

**Credit Efficiency:  
Another Indicator for  
Systemic Risk**

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## Abstract

Credit booms can lead to differing outcomes. Some credit booms are precursors to financial crises, incurring extremely high costs, while others result from high productivity and act as catalysts for economic growth. Identifying harmful booms and providing early warnings of financial crises as accurately as possible remains a key unresolved issue. Based on the theory that “The crisis is explained by a sudden collapse in the marginal efficiency of capital” (Keynes, 1936) and “The financing structure determines whether the financial system is steady” (Minsky, 1986), this study proposes a new early warning indicator - the credit efficiency indicator. This indicator uses the growth rate of credit efficiency to differentiate types of credit booms and capture early signals of financial crises. Although leverage is often associated with economic vulnerability, the allocation and efficiency of credit output is a less explored indicator. This study analyzed data sets from G20 member countries over the past 30 years and tested the early warning capability of this indicator through fixed effects models, difference models, and crisis prediction models. The verification results show that the credit efficiency indicator has a unique and significant risk prediction ability: a continuous slowdown in the growth rate of credit efficiency significantly increases the probability of a financial crisis, and inefficient credit booms are dangerous. Moreover, this study explored the joint effect of credit efficiency and leverage levels and proposed using credit efficiency as an indicator for structured credit adjustment, providing new perspectives and tools for credit policy formulation and financial regulation.

**Keywords:** systemic risk, financial crises, credit boom, credit efficiency, early warning indicator

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# Section 1

## Introduction

### 1.1. Research Background

Throughout history, almost every financial crisis has been the result of the eruption of systemic risks, leading to significant and enduring negative consequences. Laeven and Valencia's (2020) research reveals that between 1970 and 2017, there were a total of 151 banking crises, 236 currency crises, and 79 sovereign debt crises globally. The average output loss as a percentage of GDP caused by each of these crises for an economy was 19.74%, 3.04%, and 40.38%, respectively. According to Atkinson, Luttrell and Rosenblum's (2013) estimates, the financial crisis of 2007-2009 inflicted losses on the U.S. economy ranging from 6 to 14 trillion dollars, equivalent to 40% to 90% of the annual output of the United States being discarded. This financial crisis also resulted in a severe global economic downturn, with world economic growth rate declining from 4.38% in 2007 to 2.07% in 2008 and -1.34% in 2009 (World Bank). Reinhart and Rogoff (2013) found, based on their study of the history of global banking crises from 1800 to 2007, that banking crises posed an equal threat to all countries, with little difference in the incidence and duration of banking crises between high-income and low to middle-income countries. Countries may be able to "graduate" from sovereign debt crises, but "graduating" from banking crises has proven nearly impossible.

Debt-Deflation Theory (Fisher, 1932, 1933), Financial Instability Hypothesis (Minsky, 1979, 1986), and the Balance Sheet Recession concept (Koo, 2009) all suggest that the accumulation of debt may trap the economy in a vicious cycle of "debt-deflation", leading to financial crises and economic downturns. Reinhart and Rogoff (2009), by summarizing over 800 years of financial crisis cases, found that the primary cause of the eruption of systemic risks is excessive indebtedness of an economy. A substantial amount of empirical research also supports this viewpoint.

From existing literature, the judgment of whether an economy is excessively indebted mainly relies on using the leverage ratio (private non-financial sector credit/GDP) as a measurement standard. This involves assessing risk by looking at leverage levels and deviations of changes in leverage from their long-term trends. One method, known as the gap indicator, is crucial for the Basel Committee on Banking Supervision in determining countercyclical buffers. This indicator, often referred to as the "Basel Gap" (BCG), is defined as the ratio of a country's credit to GDP deviating from its long-term trend (Drehmann et al., 2010). Another method is the threshold indicator. It involves finding universally significant "crisis turning points" in financial cycles based on historical data and empirical studies and using them as a unified standard for evaluating the debt risk of various countries. For example, Reinhart and Rogoff (2010) proposed leverage ratio thresholds of 90% for government debt and 60% for external debt as a

percentage of GDP.

Although these methods have valuable insights and are widely used, numerous studies have shown that gap indicators are not reliable and threshold indicators are not robust. Edge and Meisenzahl (2011), based on their research on the credit data of the United States, found that BCG's real-time estimate of excessive credit had major errors, and the deployment of counter-cyclical capital buffers based on this would bring high economic costs, resulting in capital shortage and unnecessary loan restrictions in the banking sector, which would bring additional burdens to the American economy. Ramsay and Sarlin (2016) demonstrate that BCG is an unreliable indicator of early warning, especially when it comes to calculating long-term trends, for example, Spain experienced a large upward trend before the financial crisis, while Germany remained relatively stable and Japan showed a downward trend. Dell'Araccia (2016) points out that, in fact, not all credit booms end in crashes, and two-thirds of them are good booms. In addition, Liu and Liu (2018) show that in a sample of countries that have experienced crises over the past three decades, the leverage ratio at the onset of the crisis is spread over a wide range of 100% to 250%, and many countries have leverage well above this limit, but have not experienced a crisis. Therefore, it remains a key unresolved issue to determine more accurately in advance whether an economy is in a state of excessive debt and to give early warning of systemic risks.

## **1.2. Research Questions**

The recurring nature of financial crises, their persistent existence, and the significant disruptions they cause to economies and societies underscore the need for an effective early warning system. This study proposes a new early warning indicator, the Credit Efficiency Indicator, which uses the credit efficiency growth rate to distinguish the types of credit booms and capture the early signs of financial crises. The goal is to explore the connection between credit output efficiency and financial instability, aiming to provide a beneficial supplement to the measurement and early warning of systemic risks by monitoring the output efficiency of credit input and the quality of its underlying assets.

## **1.3. Significance of the Study**

The main contribution of this study is to propose a new systemic risk early warning indicator - credit efficiency. This indicator can more accurately determine whether an economy is in a state of over-indebtedness and provide early warning signals of crisis. Moreover, the calculation of this indicator is simple, intuitive, and easy to track vertically and compare horizontally. Compared with gap indicator and threshold indicator that mainly reflect changes in debt scale, credit efficiency effectively solves the shortcomings of leverage ratio in systemic risk warning. The main reasons are as follows:

First, according to Keynes's business cycle theory, which believes that business cycles are caused by cyclical changes in the marginal efficiency of capital (MEC), crises can be explained by the sudden collapse of MEC (Keynes, 1936). Here MEC was defined as the rate of discount that equalizes the prospective returns on investment to its replacement cost, essentially measuring the profitability of investing in new capital by comparing the present value of expected returns to the current cost of investment. Credit efficiency is essentially a reflection of the marginal efficiency of capital, in which private non-financial sector credit is an important component of the marginal efficiency of social capital as a whole and an important force driving changes in the economic cycle. Therefore, credit efficiency can more accurately capture changes in the economic cycle and become an important leading indicator for measuring financial crises.

Second, Dell'Ariccia et al. (2016) and Gorton and Ordonez (2020) distinguish between good and bad credit booms. There are two different scenarios for the impact of credit boom on economic growth: one scenario is that credit boom can be transformed into efficient investment by enterprises, generating good returns, and economic growth supports the stable operation of leverage by increasing debt solvency, which is known as Considered a good credit boom; another scenario is that rising leverage leads to the drying up of productive investment opportunities (Kopytov, 2023), the marginal return of capital declines, and continues to be close to or below the cost of credit, exacerbating risk accumulation and eventually triggering a financial crisis, This is considered bad prosperity. Credit efficiency indicator can provide insight into the type of credit boom.

Third, Minsky (1986) describes the mechanisms that lead to financial fragility. He believes that a high proportion of hedge financing is stable, while a high proportion of speculative financing and Ponzi financing is unstable. High credit efficiency indicates that the proportion of hedge financing in the economy is high, and the future cash flow of most enterprises can cover the principal and interest of debt, in this case, the financial system is stable. In contrast, low credit efficiency indicates that the economy has a high proportion of speculative and Ponzi financing, and most businesses are unable to use future cash flows to pay interest and principal, in which case the financial system is vulnerable.

#### **1.4. Structure of the Thesis**

The remaining sections of this thesis are organized as follows: The next section discusses on the definitions of the three core concepts of systemic risk, financial stability, and credit prosperity, and introduces the theoretical basis for this study. Section 3 introduces the literature review of three categories: the relationship between financial development and economic growth, the relationship between financial cycle and business cycle, the measurement of over-indebtedness and the indicators of leverage ratio, which are closely related to this study. Section 4 introduces the research design and methodology, including the selection of research samples, the definition of main variables, data sources, empirical models and verification methods. Section 5

empirically analyzes the role of credit efficiency indicators in risk assessment and risk early warning and discusses the research results and the best policy responses. Section 6 provides a summary.

## Section 2

### Definition of Core Concepts and Theoretical Basis

#### 2.1. Definition of Core Concepts

##### 2.1.1. Systemic Risk

Systemic risk is a concept that is challenging to precisely define. Merriam-Webster defines systemic risk as: “The risk that the failure of one financial institution (such as a bank) could cause other interconnected institutions to fail and harm the economy as a whole.”

The definition given by some regulatory authorities and international organizations is: “Systemic risk is the risk that disruptions occurring in one firm or financial market may spread to other parts of the financial system, with possibly serious implications for the performance of the broader economy” (Federal Reserve, Bernanke, 2007). “Broadly speaking, it refers to the risk that financial instability becomes so widespread that it impairs the functioning of a financial system to the point where economic growth and welfare suffer materially” (European Central Bank, 2009). “Systemic financial risk is the risk that an event will trigger a loss of economic value or confidence in, and attendant increases in uncertainty about, a substantial portion of the financial system that is serious enough to quite probably have significant adverse effects on the real economy” (Group of Ten, 2001). systemic risk can be defined as “a risk of disruption to financial services that is caused by an impairment of all or parts of the financial system and has the potential to have serious negative consequences for the real economy” (IMF, FSB & BIS, 2009). “The International Risk Governance Council (IRGC) determined that systemic risks typically span more than one country and more than one sector of the economy. They are not under the control of any one organization, but affect and must be addressed by many stakeholders at once. Systemic risks may be relatively low in frequency, but they have broad ramifications for human health, safety and security, the environment, economic well-being and the fabric of societies” (Becker, 2016).

Some scholars define it as: “A systemic crisis can be defined as an event in which a considerable number of financial institutions default simultaneously” (Lehar, 2005). “A more formal definition is any set of circumstances that threatens the stability of or public confidence in the financial system” (Billio et al., 2012). “Systemic risk refers to the propagation of an agent’s economic distress to other agents linked to that agent through financial transactions” (Rochet & Tirole, 1996). “A financial crisis is “systemic” in nature if many banks fail together, or if one bank’s failure propagates as a contagion causing the failure of many banks” (Acharya, 2009).

