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Analyse the Participants' Rational and Irrational Behaviour before the Financial Crisis in 2008

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Abstract

The subprime mortgage crisis that happened in 2008 in the U.S. contributed to a financial crisis all over the world. This crisis led to the bankruptcy in the Lehman Brothers and it took almost one decade for the U.S. to recover its economy. It is quite difficult to apply traditional method to explain why there is a boom for house market, why investors choose to believe in the house market is a good choice for investment and why there is no mispricing correction during the boom period. This paper will attempt to solve these puzzles from the view of behavioural finance. Explanations such as moral hazard, conflicts of interest and prior neglect etc. will be mentioned to discuss the boom of the U.S. house market. Most arguments and conclusions are cited from recognised papers or famous scholars such as Shiller, Gennaioli and Shleifer. Critical analysis will be presented to analyse the reasonability behind their arguments.

Keywords

Behavioural Finance; Subprime Mortgage Crisis; House Bubble

Introduction

With the rapid development of modern economies and continuous innovations of financial instrument, current economic system is more frequently exposed to potential crises. In particular, Financial crisis is usually accompanied by massive unemployment and long-lasting recession, which eventually reduce gross wealth and consumption of the society. In order to have effective prevention of possible financial crises, it is significant to have a deep understanding of their causes. This paper aims to discuss these causes based on the Global Financial Crisis (GFC) that happened in U.S. in 2008.

GFC is referred as a typical case in this study for the following reasons. Firstly, it is representative due to its similarities with features of other historical financial crises (Gennaioli & Shleifer, 2018). Secondly, a large number of scholars and academics have contributed considerable efforts into its investigation, which are extremely conducive and worth further exploration.

This paper is intended to discuss the push and pull factors in the causes of GFC. Analysis will be undertaken from the perspective of individual rationality or irrationality. To avoid ambiguous discussion, "rationality" and "irrationality" will be defined precisely.Meanwhile, this paper will also critically analyse popular explanations for the boom of house market in the U.S. In contrast to most arguments that blame this crisis on people's reckless behaviour, this paper will try to justify their conduct and rationalise some of their so-called behavioural mistakes based on evidence from extensive literature.

Setups and Background

After the GFC in 2008, scholars and academics were involved in a heated discussion about the house bubble collapse. Many famous scholars' theses, such as Shiller's "Herd Behaviour", intended to explain the boom in U.S. house market before the crisis. Most of these arguments ended up in criticizing individuals' irrational behaviour. However, unclear definition of "rationality" makes some criticism incautious and particularly harsh. For a clear and better understanding, using exact economic terminology to remove any ambiguousness is imperative, and therefore this chapter aims to give precise definitions to terms- "rationality" and "bubbles"- for the clarity of following arguments.

Rationality and Irrationality

In this paper, rationality is defined as no reasoning mistakes. Reasoning mistakes can be classified into (1) Logical and mathematical mistakes. (2) Inability to solve mathematical problems. (3) Violations of principles of reasoning such as Bayesian updating. (4) Neglect of critical factors when making decisions.

In this paper, being defined as rational does not indicate individuals are legitimately or morally correct. It only refers to the fact that people have right logics and they have exercised their best knowledge under specific situation when they make decisions.

Bubbles

(1) Fundamental Value

In brief, the term "bubble" is used to describe assets whose prices are over their fundamental values. The fundamental value can be generally defined by equation (1):

$$(1) FV_{ijt} = \sum_{s=1}^{n} \delta_i^s \, E_{it}\left(d_{j,t+s}\right)$$

FV_{ijt} is the fundamental value of asset j from the perspective of decision-maker i in the period t. δ_i^s is a discount factor from the point of view of decision-maker i. $E_{it}\left(d_{j,t+s}\right)$ is the expected dividend of asset j in period t+s from the perspective of decision-maker i. If the price of asset j is over FV_{ijt}, we can conclude that there exists a bubble in asset j. Equation (2) shows a similar perceived form of fundamental value from decision-maker i's subjective perspective.

$$(2) FV_{ijt}^{p} = \sum_{s=1}^{n} \delta_i^s \, E_{it}^{p}\left(d_{j,t+s}\right)$$

The difference of these two equations is that equation (2) does not require decision-makers to be rational. In the mainstream finance, economists assume FV_{ijt}^{p} is equal to FV_{ijt} which indicates no reasoning mistakes on

pricing asset j and decision-makers are rational. In the case of house market, rents can be viewed as dividends. For real estate investors, earned rents are similar to assets' dividends, while from house-owners' perspective, saved rents are similar to assets dividends. However, there is still one flaw to the statement above: the definition of fundamental value only fits individuals who are risk neutral. Otherwise, more general definitions are required.

