta(L)X_t + \Phi(L)Z_t + \epsilon_t, \tag{4}$$

where p_t is the recession dummy, X_t is one of credit, house price and leverage ratio. In order to incorporate past movements of cycles without including too many lags, I use the past-two-year moving average (de-trended) values for all three predictors. Z_t are the control variables.

Due to the well-known problems with linear probability models – the predicted values are not confined within 0 and 1, I also estimate a probit model:

$$\text{probit}(p_t) = \alpha + \beta(L)X_t + \Phi(L)Z_t + \epsilon_t. \tag{5}$$

To evaluate the predictive power of the model, I use the Receiver Operating Char-

[7]Retrieved from Federal Reserve Bank of St. Louis, OECD based Recession Indicators for China from the Period following the Peak through the Trough; https://fred.stlouisfed.org/series/CHNRECD.

[8]More details on OECD CLI system: OECD Composite Leading Indicators, "Composite Leading Indicators: Reference Turning Points and Component Series," http://www.oecd.org/std/leading-indicators/oecdcompositeleadingindicatorsreferenceturningpointsandcomponentseries.htm

acteristic (ROC) curve, following Schularick and Taylor (2012) and Jordà et al. (2021). The ROC curve is a widely used tool to assess binary classification ability. The binary classifier here is $I(\hat{p} - \theta > 0)$, where $\hat{p}$ is the predicted value of the model, θ is a varying threshold. The ROC curve plots the true positive rate (TPR), defined as the number of true positives out of all classified positives, against the false positive rate (FPR), defined as the number of false positives out of all classified negatives. Both the TPR and FPR vary along with θ. The larger the value of θ, the more conservative the classifier is in making recession calls (positives). As a result, the classification of positives becomes more accurate; while at the same time, the classifier makes increasing number of false positives (fall-out). Conversely, the smaller the value of θ, the more aggressive the classifier becomes. As the true positive rate declines, the false positive (fall-out) rate also decreases. Therefore, the 45-degree line is the benchmark non-informative line that provides no predictive ability. Any informative classifier should be above the 45-degree line. The area under the ROC curve (AUROC) provides a single statistic that gauges the predictive power of the model.

Figure 7 plots the ROC curve of a linear probability model with a single regressor (credit, housing price, or leverage ratio). All three models are above the 45-degree line, indicating they are all informative in predicting recessions. Among the three, the house price has the best predictive power as a single predictor.

Table 4 compares the models with the three financial predictors with a benchmark model with only GDP, CPI and Repo Rates as the predictors. The benchmark linear model has an AUROC of around 0.84, which itself is good enough. It is impressive that inclusion of any of the three financial variables increases the recession predictive power even more. The linear model with credit increases the AUROC to 0.95, which is almost close to perfect accuracy. The linear models with housing price and leverage ratios have AUROC of 0.88 and 0.91 respectively. The probit models have slightly higher AUROC than their linear counterparts.