At present, although there is no broad consensus on the definition of systemic risk,

judging from the existing research results, systemic risk has at least the following important characteristics: First, systemic risk is the risk relative to a single financial institution or financial market, refers to the risks of all or important components of the entire financial system. Secondly, systemic risks are highly contagious. The failure of one financial institution can have a domino effect through the interbank market, payment system, or asset prices, leading to collective defaults by other financial institutions. Third, the occurrence of systemic risks will cause huge damage to the real economy.

### **2.1.2. Financial Stability**

There is currently no widely accepted definition of the concept of financial stability. Schinasi et al. (2004) discussed the concept of financial stability earlier. They believe: First, financial stability is a broad concept that covers all aspects of the financial system, including the smooth operation of financial markets, financial institutions, financial instruments, financial infrastructure (financial supervision, legal rules and regulations), etc. Second, Financial stability not only means that finance can fully play its role in allocating resources, dispersing risks, mobilizing savings, and promoting wealth accumulation and economic growth, but also means that the country's overall payment system is running smoothly. Third, financial stability includes not only the absence of financial crises, but also the ability to self-correct before the financial system becomes imbalanced. Ramlall and Indranarain (2018) believe that financial stability can be defined as the smooth and efficient operation of all parts of the financial system, effective allocation of resources, management of risks, absorption of shocks, and ultimately promotion of economic growth. Allen and Wood (2006) proposed the ideal characteristics of the definition of financial stability: First, financial stability is a state that is conducive to public welfare and is related to the property of the nation and the country. Second, financial stability is an observable state that can be maintained and controlled by regulators. Third, financial stability is a macroeconomic phenomenon, not a microeconomic phenomenon. Small-bank crises have had a beneficial effect on capitalism. Fourth, the definition of financial stability should not be too strict because economic and financial structures are constantly changing and developing.

Central banks in some countries define financial stability as follows: “The smooth functioning of the financial system and its ability to facilitate and support the efficient functioning of the economy” (European Central Bank). “The ability of the financial system to successfully perform its key macroeconomic functions at all times, in particular the ability to effectively allocate financial resources and manage risks, as well as to provide a well-functioning financial infrastructure” (Bundesbank). “Financial intermediaries, markets and market infrastructures can help promote the growth of economic activity by facilitating the smooth flow of money between depositors and investors. On the contrary, financial instability can cause significant disruption to this intermediation process and have potentially devastating effects on the real economy” (Reserve Bank of Australia). “The financial system can promote economic welfare

through many channels: by promoting household savings to purchase houses, funding university education and smooth consumption in response to unemployment and other adverse developments; by channeling savings into businesses to start new businesses and expand existing ones, promoting responsible risk taking and economic growth; and spread risk among investors” (Federal Reserve Bank of the United States).

### **2.1.3. Credit Boom**

Credit boom is a concept that appears very frequently in the systemic risk research literature. However, there is no consensus on its definition to date, and only a few papers have captured it from an empirical perspective. Terrones (2004) argues that there are three reasons for the credit boom. First, financial deepening (trend). As the economy develops, so do financial markets and institutions, and credit typically grows faster than GDP, a process known as financial deepening. Second, normal cyclical fluctuations. This is due to the fact that a business’s investment and working capital needs fluctuate with the business cycle. Third, excessive cyclical volatility (credit boom). This is the result of the combined effect of excessive optimism of market players and the financial accelerator mechanism and is unsustainable. It is precisely because of the above reasons, and the great differences between countries in terms of economic structures and institutions, that the definition of credit boom in the literature is not only scarce, but also expressed in different opinions.

Some economists define credit boom from the perspective of empirical analysis. For example, Meng et al. (2017): “Specifically, a credit boom occurs when the deviation in the logarithm of real credit per capita from its long-run trend is equal or higher than a certain threshold, defined as 1.65 times of the standard deviation of the cyclical component.” Dell’Ariccia et al. (2016): “We classify an episode as a boom if either of the following two conditions is satisfied: (1) The deviation from trend is greater than 1.5 times its standard deviation and the annual growth rate of the credit-to-GDP ratio exceeds 10%; or (2) The annual growth rate of the credit-to-GDP ratio exceeds 20%.” Gorton and Ordoñez (2020): “We define a credit boom as starting whenever a country experiences three consecutive years of positive credit growth (as a fraction of GDP) that average more than 5%. The boom ends whenever a country experiences at least two years of credit growth (also as a fraction of GDP) not higher than 0%.”

## **2.2. Theoretical Basis**

### **2.2.1. Business Cycle Theory**

#### **2.2.1.1. Definition of Business Cycle**

Some economists define the business cycle as follows:

The business cycle is a fluctuation in the overall economic activity of a country, a cycle

is made up of the expansion of many indicators of economic activity almost simultaneously, followed by a general recession, contraction and recovery and the expansion phase of the next cycle, this series of changes is cyclic, but not periodic. The duration of the business cycle ranges from more than a year to ten or twelve years (Burns & Mitchell, 1946).

The economic cycle is first of all a phenomenon based on historical experience. It has long been observed that the economy is generally satisfactory or good most of the time, but sometimes weak or bad. The term for good times is “boom” and the term for bad times is “depression”, the transition from boom to bust is called a crisis, and the transition from a bust to boom is called recovery. The business cycle involves many interacting processes (economic, political, and broad social) and is constantly changing, characterized by recurring, persistent, and pervasive (Zarnowitz, 1991).

In some years, most industries are booming, and unemployment is low; in other years, most industries were operating well below capacity, and unemployment remained high. Periods of economic prosperity are often referred to as expansions or booms, a period of recession is called a recession or depression. The combination of expansion and recession, the ebb and flow of economic activity, is known as the business cycle. The peaks and troughs of the business cycle refer to the inflection points when several key economic indicators, such as employment, output, and commercial retail, begin to change direction (Romer, 1999).

#### **2.2.1.2. Keynesian’s Business Cycle Theory**

Keynes noted in *The General Theory of Employment, Interest and Money* (1936) that “The business cycle is caused by cyclical changes in the marginal efficiency of capital (MEC) and the crisis is explained by a sudden collapse in MEC.” Keynes argued that any new investment, such as building a road or building a factory, would generate revenue several times the expenditure itself, and this relationship is known as the investment multiplier. In addition, consumer demand has the effect of stimulating investment, and this relationship is known as an accelerator. The combination of investment multiplier and an accelerator creates a strong periodic motion. Theoretically, this interaction could continue until resources such as labor and capital are saturated to the point where they are fully utilized. By then, there will be no increase in employment and, therefore, consumer demand, and the operation of the accelerator will stop, which, combined with the lack of new lucrative investment opportunities, will reverse the process.

#### **2.2.1.3. Schumpeter’s Business Cycle Theory**

Schumpeter (1934) argues that analyzing the business cycle means analyzing economic processes in the capitalist era. Capitalism is a process of creative destruction. Schumpeter proposes five models of innovation, including new products, new markets,

new materials, new production methods and new organizational forms. He believes that entrepreneurship and technological innovation can lead to instability, but they are determinants of economic development. Schumpeter (1939) also explained the business cycle with the theory of innovation, pointing out that there are three simultaneous cycles in the development of capitalist economy: the Kitchin cycle or inventory cycle (shortwave) with a duration of about 40 months; and the Juglar cycle or manufacturing investment cycle (medium-wave) with a cycle of 10 years; and Kondratieff cycles (long waves) with a duration of 50~60 years. Which rise and fall due to major inventions and applications of science and technology (sometimes called the Industrial Revolution), which can be added together to form a composite waveform. Schumpeter argues that the Juglar and Kitchin cycles trigger financial crises and recessions at regular intervals in the Kondratieff cycle, and that recessions can be more severe during the trough phase of the long waves.

### **2.2.2. Debt-Deflationary Theory**

Fisher (1932, 1933) proposed the “debt-deflationary theory” to explain the Great Depression of the early thirties of the twentieth century, which he first articulated in his 1932 book *Boom and Bust*. He thinks the causes of all Great Depressions seem to be: over-indebtedness first, followed by deflation. Fisher argues that between 1929 and 1933, in the context of high market leverage, the initial business downturn led to the bankruptcy of some enterprises and the decline in expenditures, which directly led to a new wave of bankruptcies. In addition to this immediate effect, another, more important indirect mechanism, involving all borrowers, is at work, namely the enormous debt-servicing pressure on debtors caused by falling asset and commodity prices, forcing them to dump assets at low prices, which in turn drives prices down further, leading to a debt-deflation vicious cycle in the U.S. economy.

Fisher summarizes the factors that affect economic volatility into nine variables. Among them, debt and the price level of consumer goods are the two most important variables, while the other variables are the quantity of money, the velocity of money, the net worth of enterprises, profits, the volume of goods traded, business confidence and interest rates. Fisher points out that in an economy characterized by over-indebtedness, small external shocks can lead to a sharp contraction of corporate financing constraints, with the following knock-on effects: (1) Attempts to liquidate corporate debt leading to cheap selling; (2) The contraction of the amount of money in circulation and the decline of the velocity of money; (3) The price level of consumer goods has fallen; (4) The net asset value of the enterprise has shrunk, pushing up the real debt level, which may lead to bankruptcy; (5) Declining corporate profits; (6) Firms are forced to scale back productive investment, resulting in a reduction in production, trade, and employment; (7) The spread of pessimism and loss of confidence; (8) Exacerbating the hoarding of money and the sluggishness of circulation; (9) Money interest rates fall, but real interest rates rise. This chain of consequences will trap economies in a vicious cycle of “debt-deflation”. Fisher argues that the government

should use monetary policy stimulus to achieve reflation to correct the persistent decline in asset prices and gradually move the economy towards recovery.

### **2.2.3. Financial Instability Hypothesis**

Minsky (1979,1986) pioneered the concept of the Financial Instability Hypothesis, in which he described the mechanisms by which financial vulnerabilities and financial crises accumulate during periods of calm. Minsky divided the financing structure of economic activities into three categories: The first type is hedge financing, that is, the expected cash flow of enterprises can repay the principal and interest of debt; The second type is speculative financing, that is, the future cash flow of the enterprise can only pay interest but not return the principal; The third type is Ponzi financing, that is, the company cannot repay interest and principal with future cash flow, and can only maintain the capital chain by borrowing new funds to repay old ones.