(2) Rational Bubbles and Irrational Bubbles

Rational bubble and irrational bubble are two main types of bubbles in the market. Rational bubbles are bubbles in rational expectations or Nash equilibrium. Considering rational bubbles do not play a main role in GFC, further discussion will not be undertaken. All the "bubbles" mentioned in the rest of paper, if not specified, are default to irrational bubbles. Irrational bubbles can be defined as asset price p_{jt} over its fundamental value FV_{ijt}, while to some individuals their perceived fundamental value FV_{ijt}^{p} is even more than the asset price p_{jt} .

(3) Positive Economic Shocks

Many irrational bubbles will bust consecutively after the economic boom. People's beliefs will be changed by some positive economic shocks. For example, the boom of Japanese real estate in 1980s was largely owing to low interest rate and huge annual current account surpluses, making people hold high expectations for the economy.

Shiller explains that the advent of new technologies frequently gives people a fantasy that they live in a new era, which may further push people to be optimistic with the economy (Shiller, 2015). For instance, due to the popularity of automobiles and telephones, people living in 1920s were encouraged to believe that the economy would surge. This was also true of the Japanese bubbles in 1980s (new era of Japanese economy) and internet stock bubbles in 1990s (new era of internet and technology). Before analysing participants' behaviour, it is necessary to introduce the economic background in U.S. market before crisis. This may facilitate understanding peoples' conduct and justify their reasonable thinking.

The Role of Banks and Rating Agencies

After the economic meltdown occurred in 2008 in the U.S., about 400 banks were forced into liquidation until 2012, including one of the biggest five investment banks in Wall Street- Lehman Brothers- who had operated for 158 years. This chapter will examine the behaviour of banks and rating agencies before the crisis. Detailed discussion about rationality or irrationality of participants' behaviour will be presented in the next chapter.

Securitisation and Mortgage-backed Securities (MBS)

After the GFC, banks in the U.S. were heavily criticised by the government and investors. The financial instruments used by banks play a pivotal role in triggering the crisis. In order to understand the whole process,

it is essential to start the discussion from the term "securitisation".

Residential mortgage lending is part of the central business for commercial banks. Theoretically, clients who are able to or want to purchase a house must have stable and comparatively high income to cover the payment. The loan is secured by the property. When homeowners become delinquent or defaulted, they will face foreclosure and banks have the right to recover their loss by reselling these properties. However, an issue in this process is that residential mortgage lending is extremely illiquid and usually exists for decades. In contrast, banks' liability side such as clients' savings are usually short-term, and banks have the obligation to prepare enough reserves for savers' withdrawing requests.

As a result, securitisation is applied to banking industries. In brief, the process of securitisation in residential mortgage is to divide banks' mortgage pool as securities and sell them to investors through Special Purpose Vehicles (SPV), which are usually established by banks themselves. The establishment of SPV has two advantages. The main one is that it serves as a bankruptcy-remote mechanism for bank, as SPV is a company separated from the bank. In case that bank is trapped in liquidation, SPV's assets will be unaffected, vice versa. The other advantage is that SPV can directly build relations with investors without going through banks, therefore enhancing communication efficiency. This process is also known as originate-to-distribute (OTD) model and detailed process is shown by Figure 1.