To avoid any look-ahead bias, I also compute the pseudo out-of-sample predicted

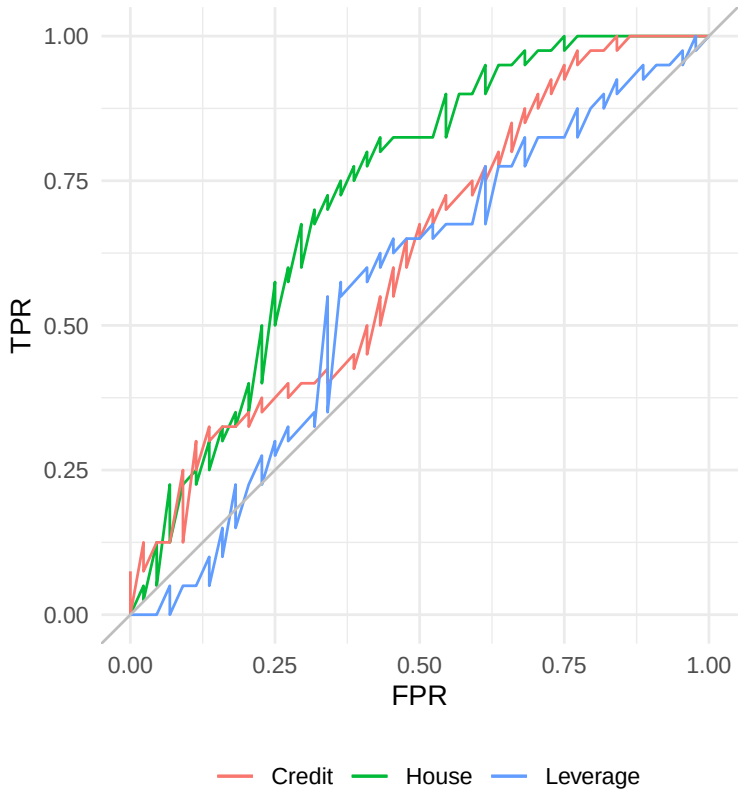

Figure 7: Receiver Operating Characteristic Curve

AUROC (denoted as AUROC†) using only past observations.[9] The out-of-sample results are generally weaker than the in-sample counterparts. The models with credit still have the best predictive power. The linear model with the leverage ratio performs the worst. Probit models generally perform better than linear models. Overall, the pseudo out-of-sample exercise confirms that financial variables have strong predictive power for subsequent recessions.

The magnitude of the coefficients are also sizable. Credit has a positive coefficient of 0.31. Given the standard deviation of credit gaps is 0.75, if credit growth is one standard deviation above the trend for the past two years, it increases the probability of subsequent recession by 0.23 points. Since the sample frequency of recessions is 0.48, credit alone predicts almost 50% of recessions.

The leverage ratio also has a significant positive coefficient, though the magnitude is not as large as credit. These evidence are generally consistent with the experience from

[9]The training set starts with half of the dataset. Then 1-step-ahead forecast is computed recursively.

developed countries, that credit booms over past years is indicative of a higher risk of subsequent recessions, though recessions are defined differently.

Another interesting finding is the negative coefficient of housing prices, which can be interpreted as housing price booms alleviate the risk of recessions, or declining of housing price over the past years presage subsequent recessions. This seems suggest housing price is even more forward-looking than credit, which is consistent with the impulse response results in Section 5.2.

Table 4: Recession prediction with financial cycles

	Dependent variable: probability of recession							
	OLS				Probit			
2-year moving average	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Credit		0.314 ***				1.925 ***		
		(0.053)				(0.471)		
House			-0.097 ***				-0.379 ***	
			(0.033)				(0.138)	
Leverage				0.154 ***				0.680 ***
				(0.039)				(0.194)
GDP	0.537 ***	0.535 ***	0.562 ***	0.692 ***	2.155 ***	3.015 ***	2.488 ***	3.465 ***
	(0.100)	(0.084)	(0.096)	(0.101)	(0.523)	(0.782)	(0.601)	(0.822)
CPI	-1.024 ***	-0.726 ***	-1.215 ***	-0.981 ***	-3.968 ***	-3.342 *	-5.192 ***	-4.764 ***
	(0.300)	(0.256)	(0.294)	(0.277)	(1.299)	(1.728)	(1.491)	(1.621)
RR	0.133 ***	0.144 ***	0.136 ***	0.114 **	0.425 **	0.952 ***	0.511 ***	0.461 **
	(0.050)	(0.042)	(0.048)	(0.047)	(0.181)	(0.302)	(0.192)	(0.194)
AUROC†	0.849	0.943	0.865	0.719	0.856	0.945	0.87	0.938
AUROC	0.844	0.952	0.877	0.907	0.84	0.953	0.88	0.911
R^2	0.355	0.555	0.418	0.46				
N	84	84	84	84	84	84	84	84

Note:

Standard errors in parentheses. Marginal effects not reported.*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