Minsky outlined two theorems of the Financial Instability Hypothesis: First, the structure of financing determines the soundness of the financial system; Second, the financial system periodically shifts from stable to unstable. He believes that the high proportion of hedging financing is stable, and the high proportion of speculative financing and Ponzi financing is unstable. As the economy expands and booms, households, businesses, and financial institutions are tempted to take more risks, leading to over-indebtedness and asset bubbles, and a market dominated by hedging finance to a market dominated by speculative and Ponzi finance, and if there is an unusual event (such as monetary tightening by monetary authorities), it will trigger a severe liquidity crisis, which in turn will lead to a collapse of asset prices, debt-deflation, and a full-blown crisis, known as the “Minsky’s moment”.

### **2.2.4. Financial Accelerator Theory**

Research by Bernanke, Kiyotaki et al. suggests that deteriorating credit market conditions and that “financial accelerators” may amplify adverse shocks to the economy. Financial accelerator theory can be explained as the result of endogenous changes in the cost of loan agents in the business cycle. Financial accelerator models can be divided into two categories: one centered on external financing premium mechanisms (Bernanke & Gertler, 1989; Bernanke et al., 1996) and the other centered on collateral constraints (Kiyotaki & Moore, 1997).

Based on a study of the Great Depression in the United States, Bernanke (1983) proposed the concept of credit intermediation cost (CCI), which is defined as “the cost of transferring money from depositors to good borrowers.” The cost including screening, supervision, and accounting costs, as well as the expected loss of nonperforming loans. He believes that financial friction due to information asymmetry will have an important impact on the aggregate demand of society. Bernanke and Gertler (1989) incorporate financial frictions into the macroeconomic general

equilibrium model, in which the external financing cost is inversely proportional to the net asset value of the borrower's balance sheet, that is, the borrower's net asset value changes positively with the economic cycle, and the external financing cost changes inversely with the economic cycle, thus triggering fluctuations in corporate financing, followed by fluctuations in corporate investment spending and output, and this change in the credit market magnifies the adverse impact of the initial shock on economic volatility.

In Kiyotaki et al.'s model, the contract between the borrower and the lender includes an asset collateral clause, which means that in order to obtain a loan, the borrower must pledge a certain percentage of the assets in his name to the bank. In this model, the asset price directly affects the value of the collateral, and the value of the collateral affects the total amount of loans that the borrower is able to receive, and the financial accelerator functions through the asset price and the collateral. In a recession, a chain reaction of falling asset prices, falling collateral values, reduced borrowers' ability to raise funds, and reduced demand for investment and consumption will lead to a vicious cycle of recession and intensified crisis. At the same time, it also shows that the cyclical changes in the value of collateral assets cause the pro-cyclical nature of bank lending behavior.

### **2.3. Summary of this Section**

The trigger of a financial crisis may be any random event that originates inside or outside the financial system, but the basis for such a shock is that the economic fundamentals have gone wrong. The economy determines finance, and the ebb and flow of human economic activities is the real reason behind the financial crisis. As Gorton (1988) concluded from an empirical study based on the last 100 years of banking crisis datasets in the United States: banking panics are not random events, but are triggered by leading indicators of recession, and are systemic responses of depositors to the unfolding economic situation, which is closely related to the business cycle. Deflationary theory, financial instability hypothesis, and financial accelerator theory reveal the fragility and procyclical nature of the financial system from different perspectives, which helps us understand the nature of systemic risk. In times of economic prosperity, households, businesses, and financial institutions are tempted to take more risks, and human sanity eventually gives way to greed, leading to over-indebtedness and asset bubbles in economies, thus sowing the seeds of crisis.

## **Section 3**

### **Literature Review**

#### **3.1. Literature Focuses on the Discussion of the Relationship between Financial Development and Economic Growth**

The Financial Development Indicator can be broadly defined as financial depth, which refers to the ratio of the size of a country's banks, other financial institutions, and financial markets to economic output. In the empirical literature, the most widely used measure of financial depth is private sector domestic credit as a percentage of GDP (World Bank, 2013).

For a long time, economists have conducted extensive and in-depth discussions on the relationship between financial development and economic growth and have formed three representative views. One view is that financial development promotes economic growth. Schumpeter (1911, 1934) noted that financial institutions play a key role in economic development because they select which businesses can use society's savings. He believes that the key driver of innovation is entrepreneurs, who need to borrow money to develop new production technologies and products, and that the financial sector has advantages in the efficient allocation of capital. MacKinnon and Shaw (1973) proposed the "financial deepening theory" and the "financial repression theory", arguing that financial repression distorts financial prices and reduces real growth rates. Financial liberalization can increase savings and investment, thereby promoting economic growth. Levine (2005) discusses five main contributions of the financial sector to the real economy: mobilizing savings, optimizing capital allocation, diversifying and managing risks, improving corporate governance, and simplifying transactions. King and Levine (1993) used a data set of 80 countries from 1960 to 1989 to test the empirical link between finance and economic growth and found that financial development is closely related to economic growth rate, physical capital accumulation, and improvements in economic efficiency. Rousseau and Wachtel (1998) examined the linkages between the financial and real sectors in five countries, the United States, the United Kingdom, Canada, Norway, and Sweden, which experienced rapid industrialization between 1870 and 1929, and argued that financial development was the driving force and causal relationship behind the rapid industrial transformation of these economies. Calderon and Liu (2003) studied data from 109 developing and industrialized countries from 1960 to 1994, and they concluded that there is a strong causal relationship between financial development and long-term economic growth, and that financial development accelerates Countries accumulate capital and increase productivity, driving their economic growth.

Another view is that the financial system is endogenously unstable, and that financial overdevelopment can lead to crises and recessions. The discussion of financial vulnerabilities can be traced back to classic works such as Fisher's "Debt-Deflationary

Theory” and Minsky’s “Financial Instability Hypothesis”, as mentioned earlier. The global financial crisis challenged the common notion that financial development is good for economic growth, and economists began to focus on the side effects of financial development. Reinhart and Rogoff (2009) based on a comprehensive survey of the history of financial crises in 66 countries over eight centuries, concludes: “Throughout history, rich and poor countries have experienced an unusual series of financial crises, with lending, borrowing, collapse, and recovery.” Koo (2008), based on Japan’s economic performance during its recession in the 1990s, coined the term “Balance Sheet Recession.” He argued that when asset price bubbles burst, firms shift their focus from maximizing profits to minimizing debt to repair their balance sheets. As firms lack the demand for new credit, monetary policy struggles to stimulate economic recovery. Using credit data from 14 advanced economies over the period 1870-2008, Schularick and Taylor (2012) examine the determinants of financial crises and conclude that the credit growth rate before the outbreak of financial crises is typically significantly faster than the normal period (4.55% before the crisis, 0.18% in normal times), and that credit booms tend to be a harbinger of financial crises. Using data from 101 developed and developing countries from 1970 to 2010, Ductor and Grechyna (2015) investigated the relationship between financial development and real sector output, and their study showed that rapid financial development can harm economic growth because financial development can reduce economic growth by increasing economic vulnerabilities and resource misallocation. Palley (2008) believes that financial overdevelopment is often accompanied by the process of financialization. Financialization is defined as the process by which financial markets, financial institutions, and financial elites have greater influence over economic policies and economic outcomes. Financialization could make the economy more exposed to the risks of debt-deflation and long-term recession. Sawyer (2017) summarized the main characteristics of financialization: (1) The rapid expansion of financial institutions and financial markets. (2) Financial liberalization and deregulation. (3) The complexity of financial products means that assessing their risk is almost impossible. (4) The dominance of the financial sector over industry has increased. (5) International capital flows have increased significantly. (6) Household debt has increased significantly. He believes that financialization has a negative impact on economic growth and leads to financial instability and financial crises.

The third view is that there is a non-linear relationship between financial development and economic growth. Rousseau and Wachtel (2011) focused on the impact of financial development on economic growth in a sample of 84 countries between 1960 and 2004. The authors find that the positive impact of finance on economic growth has diminished considerably over time and has disappeared in the last 15 years. The occurrence of financial crises is closely related to the weakening of the positive impact of finance on growth. Arcand et al. (2015) explores whether there is a threshold for financial development using different datasets and empirical methods. The authors show that this threshold does exist, that is, when the ratio of private sector credit to GDP exceeds 100%, the marginal effect of financial development on economic growth becomes

negative. Using a sample of 50 developed and emerging market economies over the past 30 years, Cecchetti and Kharroubi (2012) explored the relationship between finance and economic growth in terms of the size of the financial sector, and found that when the proportion of financial sector employees in the total employment exceeds 3.5%, finance has a negative impact on economic growth. This is due to the competition between the financial sector and the real sector for scarce resources, the authors explain. Using the 1983-2013 equilibrium panel, Swamy and Dharani (2021) examined the relationship between finance and economic growth in G7 countries, and concluded that there is an inverted U-shaped relationship between finance and economic growth, and that too much finance is harmful.

### **3.2. Literature Focuses on the Discussion of Financial Cycle**

Although the financial cycle has always existed, it is a relatively new concept as a term. There is no consensus on the definition of the financial cycle, and one of the most cited definitions in the literature is that “The term will denote self-reinforcing interactions between perceptions of value and risk, attitudes towards risk and financing constraints, which translate into booms followed by busts” (Borio, 2014).

The theoretical literature on the financial cycle can be traced back to studies such as Wicksell (1898), Keynes (1930), Fisher (1933), Schumpeter (1934), Minsky (1979), Kindleberger (1978), and Bernanke (1983), these studies emphasized the important impact of financial variables on the macroeconomy. After the 2007-2009 financial crisis, the financial cycle has once again become the focus of macroeconomic research based on the reflection of traditional mainstream macroeconomics. Among them, the most representative paper is *The financial cycle and macroeconomics: What have we learnt?* written by Borio (2014), in which he summarizes the main characteristics of the financial cycle: first, credit and real estate prices are the most concise to describe and measure the financial cycle; second, the financial cycle is much longer (about 16 years) and magnitude greater than the business cycle; third, the peak of the financial cycle often coincides with the financial crisis; fourth, debt leverage and asset prices are leading indicators of financial crises; fifth, the length and magnitude of the financial cycle depend on the policy regime. The above conclusions represent the main consensus formed by most empirical studies so far.