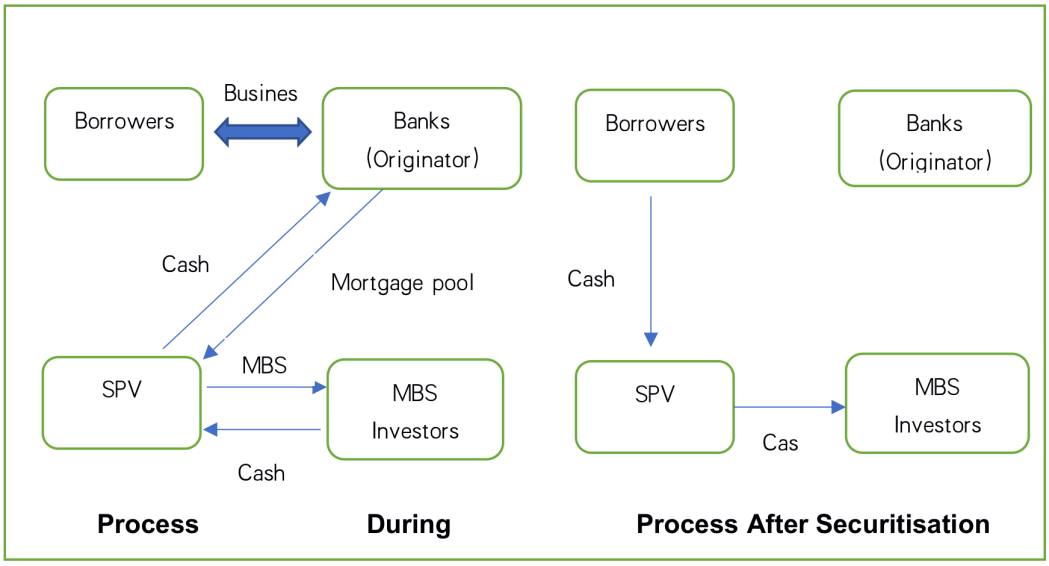

Figure 1. Process During and After Securitisation

The application of securitisation in residential mortgages is ingenious and it simultaneously benefits banks, new borrowers, and investors. Owing to disintermediation, banks release liquidity from long-term assets, thus helping reduce the pressure of reserves and economic capital. Furthermore, banks can transfer credit risk to investors and simply make profits by charging the interest between mortgage rage and pass-through rate. New borrowers can benefit from the increment of banks' liquidity as well because they no longer need to worry about additional funding costs if banks are in shortage of funds.

From investors' perspective, the invention of MBS can lower the threshold of investing real estates and pro-

vides more investment choices for market participants. Alternatively, investors are also allowed to engage in structured MBS based on their risk appetites. Structured MBS means there exists different tranches with different priorities in the same mortgage-backed pool. Risk-averse investors can enjoy higher tranches MBS with more safety but less investment return.

Low Lending Standards

Since banks can pass their mortgage assets to investors and mostly transfer credit risk from residential mortgages to investors, they do not stay alert as before and gradually become less cautious when measuring borrowers' repayment capability. A direct outcome is that banks reduce their thresholds of issuing loans, which make residential mortgages more accessible for subprime borrowers. Gennaioli and Shleifer observe that many households with low repayment capability or low credit scores should not be allowed to start a mortgage previously, while they were gradually offered the access to do so in the new millennium (Gennaioli & Shleifer, 2018). 2.5 trillion dollars of agency MBS and 4 trillion dollars of private labelled residential MBS were outstanding in the market, which exceeded the total issuance of corporate bonds in the U.S. market (ibid). The boom of house market came to an end in 2007, followed by a sharp decline in the house prices until 2009. The plunge discouraged borrowers to carry on their mortgage payment. As a result, a concentrated default for most subprime mortgages happened.

Rating Agency in the Crisis

Moody's, S&P and Fitch are regarded as the global "Big Three Credit Rating Agencies". According to Nationally Recognized Statistical Rating Organization (NRSRO), the collective market shares of these three rating agencies had accounted for 95.3 percent in the U.S. market by the end of 2018. Jewell and Livingston state that the core purpose of rating agencies is to provide an estimate to the probability of default for the bonds' issuer although the detailed process such as fee charging may be different (Jewell & Livingston, 1999). Table 1 shows the grading criteria for Moody's, S&P and Fitch respectively.

Table 1. Grading Criteria of Moody's, S&P and Fitch

	Moody's	Fitch and S&P
Investment Grade	Aaa	AAA
	Aa1	AA+
	…	…
	Baa2	BBB
	Baa3	BBB-
Speculative Grade "Junk" or "High Yield"	Ba1	BB+
	…	…
	C	C
Default	D	D

According to the grading criteria, AAA (or Aaa) rating indicates the top creditworthiness and no default risk for the issuance. However, a report published by Fitch Rating in 2007 claimed that over 95 percent of MBS

were investment grade and about 60 percent of MBS were rated as "AAA". Compared with other bonds in the market, only 1 percent of corporate bonds could reach the highest rating. It is highly questionable how the rating agencies concluded that 95 percent of MBS are "safe" to invest from the fact that there were actually 23.5 percent of subprime mortgage in the whole mortgage market.

The decrease in house price set off a chain reaction, leading to concentrated default for subprime mortgages. As is illustrated by Gennaioli and Shleifer in Home Equity Index (see Figure 2), even AAA-rating MBS with top priority had to face huge default risk and suffered from a price plunge. By the end of 2008, AAA-rating MBS had lost about 65 percent of their value while the loss for MBS with AA rating and below was up to 95 percent (Gennaioli & Shleifer, 2018).