6 Transmission mechanism

This section explores the possible transmission mechanism between financial fluctuations and real economic activities; especially how financial booms reverse itself into downturns. Based on the literature review in Section 2, financial booms have a tendency to self-reinforce, because there is a positive feedback loop between borrowing constraints and asset prices, which we termed as "financial accelerator effect." Higher asset prices inflate collateral values and encourage excessive borrowing, which in turn bids up asset prices even further. But higher asset prices require more cash flows to justify itself, once the cash flows are no longer sufficient to meet the requirement – be it a negative shock to income cash flows or a tightening of refinancing conditions – assets have to be sold for cash, which triggers a negative reinforcing process of declining asset prices and tightening credit conditions, which transmits into a slowdown of economic activities. If this theory is true, we would expect the higher the asset prices, the stronger the booms; but higher asset prices also presage more severe downturns that would follow. To verify this claim with empirical evidence, I estimate the specification below.

$$y_{t+h} = \mu_h + \beta_h \text{Credit}_t + \delta_h \text{Credit}_t \times \mathbb{1}(P_t > \theta) + \Phi(L) Z_t + \epsilon_{t+h} \tag{6}$$

I focus on credit in this section as the single proxy for financial dynamics, and interact it with various conditions on asset prices or interest rates. For example, P_t could be house price, equity price, or interest rate. θ is a threshold that could be the medium or the upper quantile of a variable. $\{\beta_1, \beta_2, \dots\}$ capture the responses of output to one unit shock of credit; while $\{\beta_1 + \delta_1, \beta_2 + \delta_2, \dots\}$ capture the responses of output to credit shock under certain conditions. To keep the lags manageable, I take two-year exponential moving average for all variables in the regression. Four lags of GDP are included as controls to account for natural business cycle dynamics.

I first estimate Equation 6 conditioned on house price (relative to its trend) being above a certain threshold. Figure 8 Panel (a) reports the impulse responses conditioned on θ being the 75th and 85th percentile respectively. The result fits in the self-reinforcing

theory very well. The credit booms associated with high house prices are much stronger than otherwise. Conditioned on the house price (relative to its trend) above its 85th percentile, during boom time, the output gap is roughly 0.6 percent higher than average; and in subsequent downturns, the negative output gap is almost 1 percent lower. It is not surprising that housing prices play such an important role given the fact that houses are not only the most common collateral for credit but also home mortgage itself contributes a significant proportion of credit creation.

I also estimate impulse responses conditioned on high equity prices. I use the Shanghai Composite Index (bHP-filtered) as a representative index for equity prices.[10] Similar to house prices, we would expect a positive feedback loop between equity prices and credit creation. We would also expect a less stronger effect than house prices, because the equity market in China is still immature and accounts for a much smaller share of total wealth. The impulse response in Figure 8 Panel (b) confirms our conjecture: credit expansion coupled with high equity prices creates a stronger economic boom, and subsequently, a worse recession. But the magnitude is roughly half of the magnitude conditioned on house prices. The result is consistent with the findings from Claessens, Kose, and Terrones (2012). Even for developed economies, house prices are more importantly associated with the strength of booms and the depth of recessions than equity prices. Nonetheless, it is worth to point out the result here must be interpreted with a caveat. It is well-known that equity market is forward-looking, high equity prices reflect optimistic expectations from the investors, which itself reasonably foresees higher growth in the future. Therefore, the evidence is consistent with the collateral constraint theory but not necessarily proves it.

To address the argument that leverage matters more than credit to stability, I estimate Equation 6 conditioned on high leverage ratios. Figure 8 Panel (c) shows that, conditioned on leverage ratios above the 75th percentile, booms are sluggish, and the subsequent downturns are more severe; conditioned on leverage ratios above the 85th percentile, booms are suppressed, the output directly falls below the trend and contin-

[10]In the recent decade, Shanghai Composite Index is becoming less representative for the overall performance of Chinese equity market due to the growth of other stock exchanges. Nonetheless, the index provides the longest historical record of the equity market in the country.