In general, economists focus on the relationship between the financial cycle and the economic cycle and the relationship between the financial cycle and financial stability. Claessens et al. (2012) looked at data from 44 countries from 1960 to 2007 and found that there is a fairly strong link between the economic cycle and the different phases of the financial cycle, and that the financial cycle can have an important impact on the timing and intensity of recessions and recoveries. Mendoza and Terrones (2012) analysis of data from 1960 to 2010 in 61 countries show that changes in output, asset prices, real exchange rates, capital flows, and external deficits are systematically related to financial cycles, while credit booms are often accompanied by financial crises or

recessions. Rünstler and Vlekke (2018) analyzed the housing and credit cycles in six economies: The United States, Germany, France, the United Kingdom, Italy, and Spain, using a multivariate structural time series model (STSM). They found that credit and house price cycles are typically longer than business cycles and play an important role in exacerbating economic volatility. During the boom, house prices, collateral values, credit volumes, and home sales rose in tandem. During a depression, it's the opposite. Such cyclical fluctuations often lead to financial instability and economic recessions. Borio et al. (2020) used the ratio of credit-to-GDP, real estate prices, and debt-servicing ratios (defined as interest payments plus amortization divided by GDP) as indicators of the financial cycle, using quarterly data from 16 advanced economies from 1985 to 2017, to explore the effectiveness of financial cycle indicators in predicting recession risk, and they found that financial cycle indicators have significant predictive power.

Recent studies have focused on the impact of the global financial cycle. The paper by Potjagailo and Wolters (2023) observes that the global financial landscape has changed dramatically since the 1980s, and today's financial system is global. The global financial cycle is characterized by a common movement between credit, asset prices, and long-term interest rates, and operates with the frequency of business cycles. Miranda-Agrippino and Rey (2020) research show that the U.S. monetary policy has a strong financial spillover effect on countries around the world, and when the Fed tightens monetary policy, it is followed by a sharp deleveraging of global financial institutions, as well as a surge in risk aversion in the global capital market, resulting in a contraction of domestic credit and international liquidity in various countries, and a sharp decline in asset prices such as real estate and stock markets, constituting a global financial cycle.

### **3.3. Literature Focuses on Measuring Over-Indebtedness and Evaluating Leverage Ratio Indicator**

The existing literature mainly focuses on two types of leverage ratio indicators: gap indicator and threshold indicator.

The gap indicator refers to the Basel Credit Gap (BCG). Basel III advocates the creation of countercyclical capital buffers, expressed as a percentage of risk-weighted assets (RWAs). When a country's credit-to-GDP gap deviates from its long-term trend by 2 percentage points, the construction of capital buffers begins. For a difference of 2 to 10 percentage points, the buffer varies linearly between 0% and 2.5%. If the gap is more than 10 percentage points, the buffer will be set at 2.5% of the RWA (Basel Committee, 2011). The Bank for International Settlements (BIS, 2016) uses the gap indicator as an early warning sign of a financial crisis, defining that when the indicator exceeds 10%, it indicates that the country may face a financial crisis within three years. Although the Basel Credit Gap (BCG) is widely accepted, a growing body of research has questioned its applicability. Ramsay and Sarlin (2016) argue that BCG is unreliable as an early warning indicator, especially when calculating long-term trends. Spain, for example,

saw a sharp upward trend before the financial crisis, while Germany remained relatively stable and Japan saw a decline. Giese et al. (2014) evaluated the specific performance of this indicator based on the Basel credit gap dataset of the UK banking system over the past 50 years, and the results show that although BCG works well in terms of early warning signals, however, as a single indicator, BCG still has some unavoidable shortcomings in its design. First, it does not take into account the source of bank credit funds, which are less resilient if domestic banks accept foreign funds, which have proven to be volatile. Second, it does not distinguish between where credit money is invested, and money flowing into the real economy can boost economic growth, but money flowing into the real estate or stock market can trigger asset bubbles and threaten financial stability. Bouvatier and Ouardi (2023) investigated the applicability of the gap indicator to low- and middle-income countries, using a database covering credit gaps in more than 160 countries. Research shows that BCG cannot be used as an early warning indicator of a crisis in low- and middle-income countries, because excessive credit is not enough to cause a banking crisis in these countries, and factors such as exchange rate risk, bank bad debt indicators, and macroeconomic instability may be better predictive of banking crises in these countries than BCG. Empirical research by Jokipii et al. (2021) found that gap indicators tend to underestimate systemic risk in the current situation when economies experience credit booms that last longer than in the past, when the most pressing issues in credit markets have shifted to credit quality, but BCG, as a measure of over credit, does not reflect these risks. Therefore, a broader range of additional metrics should be used to compensate for BCG's shortcomings.

Threshold indicator is the use of absolute levels of leverage to assess financial risk. Cecchetti et al. (2011) argue that the ratio thresholds for household, corporate and government debt-to-GDP are around 85%, 90% and 85% respectively, and believe that countries should strive to keep their debt levels well below these thresholds. Reinhart and Rogoff (2010) found in a study of 44 countries over 200 years that the threshold levels of government debt and external debt as a ratio of GDP are 90% and 60%, respectively, and that when government debt exceeds this ratio, GDP growth decreases by about 1 percentage point for every 1 percentage point increase in debt; when the size of external debt exceeds this ratio, it is usually a harbinger of a recession. However, some studies have shown that these leverage thresholds are not robust. Dell'Ariccia et al. (2016) distinguished between good and bad credit booms and defined bad credit booms as: an economy experiencing a banking crisis within three years of credit expansion, or its economic growth falling below a medium-term trend. They identified more than 2010 credit boom events based on a dataset of 170 countries from 1960 to 2010 and found that credit boom is often related to financial reform and economic growth, with two-thirds of credit booms not experiencing financial crises or economic downturns. They argue that intervening and preventing good prosperity will have high economic costs.

In view of the shortcomings of the above indicators, some scholars have proposed new indicators. Chen et al. (2019) introduced the "leveraged investment ratio" indicator,

which identifies early crisis signals by observing the use (flow) of debt funds. Liu and Liu (2018) advocate the use of the capital stock indicator as a proxy variable for an economy's assets and suggest that the debt-to-asset ratio (debt/asset) should be used to measure debt risk at the macro level. Ramsay and Sarlin (2016) discuss the role of the ratio of a country's total debt stock to total savings flows in assessing debt risk.

### **3.4. Summary of this Section**

The relationship between financial development and economic growth has been extensively and thoroughly discussed. Researchers focused on the key characteristics of the financial cycle and its connection to the economic cycle, delving into the distinction between credit booms and the overuse of leverage. Although economists have not yet formed a broad consensus, it is not difficult to draw basic conclusions from the vast amount of existing research in combination with economic theory and the history of financial development. This conclusion can be summarized as follows: Finance is one of the cornerstones of modern society, promoting economic growth. Without finance and debt, the country would be poor and forever poor. Debt is a double-edged sword. Used wisely and in moderation, it will obviously improve welfare. However, when it is used rashly and excessively, the results can be disastrous (Cecchetti et al., 2011).

In general, the existing literature mainly focuses on the size of the financial system, the size of the total amount of credit, and the level of financial leverage. In other words, these discussions are more based on the scale as a measure of their advantages and disadvantages. However, there are some important dimensions that may be overlooked by such studies. For example, the 2007-2009 financial crisis was triggered by financial institutions providing too many mortgages to low-income, low-net, low-credit scores (Bazillier & Hericourt, 2017). If we only focus on the excessive issuance of housing loans by financial institutions and ignore the fact that borrowers are from "three low" families, it is obviously not enough, or it is not comprehensive. Because there is an important causal relationship between the risk management capabilities of financial institutions and their credit allocation efficiency and the triggering of financial crises. Encouragingly, in recent literature, a number of studies have highlighted the importance of the quality and efficiency of financial development. Cavallaro and Villani (2022) focus on the measurement of financial development, and the authors argue that the existing literature mainly focuses on the size of the financial system, and does not take into account many dimensions of financial development, such as the inclusiveness, efficiency, and stability of the financial environment. The authors emphasize that the impact of financial development on growth depends on an economy's ability to direct resources to high-productivity investment, and that future research is directed toward understanding which "type" of financial development is most conducive to financial stability and economic growth.

In summary, this study argues that a credit boom alone is not enough to trigger a

financial crisis, and that an inefficient credit boom is devastating. Moreover, the sustainability of debt does not depend on its deviation from long-term trends, but on the quality of credit assets and the efficiency of their output. Therefore, the purpose of this study is to construct an early warning indicator of systemic risk from the perspective of credit efficiency. By monitoring the output efficiency of credit inputs and the quality of the underlying assets mapped to them, we can gain insight into the nature of the credit boom and provide accurate and timely early warning signals of crisis.

## Section 4

### Research Design and Methodology

#### 4.1. Research Samples

Our empirical analysis uses quarterly panel data from 1990 to early 2023 of G20 member countries: Argentina, Australia, Brazil, Canada, China, Germany, France, India, Indonesia, Italy, Japan, South Korea, Mexico, Russia, Saudi Arabia, Turkey, the United Kingdom, and the United States. As globalization progresses, these major economies increasingly impact the global economy. Their economic fluctuations and systemic risks affect not only their own countries but also potentially ripple through other nations, especially trade partners and neighboring countries. As of 2023, G20 members hold a pivotal position in the global economy, accounting for 85% of the world's GDP, conducting 75% of global trade, spanning all continents except Antarctica, and housing two-thirds of the world's population. Therefore, we specifically select G20 members as our analytical sample to ensure that our findings have significant global economic relevance and practical impact. This selection also considers the quality and reliability of economic data from G20 countries, avoiding potential data imbalance and analytical bias that might arise from including too many small economies. The 32-year span of our data ensures timeliness while explaining financial cycles longer than business cycles (Borio, 2014). It is important to note that the crisis data used for predicting the probability of financial crises is sourced from Laeven and Valencia (2020)'s crisis database, which is available up to the year 2017. In order to maintain data consistency, our sample for this particular empirical analysis is also limited to data up to the year 2017.

#### 4.2. Model and Methodology

In terms of model setting, we first designed the following panel data models to investigate the relationship between systemic risk, credit to GDP ratio, and credit efficiency.

First, we constructed (I) to study the relationship between systemic risk and credit efficiency:

$$y_{i,t} = \beta_1 \text{Efficiency}_{i,t} + \beta_2 Z_{i,t} + \mu_i + \varepsilon_{i,t} + c \quad (\text{I})$$

In this model and subsequent models, the dependent variable  $y_{i,t}$  represents the assessment of systemic risk for economy  $i$  at time  $t$ . Efficiency  $_{i,t}$  denotes the credit efficiency indicator, reflecting the efficiency of economy  $i$ 's credit in contributing to economic growth at a specific time  $t$ .  $Z_{i,t}$  includes a set of control variables, in line with existing literature, including population growth rate, savings rate, and unemployment rate. These are aimed at controlling for other macroeconomic factors that may influence

the dependent variable.  $\mu_i$  controls for individual effects, capturing characteristics such as the policy environment that are constant over time for economy  $i$ .  $\varepsilon_{i,t}$  is the error term, representing random factors not observed in the model.  $c$  is the constant term, representing the intercept of the model.

