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Asset Price Bubbles and Monetary Policy

Abdullah Yavas

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Abdullah Yavas**

University of Wisconsin - Madison

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** Chair, Department of Real Estate and Urban Land Economics, Robert E Wangard Real Estate Chair, School of Business University of Wisconsin – Madison, 5251 Grainger Hall, 975 University Avenue, Madison, WI 53706, Email: ayavas@bus.wisc.edu, http://www.bus.wisc.edu/realestate/about/yavas.asp

1. Introduction

Asset valuation theory states that the fundamental value of an asset is equal to the discounted present value of its expected cash flows. However, we know from a large body of empirical and experimental literature that asset prices do deviate from their fundamental values, leading to formation of bubbles[1] in the market. Asset price bubbles are critical because they can result in misallocation of capital and resources, affect investment decisions, and have considerable economic impact. Therefore, it is important to understand bubbles in asset markets and examine if and how monetary policy and regulatory measures can be used to reduce or eliminate bubbles and/or their impact on the economy.

It is important to note upfront that changes in interest rates do impact asset prices; hence monetary policy can be an effective instrument to deal with asset price bubbles. In housing markets, for instance, lower interest rates drive up prices in two ways: i) they enable buyers to afford more expensive homes and facilitate the entry of additional first-time homeowners who would otherwise remain renters, and ii) attract Investors and second-home buyers. In addition, lower interest rates increase the relative attractiveness of real estate as an investment instrument and lead investors and fund managers to move funds from fixed income securities to real estate markets.

The purpose of this paper is to discuss challenges that monetary authorities would face in designing policies to deal with asset price bubbles. Then, I will discuss if and how monetary policy should react to an asset price bubble. The main argument of the paper is that it is practically very difficult to target an asset price level or react to changes in asset prices. Instead, I propose an alternative where the monetary policy and regulatory authorities target credit growth rate. Credit growth rate is easy to define, less likely to face resistance from the public and politicians, and is closely linked with (serves as a good proxy for) asset prices. More importantly, an asset price bubble will cause much more economic damage if the asset purchases involve leverage. Thus, targeting credit growth is a more realistic and more effective tool to contain asset price bubbles, to minimize the economic impact of such bubbles, and to maintain financial stability.

I first offer a brief background on asset price bubbles, with a focus on recent experimental studies. I then discuss monetary policy reaction to asset price bubbles.

2. Background on Asset Price Bubbles

Asset price bubbles are not a new phenomenon. Famous historical examples of bubbles include the Mississippi Bubble (1719-20), the South Sea Bubble in England (1720) and the Roaring 20's that preceded the 1929 crash. In the most well-known bubble, Tulip Mania, a single Tulip bulb (e.g.,

[1] I will use the term bubble loosely to refer to any deviation of the asset price from the fundamental value of the asset. The difficulties associated with identifying and measuring a bubble will be discussed later in the paper.

Semper Augustus) sold for more than 5,000 guilders - the equivalent of more than $60,000 today. More recent examples of asset price bubbles include Black Monday, October 19, 1987, when U.S. equities lost more than 20% of their value in one day, the worst single day in market history. In the internet bubble, the technology heavy NASDAQ Composite Index plummeted 75% from its peak in March 2000 to the end of 2000.

Bubbles are often defined as asset prices being persistently higher than their fundamental value. Given the assumption of rational behavior and of rational expectations, economists usually believe that the price of an asset can only depend on information about current and future cash flows from this asset, hence must reflect market fundamentals. However, there has also been a large set of studies which argue that asset price bubbles are consistent with rationality (see, for instance, Blanchard and Watson, 1983). A comprehensive review of the literature on asset price bubbles can be found in Xiong (2013). In addition to providing details on some of the historical episodes of asset price bubbles, Xiong (2013) also summarizes several theories of asset price bubbles and discusses the factors that cause a bubble to crash.