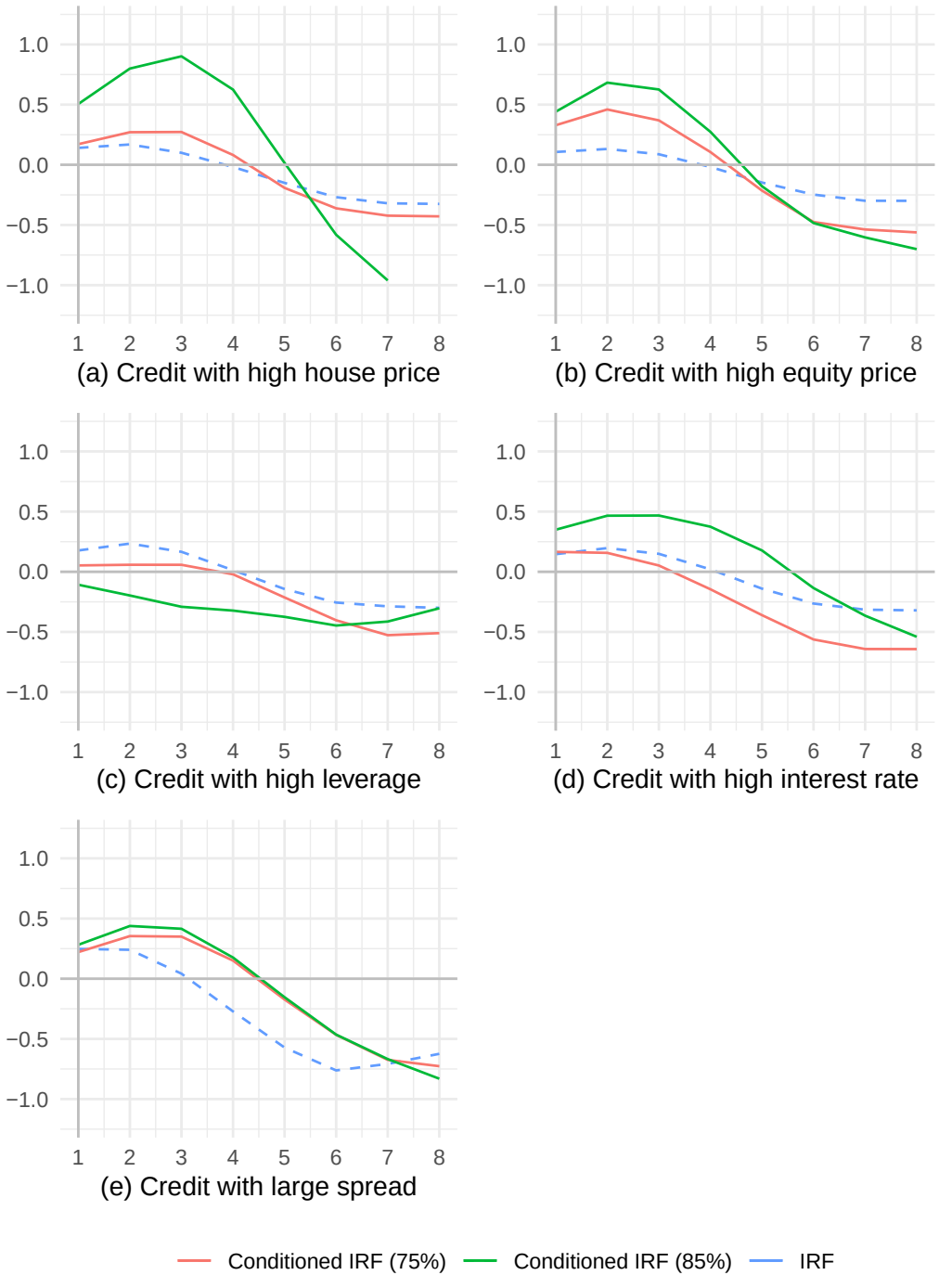

Figure 8: Response of GDP to conditional credit impulse

ues declining. The evidence roughly supports the argument that high leverage tends to destabilize. With high debt to income ratio, business are reluctant to expand, resulting in slowdown of growth. Recessions with high leverage tend to be more severe and prolonged, because it takes time to repay or restructure debt burdens, and over indebtedness may trigger a negative reinforcing process of debt, default and deflation as described by Fisher (1933). However, it needs to be addressed that high leverage ratio could be the result of either excessive debt burdens (large numerator) or low income growth (small denominator). High leverage ratios probably already contain information of low income growth. Therefore the result shown in Panel (c) is at best a upper bound estimate.

According to Minsky (1986), financing structure is critical to the stability of the economy. In boom times, with low perceived risk, business tends to engage in more vulnerable speculative financing behaviors. The result is the whole system becomes more sensitive to negative shocks to financing conditions such as an interest rate hike. We do not have direct measures of the changes of financing structure, but it is understandable that interest rate will play a key role in any financial arrangement. During periods of expansion, competition for credit resources bids up the interest rates, rendering a larger proportion of borrowing unprofitable, which eventually ends the expansion and reverse the trend. It follows that, the stronger the boom, the higher the interest rates it would entail, the higher the probability of vulnerable financing behaviors, and therefore the more devastating the following recession would become. The evidence shown in Figure 8 Panel (d) is consistent this reasoning, in which the impulse response is conditioned on high interest rate, proxied by short-term repo rates. Note that higher interest rate does not stifle growth immediately, but coexists with higher growth for some time, this reflects the pro-cyclical behavior of interest rate. There is a two-way relationship between interest rate and output growth. On the one hand, higher growth entails higher return on capital, hence higher interest rate. This could be deemed as "growth effect." On the other hand, higher interest rates discourage consumption and investment, because it lowers the marginal utility of current spending relative to future spending. This is the "discounting effect." In fast growing economies with sustaining high interest rate, the