Then, we constructed (II) to test if the leverage level drives systemic risk,

$$y_{i,t} = \beta_1 \text{Leverage}_{i,t} + \beta_2 Z_{i,t} + \mu_i + \varepsilon_{i,t} + c \quad (\text{II})$$

In model (II) and subsequent models,  $\text{Leverage}_{i,t}$  represents the leverage level of economy  $i$  at time  $t$ . The definitions of the other variables are the same as in model (I).

In (III), we included both the leverage and credit efficiency:

$$y_{i,t} = \beta_1 \text{Efficiency}_{i,t} + \beta_2 \text{Leverage}_{i,t} + \beta_3 Z_{i,t} + \mu_i + \varepsilon_{i,t} + c \quad (\text{III})$$

To explore how the interaction between leverage level and credit efficiency affects systemic risk, we have added an interaction term to (III):

$$y_{i,t} = \beta_1 \text{Efficiency}_{i,t} + \beta_2 \text{Leverage}_{i,t} + \beta_3 \text{Efficiency}_{i,t} * \text{Leverage}_{i,t} + \beta_4 Z_{i,t} + \mu_i + \varepsilon_{i,t} + c \quad (\text{IV})$$

To discuss how credit efficiency affects the changes in property prices (systemic risk). We have designed a set of difference models:

$$y_{i,t} - y_{i,t-1} = \beta_1 \text{Efficiency}_{i,t} + \beta_2 Z_{i,t} + \mu_i + \varepsilon_{i,t} + c \quad (\text{V})$$

$$y_{i,t} - y_{i,t-1} = \beta_1 \text{Leverage}_{i,t} + \beta_2 Z_{i,t} + \mu_i + \varepsilon_{i,t} + c \quad (\text{VI})$$

$$y_{i,t} - y_{i,t-1} = \beta_1 \text{Efficiency}_{i,t} + \beta_2 \text{Leverage}_{i,t} + \beta_3 Z_{i,t} + \mu_i + \varepsilon_{i,t} + c \quad (\text{VII})$$

Our last two models focus on the predictive power of credit efficiency for financial crises, we specifically chose to construct logistic and probit regression models. These models are particularly well-suited for dealing with binary dependent variables, in this case it is the occurrence (or non-occurrence) of financial crises.

$$\log \left( \frac{P(\text{Crisis}_{i,t}=1)}{1-P(\text{Crisis}_{i,t}=1)} \right) = \beta_1 \text{Efficiency\_Dummy}_{i,t} + \beta_2 \text{Efficiency\_Dummy}_{i,t} * \text{Leverage}_{i,t} + \beta_3 Z_{i,t} + \mu_i + \varepsilon_{i,t} + c \quad (\text{VIII})$$

$$P(\text{Crisis}_{i,t}=1) = \Phi \left( \beta_1 \text{Efficiency\_Dummy}_{i,t} + \beta_2 \text{Efficiency\_Dummy}_{i,t} * \text{Leverage}_{i,t} + \beta_3 Z_{i,t} + \mu_i + \varepsilon_{i,t} + c \right) \quad (\text{IX})$$

We design the logistic model (VIII) and the probit model (IX) to quantify the impact of sustained declines in credit efficiency (represented by a dummy variable) and leverage levels on the likelihood of financial crises. In the logistic model (VIII),  $\log(P(\text{Crisis}_{i,t}=1)/1-P(\text{Crisis}_{i,t}=1))$  is the log odds of a financial crisis occurring for economy  $i$  at time  $t$ . While in the probit model (IX),  $P(\text{Crisis}_{i,t}=1)$  is the probability of a financial crisis occurring for economy  $i$  at time  $t$ . The  $\Phi$  function denotes the cumulative distribution function of the normal distribution.

The choice of logistic and probit regression models allows for an effective quantification of these relationships, providing a robust method to assess the probability of a financial crisis in response to changes in key economic indicators.

### 4.3. Explanation of Regression Variables and Data Sources

In our models (I) – (VII), the dependent variable  $y$  represents the level of systemic risk, Efficiency denotes credit efficiency, Leverage indicates the level of financial leverage, and  $Z$  represents control variables. The model includes individual effects ( $\mu$ ), the residual term ( $\epsilon$ ), and a constant term ( $c$ ), with subscripts  $i$  and  $t$  representing individual entities and time, respectively. The coefficients  $\beta_1$ ,  $\beta_2$ ,  $\beta_3$  and  $\beta_4$  correspond to these variables.

For our proxy variable choice, we use the real estate price index as an indicator of systemic risk levels. The rationale is that fluctuations in real estate prices effectively reflect financial policies (Bernanke, Gertler & Gilchrist, 1999) and market volatility (Case & Shiller, 2003). Furthermore, these prices are closely linked with economic cycles and are a leading indicator of economic recovery or recession (Leamer, 2015).

In the logistic model (VIII), the dependent variable  $\log(P(\text{Crisis}_{i,t}=1)/1-P(\text{Crisis}_{i,t}=1))$  represents the log odds of a financial crisis occurring in economy  $i$  at time  $t$ . We follow the definition of financial crisis by Laeven and Valencia (2013). They define a financial crisis as an event that satisfies two conditions: one condition, significant signs of financial distress in the banking system (manifested in severe bank runs, losses in the banking system, and/or bank liquidations); The second condition is that significant policy interventions measures have been taken in response to significant losses in the banking system. These major policy interventions include: (1) Major bank nationalizations; (2) Total bank restructuring costs (at least 3% of GDP); (3) Extensive liquidity support (5% of non-resident deposits and liabilities); (4) Significant asset purchases (at least 5% of GDP); (5) Deposit freezes and/or bank holidays; and (6) Significant government bailouts to ensure that they are in place. Based on Laeven and Valencia's most recent database (2020), they identified a total of 466 systemic crisis events worldwide over the period 1970-2017, from which we obtained quarterly data for 71 crises in 19 countries over the period 1990-2023. In this model, the variable "Crisis" encompasses various types of financial crises, including banking crises,

currency crises, sovereign debt defaults and restructurings. If an economy  $i$  experiences any of these crises at time  $t$ , we assign a value of 1 to this variable; otherwise, it is assigned a value of 0. Similarly, the probit model (IX) aims to explore the probability of a financial crisis under the same definition but models the probability directly through the cumulative distribution function of the standard normal distribution.

In choosing independent variables, following mainstream literature, we use the credit to GDP ratio to represent the level of economic financial leverage. According to the World Bank, credit to the private sector refers to financial resources provided to the private sector by financial corporations, including loans, purchases of non-equity securities, and trade credits. Thus, the ratio of private sector credit to GDP measures the most active part of financial activity, making it a theoretically superior proxy for macro financial leverage.

For another independent variable, credit efficiency (Efficiency), we construct two key indicators to measure an economy's ability to generate value from credit. These are the credit efficiency of the private non-financial sector (measured by GDP/private sector credit) and non-financial corporation sector credit efficiency (measured by GDP/corporation sector credit). The choice of these indicators is based on their comprehensiveness in analyzing economic health and stability. Specifically, corporation sector credit efficiency focuses on capital investment, production expansion, and R&D, reflecting changes in the marginal benefits of capital investment. On the other hand, private sector credit efficiency, which includes both corporation and household sector credits (such as consumer and housing loans), reflects the internal demand conditions of an economy. Therefore, private sector credit efficiency not only shows the marginal benefits of capital investment in the corporation sector but also reveals the adequacy of internal demand in the overall economy. This approach allows for a more comprehensive understanding of the efficiency of financial resource allocation and its impact on financial stability.

Based on our definition of credit efficiency (Efficiency), we have further expanded its application by creating a differential variable of credit efficiency ( $\text{Efficiency}_{i,t} - \text{Efficiency}_{i,t-1}$ ) and a growth rate variable ( $(\text{Efficiency}_{i,t} / \text{Efficiency}_{i,t-1}) - 1$ ). The purpose of this is to more deeply explore the impact of dynamic changes in credit efficiency on systemic risk and the probability of financial crises. By analyzing the temporal changes in credit efficiency, we can capture short-term fluctuations in efficiency and their potential impact on macroeconomic financial stability, supplementing our understanding of static credit efficiency indicators.

In (VIII) and (IX) the  $\text{Efficiency\_Dummy}$  variable is a measure to assess the impact of credit efficiency on financial crises while avoiding reverse causality bias that might arise from direct use of current credit efficiency levels. This dummy variable is set to 1 if, in any given set of four consecutive periods, there are at least three periods with a decline in credit efficiency change rate, indicating a trend of decreasing credit efficiency.

If this condition is not satisfied, the variable is set to 0, implying stable or increasing credit efficiency. This approach allows for a nuanced understanding of how sustained shifts in credit efficiency might signal impending financial instability.

In addition to these independent variables, we also include the following factors in our analysis as control variables to account for the influences that might affect economic growth: population growth rate, savings rate, and unemployment rate. Some literature has used other control variables such as industrial added value, but due to data availability issues, this would reduce the sample size, and moreover, they are not significant in the results. Therefore, I have chosen to use only these three significant controls to ensure the sample is as large as possible.

The symbols, definitions, and data sources of these regression variables are shown in table 1, and table 2 provides basic statistical descriptions of these variables. The line graphs display the relationship between the credit efficiency variables and property prices over time.