There have been various empirical attempts to test the predictions of market efficiency models. The challenge with empirical tests of bubbles is that the fundamental value of the asset is unobservable. Another problem with empirical attempts is that many of the potentially important market and asset attributes cannot be isolated from each other, which makes it difficult to examine their individual impact. Case and Shiller (1989) conclude that data problems leave “little hope of proving definitely whether the housing market is not efficient.” In a comprehensive survey of empirical literature on bubbles, Gurkaynak (2008) argues that “despite recent advances, econometric detection of asset price bubbles cannot be achieved with a satisfactory degree of certainty.”

Difficulties with using the field data for empirical tests of asset price bubbles has naturally led to a growing literature utilizing experimental methodology. In a pioneering study, Smith et al. (1988) consider spot asset trading in an environment where all investors receive the same dividend from a known probability distribution at the end of each trading period. The authors report that bubbles are observed in more than half of the 22 sessions conducted, and in most of the experiments, bubbles are followed by crashes during which asset prices fall sharply below their fundamental values. Given the simplicity of their experimental setup, it is surprising that bubbles form in such a market environment. However, Smith et al. (1988) results have been replicated in numerous later studies, including King et al. (1993), Van Boening et al. (1993), Porter and Smith (1995), Noussair, Robin, and Ruffieux (2001), Lei et al. (2001), Porter and Smith (2003), Haruvy and Noussair (2006) and Ikromov and Yavas (2012a). A typical outcome of these experiments is illustrated in Figure 1.[2] Transactions initially take place at prices below fundamental values, then transaction prices increase above fundamental values, and converge back to fundamental values towards the end of the experiment. What these

[2] The appendix provides an example of instructions used in these experiments. The instructions are useful in understanding the simplicity of the market environment used in their study and in many other similar experiments on asset price bubbles.

experiments clearly document is that bubbles and crashes can take place in very simple environments with little/no uncertainty about future cash flows, with no need for exotic derivative financial products, noise traders, asymmetric information or any agency problems. Porter and Smith (1995), for instance, test whether bubbles form because of risk aversion in a market with uncertain dividends. Lei et al. (2001) study trading in a market where speculation is not allowed. Noussair, Robin, and Ruffieux (2001) examine a market where the fundamental value of the asset is constant throughout trading periods. Haruvy and Noussair (2006) investigate the impact of allowing for short selling. In all of these studies, boom and bust cycles continue to emerge. Porter and Smith (2003) conduct the same experimental sessions with mid-level corporate execs and over-the-counter market dealers as well as students and obtain similar results. In support of these experimental studies, a recent study by Jones (2011) highlights how bubbles can emerge even in a very deterministic environment. The author studies a set of eBay auctions of Amazon.com gift certificates, and shows that 41.1% of winning prices exceed face value. Face value is an observable upper bound for rational bidding because Amazon.com sells certificates at face value.

These studies show us that asset price bubbles are basically an unavoidable part of trading. This raises a critical question for policy makers: Does this mean that monetary and regulatory policies will be ineffective in fighting asset price bubbles? Fortunately, the answer is (partially) no. While the above studies show that bubbles emerge even in very simple and deterministic market environments, they also show that the magnitude and duration of bubbles vary with market conditions. A recent experimental study by Ikramov and Yavas (2012a), for instance, shows that asset and market characteristics such as transaction costs, short selling restrictions and divisibility of the asset affects the magnitude of the boom and bust cycles. In another experimental study, Robin, Straznicka and Villeval (2012) report that the existence of bonus contracts does not affect the likelihood of bubbles but they affect the severity of bubbles: markets with long-term bonus contracts experience lower price deviations and a lower turnover of assets than markets with either no bonuses or long-term bonus contracts. Ikramov and Yavas (2012a) also find that, compared to experimental financial markets, experimental real estate markets display larger deviations of prices from fundamental values, longer boom and bust cycles and smaller turnover.[3]