"growth effect" usually dominates the "discounting effect," until high interest rates are exerted by policy makers for sufficient long time to cool down the growth engine.

Krishnamurthy and Muir (2017) finds that the severity of the decline in output is informed by the size of the increase of credit spread together with the growth rate of credit. A dramatic increase in credit spread (the spreads between higher and lower graded bonds) is a sign of credit crunch, which drains financial resources from business, especially those with low creditworthiness. An increase in credit spread might be the result of either changing market conditions or changing regulation requirements. In either case, if the large credit spreads were to persist, it would severely impair economic activities. To verity this claim, I constructed a "pseudo credit spread" from the Treasury Bond Index and the Corporate Bond Index published by Shanghai Stock Exchange.[11] I calculate the quarterly growth of the indices and take the 2-year exponential moving average. In normal times, corporate bonds will outperform Treasury bonds as they offer higher yields. But in the time of credit crunch, Treasury bonds will perform better because investors flee to safe-heaven assets. Therefore, the difference between the return of Treasury Bond Index and Corporate Bond Index could serve as an rough approximation for credit crunch. I therefore term it as "pseudo credit spread." The impulse response conditioned on the pseudo credit spread are reported in Figure 8 Panel (e). Conditioned on large spread, the credit booms do not pull up immediately, but continue to expand even higher; but it ends up slightly worse than average. This result is barely consistent with Krishnamurthy and Muir (2017). We would expect the downturn comes more severely with large credit spread, according to the theory; it is hard to reconcile the fact that GDP expands even higher in presence of increasing credit spread. A possible explanation could be low pricing efficiency of China's bond market. As Wang and Qu (2020) documented, the credit spread in China's bond market exhibits pro-cyclical behavior. Higher spread does not necessarily reflect tightening credit conditions but higher growth rate. Nonetheless, due to the limitation of the data, this empirical exercise only provides limited validity and

[11]Data on the yield of bonds with different credit ratings are available only from 2007. The limited data points significantly undercut the validity of the study. Although the Shanghai Stock Exchange (SSE) is not the primary marketplace for bond trading in China, the Treasury/Corporate Bond Indices published by SSE enable us to extend the data to 2003.

the conclusion made here should be regarded as tentative.