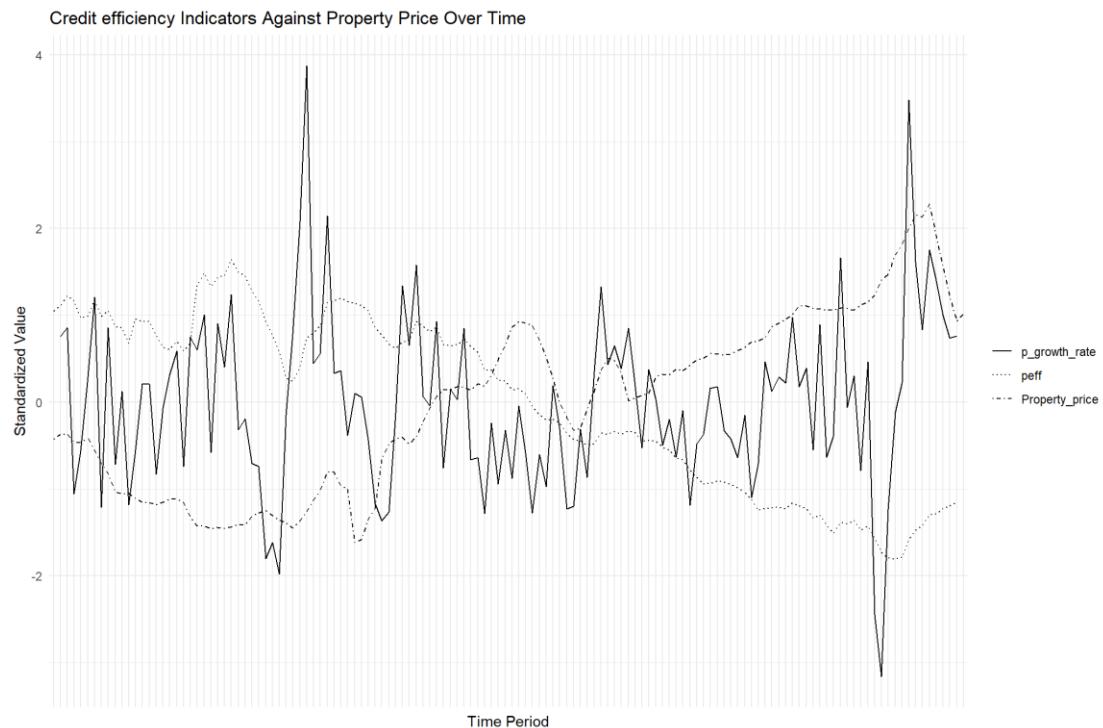
**Table 1. Regression Variables and Data Sources**

Type	Variable	Variable Definition	Data Source
Dependent Variable	Property_price	Real residential property prices index - the base year is 2010	Bank of International Settlement (BIS) database
	Crisis	Crisis, binary dependent variable	Laeven and Valencia (2020)
Independent Variable	leverage	The most used leverage level indicator: private sector credit/GDP	Bank of International Settlement (BIS) database
	peff	Private non-financial credit efficiency indicator: GDP/private sector credit	
	ceff	Non-financial corporation credit efficiency indicator: GDP/corporation sector credit	
	diff_peff	Differential variable of private credit efficiency: $peff_{i,t} - peff_{i,t-1}$	
	diff_ceff	Differential variable of corporation credit efficiency: $ceff_{i,t} - ceff_{i,t-1}$	
	p_growth_rate	Change in private credit efficiency: $peff_{i,t} / peff_{i,t-1} - 1$	
	c_growth_rate	Change in corporation credit efficiency: $ceff_{i,t} / ceff_{i,t-1} - 1$	
	eff_dummy	Dummy variable measuring the persistent decline in p_growth_rate - Labeled 1 if there is a decline in credit efficiency in at	

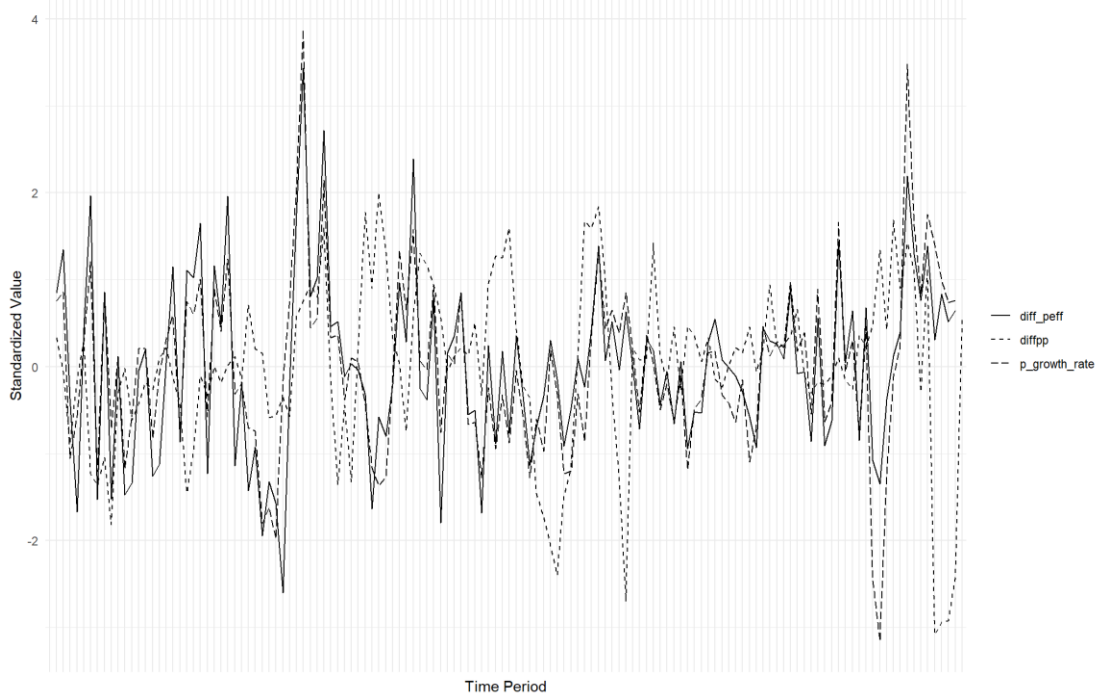
		least three out of any four consecutive periods, and 0 otherwise.	
Control Variable	pop	Population growth rate	The World Bank World Development Indicators (WDI) database
	sav	Savings rate	
	une	Unemployment rate	

**Table 2. Descriptive Statistics for Regression Variables**

Statistic	Mean	Median	SD	Min	Max
Property_price	100.4850	100.9836	31.7521	34.9444	305.4705
peff	1.5297	0.9355	1.2261	0.4070	6.7114
ceff	2.1806	1.5096	1.5565	0.5785	7.7979
leverage	1.0369	1.0690	0.5788	0.1490	2.4570
diff_peff	-0.0063	-0.0023	0.1096	-1.6366	0.9307
diff_ceff	-0.0053	-0.0023	0.1428	-1.7465	0.9973
p_growth_rate	-0.0030	-0.0031	0.0384	-0.4761	0.5429
c_growth_rate	-0.0017	-0.0019	0.0383	-0.5306	0.2172
pop	0.8235	0.8595	0.6290	-1.8537	3.0784
sav	25.8236	24.2814	7.3793	11.5221	51.0866
une	7.4671	6.8225	4.4000	2.0500	29.8060



Credit efficiency Change Indicators Against Property Price Over Time



## Section 5

### Empirical Analysis and Findings

#### 5.1. Regression Analysis Results Based on Private Non-Financial Sector Credit Efficiency

Models I, II, and III reveal the impact of credit efficiency (represented by the ratio of GDP to private sector credit, *peff*), financial leverage (*leverage*), and control variables such as population growth, savings rate, and unemployment rate on property prices. Variance Inflation Factor (VIF) tests indicate that, despite a certain degree of multicollinearity (VIF value for *peff* is 4.09, and for ratio is 4.19), we can still independently examine the impact of these two core variables on property prices.

Model I shows that an increase in credit efficiency *peff* is significantly related to a decrease in property prices, implying that higher credit efficiency could reduce the level of systemic risk. This finding emphasizes the important role of credit efficiency in promoting financial stability. Model II indicates that, without considering the impact of credit efficiency, an increase in financial leverage (*leverage*) significantly raises property prices. This may reflect more credit flowing into the asset market, thereby driving up property prices and increasing systemic risk. The results of Model III suggest that when considering both credit efficiency *peff* and financial leverage simultaneously, the positive impact of financial leverage on property prices becomes more significant, while the impact of credit efficiency turns positive. This could be due to the multicollinearity and interaction between credit efficiency and financial leverage. Further analysis incorporating the interaction term between credit efficiency and financial leverage will explore how they jointly affect property prices.

In Models IV, V, and VI, we analyze the impact of the change in private sector credit efficiency (*diff\_peff*) and financial leverage (*leverage*) on the change in property prices (*diff\_pp*). Model IV reveals a negative correlation between changes in credit efficiency and changes in property prices, which, although not entirely significant at the 5% traditional level of significance ( $p\text{-value} = 0.086$ ), becomes significant at the 10% level. This suggests that, in the short term, an increase in credit efficiency represents a flow of capital towards more efficient sectors of the economy, implying a reduction in investments in less efficient or overheated areas. Hence, we can infer that a more rational allocation of credit resources and curbing overheated investments could effectively reduce systemic risk.

Model V shows that the impact of financial leverage (*leverage*) on changes in property prices is not statistically significant. However, the results of Model VI delve further into the joint impact of changes in credit efficiency and financial leverage on changes in property prices. When considering financial leverage, the negative impact of changes in credit efficiency on property prices slightly weakens ( $p\text{-value}$  increases to 0.104), but

this does not alter the conclusion drawn from Model IV, indicating that changes in credit efficiency could have a short-term negative impact on systemic risk changes.

**Table 3: Panel Regression Results of Private Non-Financial Sector Credit Efficiency and Financial Leverage on Property Price**

	Dependent variable					
	property_price			diff_pp		
	I	II	III	IV	V	VI
peff	-14.628*** (1.769)		9.205*** (1.800)			
leverage		53.929*** (2.082)	60.607*** (2.445)		-0.613 (0.456)	-0.559 (0.457)
diff_peff				-4.627+ (2.696)		-4.386 (2.702)
pop	-1.000 (1.784)	0.351 (1.538)	-0.420 (1.534)	-1.217*** (0.334)	-1.245*** (0.335)	-1.248*** (0.335)
sav	0.155 (0.269)	0.884*** (0.235)	0.882*** (0.234)	0.051 (0.051)	0.043 (0.052)	0.042 (0.052)
une	-5.210*** (0.359)	-3.609*** (0.314)	-3.780*** (0.314)	-0.036 (0.066)	-0.062 (0.068)	-0.060 (0.068)
Observations	1,763	1,763	1,763	1,748	1,748	1,748
R <sup>2</sup>	0.187	0.390	0.399	0.010	0.009	0.011
Adjusted R <sup>2</sup>	0.178	0.383	0.392	-0.001	-0.002	-0.001
F Statistic	100.052*** (df = 4; 1743)	278.319*** (df = 4; 1743)	231.098*** (df = 5; 1742)	4.326** (df = 4; 1728)	4.040** (df = 4; 1728)	3.762** (df = 5; 1727)

Note:  $p < 0.1$ , +;  $p < 0.05$ , \*;  $p < 0.01$ , \*\*;  $p < 0.001$ , \*\*\*

Regarding the control variables, population growth (pop) has a significant negative impact on changes in property prices in the short term (in Models IV, V, and VI), revealing an interesting dynamic: rapid population growth increases the demand for assets, which could potentially raise property prices. However, this growth could also expand market demand, leading to a slower decline in marginal returns on capital, thereby potentially reducing the overall level of market risk. The savings rate (sav) has a significant positive impact on property prices in Models II and III, possibly because a high savings rate increases the funds available for investment, driving up leverage levels and causing an increase in property price levels. An increase in the unemployment rate is often seen as a sign of economic recession, typically implying an increase in risk. Yet, across all model results, unemployment rates are inversely related

to property prices (i.e., a decrease in systemic risk). One possible explanation is that, as one of the most widely monitored macroeconomic indicators, an increase in the unemployment rate may prompt the market to adjust to the current economic situation, thereby lowering property price levels and adjusting systemic risk to some extent.