It is important to note that up until the current crisis most of the literature on asset price bubbles had focused on stock market bubbles and central banks' reaction to stock market bubbles, not on housing bubbles. The reality is that house price fluctuations impact aggregate spending more than stock returns. Households borrow in nominal terms using real estate as collateral, and housing is the biggest component of a typical household's wealth. In addition, house price inflation is a better predictor, than stock price inflation, of both inflation and output (two components of inflation targeting). What experimental evidence also shows is that compared to financial markets, real estate markets involve longer boom and bust periods. This is in line with the historical data. Historically, equity price

[3] In the experimental sessions of Ikramov and Yavas (2012a), real estate markets are characterized by high transaction costs, high asset price (indivisible asset) and no short-selling while financial markets are characterized by low transaction costs, low asset prices and short-selling.

busts occur on average every 13 years, lasts for 2.5 years, and result in about 4 percent loss in GDP. Housing price busts are less frequent, but last nearly twice as long and lead to output losses that are twice as large (IMF World Economic Outlook, 2003). Therefore, both researchers and policy makers need to pay particularly close attention to housing prices.

3. Monetary Policy and Asset Price Bubbles

Given the significant damage that asset price bubbles can cause in the real economy, a crucial question for central banks is whether or not they should react to excessive changes in asset prices. On one side of the argument, some economists (e.g., Bernanke and Gertler, 2001, and Greenspan, 1999) argue that central banks should not respond to asset prices, unless these prices impact inflation expectations. Gali (2013) goes further and argues that, contrary to the conventional wisdom, any increase in the (real) interest rate engineered by the central bank will tend to increase, not decrease, the size of the bubble.[4] According to these authors, central banks should get involved only after the bubble bursts in order to reduce the resulting economic and financial damage. On the other side of the argument, some economists (e.g., Cecchetti, et. al., 2000) argue that central banks can improve macroeconomic performance by responding to excessive asset price movements.

Before we address the issue of central banks' reaction to an asset price bubble, it is important to state that central banks cannot avoid getting involved. The question for central banks is not whether or not to get involved, but rather whether to get involved before or after the bubble bursts. The reason is that central banks are forced to provide liquidity during a crisis caused by the bursting of a bubble as they are the only institutions capable of doing so.

There are two major challenges for a central bank that wants to react to an asset price bubble before it bursts. One is that it is very difficult to know if there is a bubble, i.e., if observed prices are different from fundamentals, since it is very difficult to determine the fundamental value of an asset.[5] The other challenge is to define how large of a deviation of the asset price from its fundamental value constitutes a bubble and deserves a policy reaction. Is it 8%, 20%, or a 36.5% deviation? These two challenges explain partly why central banks have an asymmetric response to asset price bubbles whereby they do nothing during the bubble, and get involved only after the bubble crashes to mop up the ensuing mess.

4 The explanation given by Gali (2013) is based on the argument that an asset price has a fundamental component and a bubble component, and the bubble component grows at the rate of interest. Thus, while an increase in the interest rate decreases the fundamental component, it will increase the bubble component, making it possible for the net effect on the asset price to be positive.

5 As mentioned earlier, in his survey of empirical literature on bubbles, Gurkaynak (2008) concludes that despite recent advances, it is very difficult to detect asset price bubbles. A similar conclusion is drawn for housing markets by Case and Shiller (1989) who point out that data problems make it extremely hard to prove whether or not the housing market is efficient.

However, facing uncertainty about the presence and magnitude of an asset price bubble should not be an excuse for central banks to remain on the sidelines until the bubble bursts. After all, monetary policy always involves uncertainty. How certain, for instance, are the central banks about the components of the Taylor Rule? The difficulties of estimating the output gap are well known, and there is always a great deal of uncertainty about many of the leading economic indicators used in monetary policy decision making. After all, monetary policy is about making assessments of uncertain events. The optimal strategy for central banks is to react not to past macro data but rather to forecasts of current and future economic activity.

An additional reason offered for the asymmetric response by central banks is that it is easier to justify monetary easing after the crash than justifying monetary tightening in good times. This might be a good excuse for the actions of elected politicians. Central banks, however, are supposed to be countercyclical and are expected to serve as party crashers (that is why they are independent).