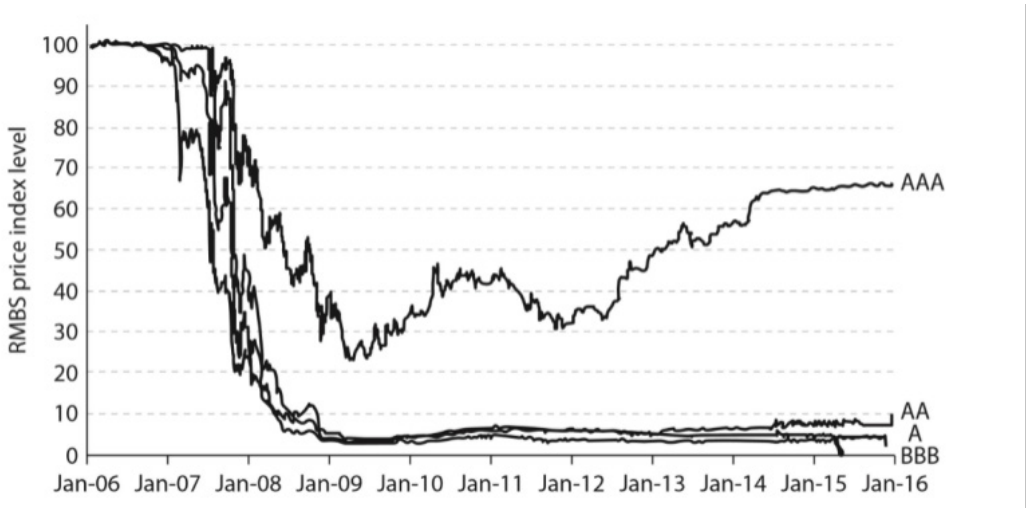

Figure 2. Price of Mortgage-Backed Securities
(Source: Gennaioli and Shleifer (2018))

Summary

So far, we have had a general review of U.S. subprime mortgage crisis from the perspective of two institutions – banks and rating agencies.However, there are so many puzzles to be answered for these two institutions: How can banks issue such large number of subprime mortgages without worrying about the outcomes? How can leading rating agencies simultaneously conclude these subprime mortgages are safe without any default risk? And why the majority of investors can trust this boom to be true with few voices of doubt? These questions will be discussed in the next chapter.

Rational and Irrational Behaviour before the Crisis

This chapter is designed to discuss the rationality and irrationality about participants' behaviour before the crisis. Given that the following arguments use some concepts and terms which might be different from the common understandings, two points need to be clarified: (1) It is important to note that all the factors are not necessarily independent. There might exist multiple factors cause synergistic effects to the crisis. (2) It is implausible to conclude behavioural explanations can perfectly apply to everyone. Indeed, it is difficult to pin-

point who had the rational or irrational behaviour before the crisis and how this behaviour exerts its impact on the whole group. Therefore, the discussion of behavioural explanation will only base on the evidence that is fit for the majority. (3) Some behavioural explanations, unfortunately, cannot be conclusive to neither part, although discussions focus on individuals' rationality or irrationality. All these indecisive explanations will be catalogued as non-solid arguments.

Rational Explanations from Participants' Aspects

(1) Moral Hazard form Banks

Moral hazard refers to the lack of incentives to measure and manage potential risk because banks do not take the consequences. Gennaioli and Shleifer highlight that theory of moral hazard led to the crisis, which is widely accepted by prominent economists (Gennaioli & Shleifer, 2018). Recalling Figure 1, after the process of securitisation, ownership of mortgages was transferred. Meanwhile, banks also transferred the credit risk of mortgages to investors. With less default risk exposure and lucrative pass-through rate, banks tend to seek and serve more borrowers regardless of their credit qualities. In other words, the profit from OTD model before the crisis is dependent on quantity rather than quality of residential mortgage issuance. With relaxing standards, more subprime borrowers can start a residential mortgage. The house market experienced a boom, and the percentage of subprime mortgage witnessed a significant increase before the crisis.

Banks held the belief that even though they may be trapped in financial distress, the government will bail them out because of their critical financial status, i.e. "too big to fail". This belief pushed banks to be more risk-taking and to some extent reckless. For example, after transferring the default risk, some banks exposed themselves to the default risk from the same subprime borrowers again by involving in trading MBS or absorbing them as investment assets. Moreover, banks also sought pathways for MBS-related derivatives trading to further maximise their "profitability". Lehman is the most typical bank that suffered from this blind optimism of "too big to fail". As demonstrated by Vo (2015), Lehman's loss of 2.8 billion dollars in the first quarter mostly attributed to the residential mortgage securities and relevant hedge positions.