Table 5 provides the tabulation of the above investigation. I only report the results conditioned on the 85th percentile for clarity. To summarize, our results are broadly consistent with the "financial accelerator" theory, and confirm the positive feedback loop among asset prices, credit expansion, and output growth; in the meanwhile, cash flows to fulfill debt requirement and interest rates are import transmission mechanism. We also find peculiar behaviors of interest rate and credit spread. The peculiarities are not consistent with common expectation but, given the fast-growing context, they do not falsify the transmission mechanism either. It is worth to emphasize again, the empirical exercise here only shows itself consistent with the theory, but not necessarily proves it, since we do not have causal interpretations to these results.

Table 5: Response of GDP to conditional credit impulse

	Dependent variable: GDP gap, 2-year MA									
	(1)		(2)		(3)		(4)		(5)	
	1 year	2 years	1 year	2 years	1 year	2 years	1 year	2 years	1 year	2 years
Credit	-0.024	-0.307 *	-0.034	-0.297	0.022	-0.352 *	-0.020	-0.336	-0.151	-0.599
	(0.128)	(0.161)	(0.136)	(0.184)	(0.103)	(0.202)	(0.137)	(0.223)	(0.598)	(0.548)
× High House Price	0.649 ***	-0.947 **								
	(0.229)	(0.403)								
× High Equity Price			0.308	-0.404 *						
			(0.302)	(0.229)						
× High Leverage					-0.344	0.048				
					(0.330)	(0.309)				
× High Interest Rate							0.394 *	-0.204		
							(0.236)	(0.355)		
× Large Spread									0.327	-0.231
									(0.387)	(0.844)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.682	0.684	0.658	0.627	0.658	0.604	0.654	0.606	0.647	0.709

Note:

Newey-West standard errors are reported in parentheses. * $p < .10$; ** $p < .05$; *** $p < .01$.

7 Conclusion

This paper characterizes the short-term financial cycles in China and explores the interactions between financial cycles and real business cycles. There is strong evidence that financial cycle movements lead real economic activities. I study three financial indicators, namely credit, house price and leverage ratio separately. I emphasize the heterogeneous economic response to different types of financial shocks. A positive shock to any financial variable has the effect of boosting the economy, and peaks in financial variables signal a forthcoming slowdown in economic activities. China's economy seems particularly sensitive to house price movements. The empirical evidence is consistent with the well-known financial accelerator effect and the financial instability hypothesis, though the study only focus on short-run dynamics.

These findings advise an opposite stand against the view that China is immune to financial crises. It is true that every incident of recessions so far is short-lived and seems to cost no permanent economic loses. Because the extraordinary growth over the decades has overwhelmed any destabilizing factor. However, as the growth is inevitably slowing down and the systemic risk has accumulated over the years, the destabilizing effect of high leverage will eventually dominate the growth momentum. Given the importance of the real estate market to the economy, the approaching housing peak should sound the alarm to a major adjustment possibly in the near future (Rogoff and Yang 2020).

Nonetheless, the study has several shortcomings that require readers' caution. First is the data limitation. With only 20 years data (roughly 6 rounds of boom-bust cycles), we can hardly confirm any laws or regularities. The conclusions should be treated as conjectures rather than confirmations. Secondly, constantly changing institutional frameworks is another major concern. During the decades, China has undergone several rounds of significant economic reforms, which could fundamentally alter the relationships among economic variables. Thirdly, the study focuses on economic mechanism only and ignores other potential forces that affect the business cycle. The Chinese government exerts great influence on the economy. How government interventions intertwine with the market mechanism and alter the patterns of business cycles is an intriguing question that

requires further research.

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