It is also argued that using interest rates to burst an asset price bubble is inefficient since doing so would impact every sector of the economy, which would lead to misallocation of resources. However, if ignored, asset price bubbles could cause even more significant misallocation of resources. Furthermore, this argument could be used against changing the interest rates for *any* reason. It is hardly the case that every sector of the economy requires the same interest rate policy. Hence, any interest rate policy would cause some level of resource misallocation.

Therefore, none of the arguments above offer convincing justifications for monetary policy to ignore bubbles in asset markets. As the enormous damage caused by the last bubble in housing markets has clearly illustrated, it is vital for monetary policy to watch asset prices closely and take necessary measures in a timely fashion.

Given the challenges involved in targeting asset prices, the natural question is if there is an alternative indicator that the central banks can target and still be able to effectively contain asset price bubbles and their damaging consequences. The next section of the paper offers such an alternative target for policy makers.

4. Proposed Policy Reaction

The discussion above has demonstrated the difficulties for policy makers in dealing with asset price bubbles. Asset price bubbles can be very difficult to identify, and central banks are likely to face strong criticism from politicians and the public for fighting “increasing” asset prices. However, we need to keep in mind that the problem is not with increasing asset prices per se. Rather, the problem is with the economic damage that excessive asset price movements inflict. The severity of the economic damage depends largely on the involvement of the lending industry in financing the purchase of these assets at inflated prices. It is true that asset price bubbles can and do occur without lending; however, lending turns an asset price bubble into a financial crisis, and into a much bigger economic crisis.

Consider the extreme case where all property purchases in a real estate market are done with 100% cash. An asset price bubble in such a property market will still cause misallocation of resources. However, there will be little, if any, impact on the banking sector and financial stability, and the degree and the duration of the impact on the rest of the economy will be much smaller than that of a similar asset price bubble in a highly leveraged property market. This is one of the main reasons why the stock market crash of 2000 did not cause nearly as much damage to the economy as the housing market crash in 2007. As Norman T.L. Chan, Chief Executive of Hong Kong Monetary Authority states "the Global Financial Crisis taught us in the most emphatic manner that over-borrowing and the creation of asset price bubble is a recipe for financial disaster."[6]

What I propose here is that, instead of targeting asset prices, central banks should target credit growth. Targeting credit growth, instead of an asset price bubble, has many advantages. First, it avoids the problems with identifying an asset price bubble. Second, it is much easier to measure the size of credit growth than the size of an asset price bubble. Third, there is more current and more reliable data available on loan originations than on prices of many asset classes, including real estate prices. Fourth, targeting credit growth is much less objectionable by the politicians (and public).

It is true that many asset price bubbles are not accompanied with high leverage. A good example is the internet bubble that burst in 2000. Clearly, the policy of targeting credit growth will not help with averting such asset price bubbles. However, we also know that asset price bubbles that are not financed with borrowing are not as damaging to the economy and the financial system. For this reason, and given the above-mentioned difficulties of identifying and measuring asset price bubbles, I argue that central banks should not be concerned with such asset price bubbles. Instead, central banks should focus on asset price bubbles that are preceded with high leverage levels. Targeting credit growth will be effective against those asset price bubbles, and these are the bubbles that pose serious threat to economic activity and financial stability.

A natural question is whether targeting credit growth will be effective in preventing or reducing the magnitude of an asset price bubble. In particular, would mortgage leverage serve as a good proxy for a housing bubble? There is plenty of evidence in the literature that it would. According to Mian and Sufi (2009), household leverage was an early and powerful predictor of the 2007 to 2009 recession. The IMF 2009 World Economic Outlook concludes that credit typically displays unusual behavior ahead of asset price busts. Borio and Lowe (2002) examine a number of indicators and show that the credit gap (deviation of credit-to-GDP ratio from its trend) correctly predicts the largest number of crises. According to Voigtlander (2012), the housing boom in EU countries was triggered largely by a credit boom. Glick and Lansing (2010) report that countries with larger increases in household leverage experienced larger increases in house prices in the decade prior to 2007.