Moral hazard is a recognised mainstream explanation of why there were large quantities of subprime mortgages in the market. In fact, the banks' subprime lending behaviour is perfectly rational because they fully understand the mechanism of risk transformation in the securitisation process and wisely exploit this opportunity.That being said, banks' deliberate behaviour constituted a potential danger to investors at the expense of their interests, so strict laws and surveillance must be put into effect to prevent their further misconduct. Considering that betting on others' capitals enables banks to act without due diligence and cautiousness, banks must have "enough skins" in the game, i.e. keep enough percentage of MBS in their balance sheet.

(2) Moral Hazard form MBS investors

For the moral hazard discussed in the section above, this behaviour is also true of investors who purchase residential MBS with its "insurance". With the protection of Credit Default Swap (CDS), investors who originally do not want to hold MBS start to join in this market.

CDS is a type of financial derivative used to transfer the lenders' credit risk to their counterparties, functioning as an insurance. If the borrowers fail to repay the loan, the CDS issuers will compensate the loss for the lenders. Kalinowski observes that market share of CDS had increased to 10% until 2008 in the OTC market, in contrast to 2.5 percent OTC market share in 2004. The CDS should help investors mitigate the credit risk and serve a purpose for wealth protection (Kalinowski, 2011).

It is understandable for investors to join in investing MBS with moral hazard. Even if they realize the rating of MBS should not be that high, it is still rational for them to take this risk owing to prevention from the worst outcome by CDS. In addition, CDS buyers believe that government will bail CDS issuers out if they fail to fulfil their obligations because these issuers are usually big banks. To some extent this belief is right. Although Lehman's fall shocked the market, some firms still survived through the crisis by governmental bail-out. One example is the American International Group (AIG). According to Stulz, AIG is one of the most famous issuers for CDS that went into liquidation in late 2008. With the aid of federal government, AIG successfully survived through the GFC (Stulz, 2010).

Based on what has been discussed above, investors' moral hazard is well-grounded and rational. However, this argument still seems to be incomplete and there still exists some irrational components for investor's decision making. Since the issuers of CDS in the market are only limited to several famous financial institutions, the buyers cannot diversify their counterparties. In other words, defaults of CDS are highly correlated. When house bubbles collapse, the concentrated default from subprime borrowers will cause a chain effect on the default of CDS. If MBS investors purchase CDS and neglecting their issuers' correlations, it fair to categorize them as irrational.

(3) Rating Agencies and Conflicts of Interest

Rating agencies are responsible for offering correct measurements for creditworthiness of bonds as a reference to investors. Ironically, most rating agencies simultaneously gave out over-optimistic information about the MBS before the crisis. Faced with concentrated default, top ratings residential MBS lost 65 percent of their value. The rest of residential MBS above investment level only had 5 percent of their value left (see Figure 2). There is no decisive conclusion as for how much credit ratings can affect individuals' beliefs. Nevertheless, simultaneously giving out over-graded ratings must be push and pull factors for the market's over-optimism.

Conflicts of interest is one of the explanations for rating agencies' lack of due diligence. For rating agencies this behaviour is apprehensible because they comprehend the benefits of giving out optimistic ratings outweigh its potential losses. There are two types of conflicts of interest for rating agencies – the analyst aspect and the agency aspect. From the point of view of analysts, they may hold the issuers' securities, and posting good ratings may benefit them, while in terms of rating agencies, they prefer to maintain long-term business relations with issuers because of the Issuer-Pay Model. In either way, rating agencies' behaviour is explicable, and the ratings published by them may be inflated.

Although it seems make sense for rating agencies to give out inflated ratings to MBS by virtue of conflicts of interest, there are still some puzzles unsolved. Firstly, since the conflicts of interest problem is not a secret in

the market, why investors still believe in these credit ratings? One behavioural explanation is that irrational individuals neglect the correlation between different credit ratings (detailed discussion comes in later section). Another explanation is that the costs of trusting these credit ratings are very low. On one hand, individuals hold the beliefs that rating agencies are concerned about their reputations when giving out credit ratings. On the other hand, refusing to trust rating agencies means individuals must do their own research on each issuer and this cost is extremely high.

Unfortunately, there is no effective improvement in addressing the issue of conflicts of interest. The only method at current stage is to require credit rating analysts and agencies to publish accurate and reliable self-disclosure about their conflicts of interest, but this entirely depends on their own disciplines and operations, making it difficult to supervise.