## **5.2. Regression Analysis Results Based on Non-Financial Corporation Sector Credit Efficiency**

In Table 4, we introduced the regression analysis results based on the corporation sector's credit efficiency (ceff) for comparative analysis and robustness tests. Unlike private sector credit efficiency (peff), corporation sector credit efficiency more closely reveals the credit strategies and investment behaviors of corporations. The analysis of Models I, II, and III demonstrated that, similar to private sector credit efficiency, an increase in corporation credit efficiency is significantly correlated with a decrease in property prices. Notably, the variance inflation factor (VIF) results indicate ceff and ratio VIF values of 3.6 and 3.45, respectively, suggesting a reduction in the issue of multicollinearity compared to the analysis involving private sector credit efficiency.

However, the influence of corporation sector credit efficiency on property prices appears to be less significant than that of private sector credit efficiency. This may reflect the significant role of household mortgages, consumer loans, and education loans in market demand on property prices. In the differential models IV, V, and VI, changes in corporation credit efficiency do not significantly impact property prices, implying that the direct effect of corporation credit efficiency changes on property prices is relatively limited in the short term.

Our robustness testing unveils a consistent trend: enhancements in credit efficiency have a positive role in diminishing systemic risk. This insight has been validated in the analyses of both the corporation and private sectors' credit efficiency, albeit with variations in the degree of their significance on property prices. Specifically, the levels of property prices and their variations appear more sensitive to private sector credit efficiency. This may be due to private sector credit efficiency being directly linked to aspects of market demand such as household consumption and housing loans. Hence, private sector credit efficiency emerges as a superior indicator, more accurately reflecting the allocation efficiency and changes in credit resources within an economy and offering more precise signals for systemic risk.

**Table 4: Panel Regression Results of Non-Financial Corporation Credit Efficiency and Financial Leverage on Property Price**

	Dependent variable					
	property_price			diff_pp		
	I	II	III	IV	V	VI
ceff	-5.785*** (1.153)		5.468*** (1.086)			
leverage		53.929*** (2.082)	54.528*** (2.202)		-0.613 (0.456)	-0.440 (0.459)
diff_ceff				-0.618 (1.182)		-0.604 (1.182)
pop	1.771 (1.794)	0.351 (1.538)	2.472 (1.535)	-1.123** (0.348)	-1.245*** (0.335)	-1.146** (0.348)
sav	-0.356 (0.259)	0.884*** (0.235)	0.500* (0.224)	0.051 (0.051)	0.043 (0.052)	0.043 (0.051)
une	-6.526*** (0.354)	-3.609*** (0.314)	-4.629*** (0.313)	-0.003 (0.067)	-0.062 (0.068)	-0.025 (0.071)
Observations	1,692	1,763	1,692	1,676	1,748	1,676
R <sup>2</sup>	0.223	0.390	0.431	0.007	0.009	0.007
Adjusted R <sup>2</sup>	0.214	0.383	0.425	-0.004	-0.002	-0.005
F Statistic	119.755*** (df = 4; 1672) 278.319*** (df = 4; 1743) 253.552*** (df = 5; 1671) 2.879* (df = 4; 1656) 4.040** (df = 4; 1728) 2.488* (df = 5; 1655)					

Note:  $p < 0.1$ , +;  $p < 0.05$ , \*;  $p < 0.01$ , \*\*;  $p < 0.001$ , \*\*\*

### 5.3 Using Credit Efficiency Growth Rate as an Indicator of Credit Efficiency

To delve deeper into the dynamic changes in credit efficiency, this study introduced the growth rate of private credit efficiency (*p\_growth\_rate*) and corporation credit efficiency (*c\_growth\_rate*) as supplements to traditional static credit efficiency indicators. The panel regression results displayed in Table 5 revealed a significant negative correlation between the growth rate of private credit efficiency and property prices and their changes, indicating that the growth rate of private credit efficiency could be an effective indicator for measuring the level of credit efficiency. In the robustness tests, we found that the significant level of the private efficiency growth rate was over 99.9%. In contrast, the impact of corporation credit efficiency growth rate on property prices was not significant.

Compared with traditional static credit efficiency indicators, these growth rate indicators offer a dynamic perspective on the evolving trend of credit efficiency, enabling real-time monitoring and analysis of improvements or regressions in credit efficiency. Moreover, compared to the absolute increase in credit efficiency, the growth rate indicators present the relative proportion of changes in credit efficiency, making these standardized change rates more suitable for comparative analysis across economies of different sizes. However, a potential challenge arises from the base effect: in emerging markets with a low baseline of credit efficiency, even minor improvements may appear as significant growth rates, potentially overemphasizing positive changes; conversely, in mature markets with high baseline efficiency, the same improvements might reflect as lower growth rates, possibly underestimating the actual positive changes in credit efficiency. In the following section, we will continue to explore how the interaction between the growth rate of credit efficiency and financial leverage affects systemic risk.

**Table 5: Panel Regression Results of Private Non-Financial Sector and Non-Financial Corporation Credit Efficiency Growth Rate and Financial Leverage on Property Price**

	Dependent variable			
	property_price		diff_pp	
	I	II	III	IV
p_growth_rate	-53.172* (24.153)		-13.112* (5.321)	
c_growth_rate		12.854 (17.535)		-2.460 (4.007)
leverage	54.235*** (2.090)	49.975*** (2.026)	-0.548 (0.456)	-0.440 (0.459)
pop	0.076 (1.537)	3.213* (1.538)	-1.268*** (0.335)	-1.150*** (0.348)
sav	0.853*** (0.236)	0.436+ (0.226)	0.049 (0.052)	0.044 (0.051)
une	-3.536*** (0.315)	-4.475*** (0.314)	-0.047 (0.069)	-0.022 (0.071)
Observations	1,754	1,681	1,748	1,676
R <sup>2</sup>	0.391	0.423	0.013	0.008
Adjusted R <sup>2</sup>	0.384	0.416	0.001	-0.004
F Statistic	222.868*** (df = 5; 1733)	243.435*** (df = 5; 1660)	4.456*** (df = 5; 1727)	2.511* (df = 5; 1655)

Note:  $p < 0.1$ , +;  $p < 0.05$ , \*;  $p < 0.01$ , \*\*;  $p < 0.001$ , \*\*\*

#### **5.4 Interaction Between Financial Leverage and Credit Efficiency**

Table 6 thoroughly investigates the impact of corporation credit efficiency (ceff), the growth rate of private credit efficiency (p\_growth\_rate), and the growth rate of corporation credit efficiency (c\_growth\_rate), along with changes in credit efficiency (diff\_peff and diff\_ceff) on property prices, examining the interaction between these variables and financial leverage (leverage). By incorporating control variables such as population growth (pop), savings rate (sav), and unemployment rate (une), the model aims to provide a comprehensive perspective on how credit efficiency and financial leverage jointly influence systemic risk.

The analysis indicates significant impacts of credit efficiency growth rate on property prices in Models II and III, highlighting the effectiveness of an efficient credit allocation mechanism. Specifically, an increase in credit efficiency significantly reduces property prices, suggesting that improvements in credit efficiency can effectively lower systemic risk. Additionally, the interaction between financial leverage and the growth rate of credit efficiency has a significant positive impact on property prices. This means that as financial leverage increases, the negative impact of the growth rate of credit efficiency on property prices shows a weakening trend. This interpretation suggests that when credit efficiency decreases, the increase in financial leverage poses a more significant threat to market stability.

It is noteworthy that in Models I, IV, and V, the coefficients and significance levels of credit efficiency-related variables change after the introduction of interaction terms, implying that the inclusion of interaction terms might affect the model's ability to capture the interaction between credit efficiency and financial leverage. This change could indicate that considering the moderating role of financial leverage, the independent effects of credit efficiency and financial leverage might have more direct and significant impacts on property prices, with the interaction effects being relatively minor.

Overall, this part of the study demonstrates that the growth rate of credit efficiency is an important indicator in the interaction with leverage levels affecting the level of systemic risk. It significantly influences property prices and affects the impact of leverage rates on property prices. It reveals that inefficient credit amplifies the risks brought by leveraging, emphasizing the importance of maintaining or improving credit efficiency in a high-leverage financial environment to curb systemic risk.

**Table 6. Dynamic Interaction of Credit Efficiency and Financial Leverage under a Systemic Risk Perspective**

	Dependent variable				
	property_price			diff_pp	
	I	II	III	IV	V
ceff	4.964*** (1.170)				
p_growth_rate		-169.373*** (46.716)			
c_growth_rate			-56.667+ (32.812)		
diff_peff				3.954 (5.232)	
diff_ceff					-0.547 (2.062)
leverage	52.841*** (2.641)	54.676*** (2.091)	50.186*** (2.025)	-0.564 (0.457)	-0.441 (0.459)
pop	2.662+ (1.543)	0.143 (1.534)	3.242* (1.535)	-1.273*** (0.335)	-1.146** (0.349)
sav	0.524* (0.225)	0.784*** (0.237)	0.387+ (0.227)	0.052 (0.052)	0.043 (0.052)
unc	-4.568*** (0.317)	-3.601*** (0.315)	-4.519*** (0.314)	-0.042 (0.069)	-0.024 (0.071)
ceff: leverage	4.375 (3.782)				
p_growth_rate: leverage		135.442** (46.646)			
c_growth_rate: leverage			78.972* (31.524)		
diff_peff: leverage				-18.780+ (10.091)	
diff_ceff: leverage					-0.137 (4.139)
Observations	1,692	1,754	1,681	1,748	1,676
R <sup>2</sup>	0.432	0.394	0.425	0.013	0.007
Adjusted R <sup>2</sup>	0.425	0.387	0.418	0.001	-0.005

F Statistic	211.559*** (df = 6; 1670)	187.925*** (df = 6; 1732)	204.553*** (df = 6; 1659)	3.716** (df = 6; 1726)	2.072+ (df = 6; 1654)
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*Note:*  $p < 0.1$ , +;  $p < 0.05$ , \*;  $p < 0.01$ , \*\*;  $p < 0.001$ , \*\*\*

## 5.5 Financial Crisis Early Warning Model

In exploring how credit efficiency impacts the probability of a financial crisis, we employed Probit and Logistic models, utilizing data from G20 countries over the past 30 years, focusing on 71 quarters of financial crisis data. To avoid potential reverse causality biases associated with directly using credit efficiency indicators and financial leverage variables, this study introduced a dummy variable related to changes in credit efficiency (Eff\_dummy). Specifically, we created a new variable for credit growth rate (using private sector credit in this context), where if a decrease in credit efficiency growth rate occurs in at least three out of four consecutive periods, then this variable is marked as 1, otherwise 0. This methodological innovation allows for a more accurate capture of the relationship between the trend of declining credit efficiency and the probability of financial crisis occurrence. It is important to note that the financial crisis data used in this study come from the crisis database by Laeven and Valencia, up to 2017, to maintain consistency in data analysis.