Failure of Rational Individuals

(1) Herd Behaviour and "An Elephant in the Room"

In 1995, Shiller defined "herd" as an irrational behaviour when a group of people have the tendency to interact with each other and behave similarly. Shiller's theory of herd behaviour is a push and pull factor in the boom of market before 2008. However, in Shiller's paper, he did not offer a clear definition of rationality nor irrationality, which makes his argument incomplete. Additionally, it is unreasonable to judge people as irrational merely from their behaviour that they follow with the crowd. On one hand, it is quite possible that after a group discussion, they make a common opinion. On the other hand, unprofessional individuals can view seniors' opinion as a suggestion. To avoid making naïve mistakes, following suggestions is a sensible way. The Figure 3 tries to give an example of how different participants update their beliefs and generate herd behaviour before the crisis.

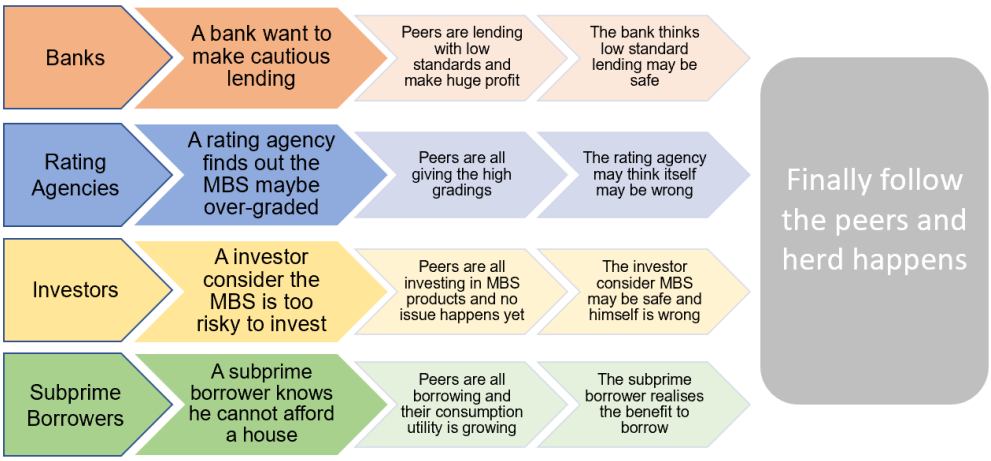

Figure 3. Herd and the process of how different participants update their beliefs

However, when people realize that it is an obvious mistake and still decide to follow others, they are in an entirely different situation and they are still rational, because individuals may suffer from some costs if they point out an issue. These costs may include contradiction to their peers or seniors and a matter of courtesy.

This is also known as “an elephant in the room” problem. For instance, if an analyst holds a contrasting opinion and refuses to be herding, he has to hold bearish opinions with regard to house market. In view of the fact that house market has been booming since 2003 and it has lasted for 4 years, it would be less confident for an analyst to say so in these 4 years. In consequence, long-term uncertain benefits and short-term observable costs hold rational individuals back.To sum up, distinct from what Shiller argues about irrational herd behaviour, it is still possible for decision makers to be rational if herd behaviour happens.

(2) Herd Behaviour and “An Elephant in the Room”

The Efficient Market Hypothesis (EMH) points out that rational investors and arbitrageurs will eliminate the mispricing if they find the prices are disparate from their fundamental value. However, the market failed to correct this mispricing when house price in the U.S. was over its fundamental value. In this case, EMH was harshly criticised, while limits to arbitrage could be applied as an explanation to this.

De Long et al. state that arbitrageurs diminish their aggressiveness of eliminating mispricing when worrying about uncertainty in the market especially the highly unpredictable behaviour of irrational investors (De Long et al., 1990). As a result, arbitrageurs require more financial liquidity with shorter investment horizons. The following two explanations to this phenomenon are provided here. Firstly, fund manager may be required to meet the hurdle rate set by their clients. If they do not manage to reach investors’ goal, they may face punishment or dismissal. A textbook example is Julian Robertson, a hedge fund manager, who resolutely refused to buy internet stocks in late 1990s. The disappointing result is that the hedge fund clients withdrew the money, and the fund was finally closed (Brunnermeier & Nagel, 2004). The second explanation is that betting against the bubbles expects leverage to hold a short position. Regardless of the borrowing cost of short selling, the uncertainty makes price unpredictable and requires rational investors to have enough margins and to be patient enough. Considering the house bubbles may last for years, lenders may require even more margins which further makes borrower unwilling to take the risk. These two reasons may explain the puzzles why rational investors slight influence have on correcting the mispricing.

Limits to arbitrage is utterly rational for investors. This does not indicate that EMH is a failure, nor rational parties are not strong enough to correct the market mispricing. Instead, Shleifer and Vishny explain that mispricing correction works worse under extreme circumstances (Shleifer & Vishny, 1997).

Extrapolators and X-CAPM

Eatwell et al. argue that bubbles are assets whose price increase are mainly pushed by speculation in attracting new buyers. In their argument, bubbles originate from the process that speculators exploit exuberance and create a short-term momentum to sell their assets quickly to other investors. Extrapolative capital asset pricing model (X-CAPM) published by Barberis et al. can be used to demonstrate this phenomenon (see equation (3)) (Eatwell et al.,1987).

$$(3)\ E_t^x(P_{t+1} - P_t) = (1-\theta)[(P_{t-1} - P_{t-2}) + \theta(P_{t-2} - P_{t-3}) + \theta^2(P_{t-3} - P_{t-4}) + \cdots]$$

Extrapolators are those who receive information from the events that have happened. For example, it is only

when house market booms that some people realise investing in house market can be lucrative.

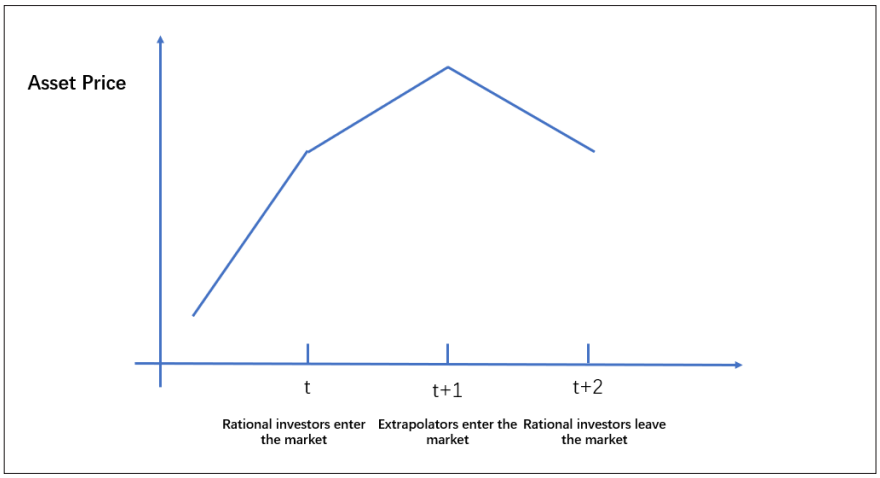

Figure 4. How asset prices change based on X-CAPM

Figure 4 can be used to interpret this model as follows: 1) At time t, rational investors are encouraged by good news and increase demand, which make $P_{t+1} > P_t$. 2) At time t+1, news is equally good or bad. Rational investors do not increase demand while extrapolators decide to do so for they start to notice that the price increases at time t. As a result, the price still increases at time t+1. 3) At t+2, without any further good news, rational investors decide to unwind their positions. Decrease in price discourages extrapolators and the asset price may drop back. One doubt about X-CAPM is that it is based on an assumption that extrapolators do not pay attention to the latest price change in most recent 6 months. However, Barberis defends that it is possible for individuals to observe prices with a delay in house market (Barberis, 2018).

Discussing whether extrapolators are rational seems to be tricky. It is mainly because when individuals form their beliefs, they keep receiving new information from the house market. Glaeser et al. demonstrate that these extrapolators do not have reasoning mistakes because there does exist a short-term momentum in house price. In his paper, the historical data proves that the house prices in one-year period have a strong positive correlation (Glaeser et al., 2014). However, when the house price is at its high-water mark, the probability of a consistent growth in house price is not as high as investors expect. Rather, an influx of extrapolators into house market is likely to change price towards an unfavourable direction for their earnings. This phenomenon may be considered as miscalibrated beliefs instead of irrationality.

Bayes' Rule, Prior Neglect, and Sensitivity Loss for Business Cycle

When individuals' beliefs updating violates Bayes' Rule, individuals are considered to be irrational. The common case of violating Bayes' Rule is prior neglect (see equation (4)).

$$(4)\ \Pi(Continuing\ Boom|Historically\ highest\ house\ price) = \frac{1}{1+\frac{p(Recession)}{p(Continuing\ Boom)}\frac{p(Historically\ highest\ house\ price|Recession)}{p(Historically\ highest\ house\ price|Continuing\ Boom)}}$$

When updating beliefs, if individuals neglect their own priors, i.e. the probability of continuing boom or recession, the estimation for is biased. This bias is particularly significant when the probability of prior is very small. For example, low probability of leads to large value of. If individuals neglect this, will be much larger.