**Table 7. Logistic and Probit Financial Crisis Early Warning Models Based on Credit Efficiency Dummy Variables**

	Model			
	logistic		probit	
	I	II	III	IV
Eff_dummy	0.66** (0.28)	1.57*** (0.45)	0.30* (0.12)	0.70**** (0.21)
pop	0.30 (0.19)	0.19 (0.19)	0.13 (0.08)	0.09 (0.08)
une	0.05* (0.03)	0.04 (0.03)	0.02* (0.01)	0.02 (0.01)
sav	-0.02 (0.02)	-0.02 (0.02)	-0.01 (0.01)	-0.01 (0.01)
Eff_dummy:leverage		-1.23* (0.55)		-0.52* (0.23)
Constant	-3.88*** (0.63)	-3.78*** (0.62)	-2.10*** (0.27)	-2.03*** (0.27)
Observations	1,976	1,976	1,976	1,976

Note:  $p < 0.1$ , +;  $p < 0.05$ , \*;  $p < 0.01$ , \*\*;  $p < 0.001$ , \*\*\*

The analysis results in Table 7 show that in both Logistic and Probit models, the dummy variable for declining credit efficiency (Eff\_dummy) significantly positively correlates with the probability of a financial crisis occurring. This indicates that if an economy is experiencing a sustained slowdown in credit efficiency growth rate, the likelihood of a financial crisis significantly increases. Moreover, when the interaction term between Eff\_dummy and financial leverage is added to the models, this interaction term is significant in both models, revealing that a continuous decline in credit efficiency at high debt levels significantly exacerbates the risk of a financial crisis.

These findings not only support the effectiveness of a declining trend in credit efficiency as an early warning signal for financial crises but also highlight the importance of monitoring changes in credit efficiency in a high-debt environment. This helps in more accurately identifying and preventing potential risk factors for financial crises.

## 5.6. Implications for Credit Policy

Our research emphasizes that the slowdown or stagnation in the growth rate of credit efficiency is a key factor causing financial instability. The underlying economic

rationale is that by monitoring credit efficiency within the economy and maintaining effective credit distribution through financial policies, the default risk of various non-financial sectors can be reduced, thereby lowering the rate of bad loans and the likelihood of banking crises. Therefore, policymakers should strive to promote the flow of funds to more efficient economic sectors to reduce instability in financial fundamentals. This adjustment in the flow of funds not only enhances the overall economy's efficiency in using funds but may also reduce systemic risk by curbing overheated investments, having a potentially positive impact on maintaining financial market stability.

Although financial leverage can enhance economic vitality, it also increases the instability of the economy. However, the sensitivity of systemic risk to financial leverage may differ at various levels of credit efficiency, and vice versa. Our analysis further confirms a significant positive correlation between debt levels and systemic risk. More importantly, by studying the interaction between the growth rate of credit efficiency and financial leverage, we have revealed that the threat to economic stability significantly increases with high debt levels when credit efficiency decreases.

This finding issues a clear warning to policymakers and financial institutions: There must be particular caution with financial leverage in contexts of insufficient credit utilization. This means that, regardless of the extent of financial leverage used by the economy, in situations where credit utilization efficiency is low or growth is slowing, the financial sector must control and use financial leverage prudently to avoid uneconomical credit. This approach will also force non-financial sectors to more cautiously evaluate the stage of their industry and changes in supply and demand relations, thereby reducing uneconomical investment behaviors and minimizing the risk of debt default and bankruptcy. Concurrently, banks and other financial institutions must closely monitor overall credit efficiency and debt levels to prevent economic imbalances. Loan strategies and review standards should be timely adjusted based on changes in the economy's overall leverage and credit efficiency levels to avoid the accumulation of risks and protect against potential systemic threats.

In economies with high leverage and declining growth rates of credit efficiency, measures to cool down overheated investments, such as increasing interest rates, serve as viable methods. This is because they can elevate the cost of borrowing, thus dampening enthusiasm for investment and consumption, thereby slowing credit growth. Other examples include raising banks' capital adequacy requirements or imposing stricter lending restrictions on certain sectors, like real estate. However, such measures may inadvertently impact both high and low efficiency credits, potentially reducing the overall economic vitality.

Our research findings suggest that reducing high-efficiency credit could actually harm economic stability. Therefore, the key to lowering systemic risk and preventing crises lies in precise control rather than broad, indiscriminate measures. This means that

policymakers and financial institutions need to more accurately differentiate between high and low efficiency credits, adopting differentiated or structured policy measures in response.

For precise regulation, policymakers could consider introducing assessment indicators, such as credit efficiency or the growth rate of credit efficiency, to categorize and manage different industries and loan projects distinctly. Financial institutions should also employ sensible metrics and more flexible strategies, adjusting loan conditions based on the borrower's industry, rather than implementing a one-size-fits-all policy. This approach allows for a more targeted reduction in low-efficiency credit while protecting or even encouraging high-efficiency credit, thereby minimizing risk accumulation during economic upturns and effectively reducing systemic risks when deleveraging is necessary.

We also believe that in a highly globalized financial environment, there may be differences in credit efficiency levels and trends between emerging markets and developed markets. Assessing risk based solely on debt levels may lead to an underestimation of investment and credit risks. Therefore, incorporating an analysis of credit efficiency is particularly important in formulating financial policies and risk management strategies for banks.

Finally, our financial crisis early warning model further confirms the importance of a continuous decline in credit efficiency as a significant early warning indicator of financial crises, especially in high-debt environments. This model not only identifies trends in declining credit efficiency but also provides an effective buffer for financial crisis warnings, offering policymakers and market regulators a window for prevention and intervention. According to our analysis, if the growth rate of credit efficiency continues to decline for 2 to 3 consecutive quarters, it should be seen as a clear signal of a threat to financial stability. This warning indicator emphasizes the importance of monitoring changes in credit efficiency and suggests that all relevant departments should take preventive measures at the early signs of declining credit efficiency to prevent the occurrence of financial crises. Additionally, the risk amplification effect of declining credit efficiency under high debt levels requires policymakers and financial regulatory agencies to remain highly vigilant about the interaction between debt levels and credit efficiency and to take proactive macroprudential policies when necessary to avoid potential financial instability.

## **Section 6**

### **Conclusion**

This study offers a new perspective on the complex relationships between credit efficiency, financial leverage, and systemic risk, providing strong empirical support for financial regulatory practices. Although much of the literature has focused on systemic risk within the banking and non-banking financial sectors, exploring perspectives such as bad debt ratios, cash flows, and portfolio risk management to explain and prevent financial crises, the direct manifestation of banking crises-defaults by financial institutions-undoubtedly remains a focal point of research. However, since the non-financial sector is closely linked to financial institutions through its financing and investment activities, the risk of default by financial institutions essentially stems from the default and bankruptcy risks within the non-financial sector. Compared to this, studies on the relationship between the non-financial sector and systemic risk are relatively scarce.

This study primarily investigates the link between credit efficiency and systemic risk and introduces a new early warning indicator that connects the growth rate of credit efficiency with financial crises, offering a unique perspective for studying systemic risk and financial crisis early warning. Specifically, through constructing fixed-effect models, difference models, and crisis prediction models, this study systematically examines the impact of “private non-financial sector credit efficiency”, “non-financial corporations’ credit efficiency”, “financial leverage”, and “credit efficiency growth rate” on asset prices and the probability of systemic financial risk outbreaks, drawing the following main findings:

1. There is a negative correlation between credit efficiency and systemic risk, while there is a significant positive correlation between financial leverage and systemic risk. However, the impact of financial leverage on systemic risk weakens at higher levels of credit efficiency.
2. In explaining changes in the level of systemic risk, changes in credit efficiency demonstrate stronger explanatory power than financial leverage indicators, revealing that a more rational allocation of credit resources and curbing overheated investments can effectively reduce systemic risk.
3. A sustained slowdown in the growth rate of credit efficiency has a very significant positive impact on the probability of a financial crisis occurring, indicating that the credit efficiency indicator constructed in this study has significant indicative significance in analyzing and predicting the probability of a financial crisis.

Based on these findings, our study provides significant evidence and insights for the formulation of credit policies. Initially, we uncovered that a slowdown or stagnation in

the growth rate of credit efficiency is a key factor leading to financial instability. This discovery emphasizes the importance of effectively allocating credit resources through financial policies to reduce the default risk within non-financial sectors. Furthermore, our analysis has further confirmed that high debt levels pose a greater threat to economic stability when credit efficiency declines. We highlight the necessity of precisely controlling financial leverage and distinguishing between high and low efficiency credits. We believe that by introducing assessment indicators such as credit efficiency or its growth rate, policymakers can more specifically manage different industries and loan projects, reducing low-efficiency credit while protecting or encouraging high-efficiency credit. This approach not only mitigates risk accumulation during economic upturns but also effectively lowers systemic risks during deleveraging periods.

Moreover, our financial crisis early warning model has unveiled that a continuous decline in credit efficiency serves as a significant early warning sign of financial crises, especially in high-debt environments. This necessitates heightened vigilance from policymakers and financial regulatory bodies, who must timely implement macroprudential policies and preventive measures to avert potential instability in the financial market. Overall, our research emphasizes the importance of credit efficiency in the development of financial policies and regulatory measures, providing strategies and directions for preserving the stability of financial markets. Future research may further explore the specific impact of credit efficiency on systemic risk in different economic environments and how financial policy can effectively manage credit efficiency to maintain the stability of the financial market.

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