The development of the economy is cyclical, and an economic boom is usually followed by a recession, vice versa. Unfortunately, detecting the exact time of a change from boom to recession is quite difficult. Even if policymakers are able to detect a forthcoming recession accurately and timely, it still time-consuming to formulate effective policies and wait for them to take effect. However, market participants should be conscious that the credit ratings from rating agencies are higher than normal and banking industry is adding fuel to the flame of residential mortgage lending during the boom period of house market.

The prior neglect is an irrational behaviour for it violates Bayes' Rule. Overestimation of caused by prior neglect injects false optimism into market participants by making them less sensitive to critical points in the economy. When the house price starts to decline, most market participants are negatively surprised, many of whom decide to quit the market with disappointment, which further press the house price down.

Correlation Neglect

Overwhelming information published by social media has brought about an issue of information similarity and redundancy. Akerlof and Shiller summarise this phenomenon as repeating same "stories" too many times. In other words, if two persons receive the same source, they exchange their opinions and both of them realise that they acquire this opinion from the same source. When they over-react the authenticity of the source, correlation neglect happens (Akerlof & Shiller, 2009). This has been seen in experiments performed by Enke and Zimmermann, where individuals have the tendency to neglect the correlation of sources when forming their beliefs (Enke & Zimmermann, 2019).

Correlation neglect is viewed as irrational behaviour because individuals neglect a source correlation when accessing the accuracy of sample average. Before the crisis, source correlation is common in the market. Individuals may receive information from the same source that MBS is safe and lucrative (recalling the high ratings from rating agencies). After their communication, they neglect the source correlation and hold these beliefs more firmly.

Motivated Beliefs

Motivated beliefs can be defined as specific beliefs subjectively held by decision-makers. When individuals consciously want to hold certain beliefs, they may make mistakes of processing good and bad news differently i.e. asymmetric updating. Eil and Rao reveal that individuals tend to discount, minimise, or ignore the negative effects from bad news or the things they do not like (Eil & Rao, 2011). Different beliefs as a result from individuals' subjective manipulation is viewed as a violation of Bayes' Rule, which is irrational.

Apart from asymmetric updating, Bénabou also argues that motivated beliefs may cause a series effects,

which are called "Sunk-cost fallacy, escalating commitment and hedonic treadmill" in his word (Bénabou, 2015). This can be summarised as when investors hold illiquid (sunk type) assets and at the same time they receive some bad news about their assets, they tend to persuade themselves the assets' future value. Therefore, they want to invest even more in this type of assets, i.e. escalating commitment.

To discuss how these effects listed above contribute to the boom of house market, it is necessary to specify what happens in different stages of the boom: 1) At the beginning, the house price is at its fundamental value and there are few subprime mortgages in the market. In this stage, the news about house market is good and individuals start to invest in residential MBS. 2) Banks start issuing some subprime mortgages and bad news comes out. Individuals who have invested in MBS selectively choose to believe in the good news and turn a blind eye to the bad one, i.e. asymmetric updating. 3) Finally, when subprime mortgages are growing in the market, bad news becomes too frequent to be ignored. MBS investors may be restricted from some reasons so that they cannot withdraw from MBS investment. For example, they may suffer from reputation loss directly if they retreat considering they may strongly suggest someone else to buy MBS before. Under this condition, MBS becomes illiquid for these investors. After persuading themselves, to avoid being anxious, they even absorb more these MBS assets. In this case, although investors seem to be irrational for violating Bayes' Rule, their behaviour is somewhat understandable, as neglecting bad news allows them to release from their anxiety.

Conclusion

So far, this paper has attempted to analyse rational and irrational behaviour of house market participants for the causality of the boom before GFC in 2008.Fortunately, we have a clearer understanding of whether participants make behavioural mistakes before the crisis. Discussing people's rational or irrational behaviour is not for a purpose of criticism but to recognise whether people make mistakes due to their reasoning process. If regulation authorities are fully informed of participants' behaviour before the crisis, they can take more effective measures to address the existing issues and prevent the potentially incoming financial crisis. However, it is vital to point out that these explanations are not complete, and they have some limitations. In chapter four, we have examined some of the behaviour are ambiguous to be labelled as either rationality or irrationality. These areas are gaps in academic discussion, and they are deserved to be further investigated in the future.

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