[6] Hong Kong Monetary Authority, Annual Report, 2011.

In addition to being a good proxy for asset price bubbles, credit growth is also critical for financial crisis. Using data from 1973 to 2010, Gourinchas and Obstfeld (2012) find that a rapid buildup of domestic and external leverage and real currency appreciation are the two most robust and significant predictors of financial crises, both for emerging and advanced economies. Using data for 14 countries over the1870-2008 period, Shularick and Taylor (2012) conclude that credit growth is a powerful predictor of financial crisis. Borio and Lowe (2002) find the probability of an episode of financial instability is increased when rapid credit growth is combined with large increases in asset prices increase.

In addition to monetary policy, there are certain macro-prudential measures that Regulatory Authorities can take to influence credit growth. In property markets, for instance, they can set maximum loan-to-value-ratios and impose limitations on the ratio of the borrower's monthly mortgage payments to his/her income. They can also utilize taxation of short term capital gains to discourage speculative property purchases. Similarly, whether the mortgage laws allow the loans to be recourse loans, i.e., whether the lender is allowed to go after other assets of the borrower if the borrower goes into default, is another example of a regulatory measure. Such measures have been effectively used in some countries. A good example is the Hong Kong property market. Figure 2 displays the evolution of the loan-to-value ratio restrictions, boom and bust cycles in property prices, and the delinquency ratios in Hong Kong since early 90's. A maximum loan-to-value ratio of 70% has been in effect in Hong Kong since 1991; the ratio was later reduced to as low as 50% for higher price properties. In addition, mortgage loans in Hong Kong are recourse loans. It is widely believed that such tight regulatory restrictions played an important role in keeping the delinquency ratios at very moderate levels even during periods of sharp drops in property prices. The mortgage delinquency ratio, for instance, never exceeded 1.4% even after a more than 65% correction in property prices, and there was no banking crisis following such a correction (He, 2013).

However, it is also well known that supervisory and regulatory tools can fail to address financial stability concerns. In a booming housing market, for instance, increasingly larger mortgage loans would satisfy a given loan-to-value ratio requirement. That is, if there is a bubble in the property market, it can lead to very high rates of growth in mortgage debt while still maintaining the loan-to-value ratio requirement. Thus, high property prices and high growth rate in mortgage debt can feed into each other. It is also known that the financial institutions can become very creative in circumventing regulatory restrictions if the underlying economic environment creates a strong incentive for financial institutions to do so.[7] An increase in interest rates, on the other hand, will affect every player and reach into every corner of the market.[8]

[7] An example is where banks offer to attach a personal loan to a mortgage loan in order to circumvent a regulatory limitation on the loan-to-value ratio.

[8] It is also worth noting that monetary policy influences credit standards as well. Recent studies by Maddaloni and Peydro (2011), Bruno and Shin (2012), and Dell'Ariccia, Laeven and Suarez (2013) show that low policy rates lead to riskier lending as it erodes banks' lending standards for both businesses and households.

To summarize, monetary policy should not, and realistically cannot, target a certain level or a range of asset prices. Instead, monetary policy should strive to contain credit growth, which is highly correlated with property prices. Targeting credit growth will also help minimize the economic impact of inflated asset prices, as leverage significantly increases the damage caused by an asset price bubble.

More specifically, for real estate markets, the policy should target

$$\theta_t = \frac{\Delta L_t}{Y_t}$$

where ΔL_t represents the change in total mortgage debt in period t and Y_t represents GDP in period t. This target can be easily incorporated into the Taylor rule.

5. Modified Taylor Rule

According to the original version of the Taylor rule, the nominal interest rate at time *t* should react to deviations of the actual inflation rate from the target inflation rate and of actual GDP from potential GDP at time *t*:

$$i_t = r_t^* + \pi_t + \alpha_1(\pi_t - \pi_t^*) + \alpha_2(y_t - y_t^*)$$

where i_t is the policy interest rate (e.g. the federal funds rate in the US), r_t^* is the "natural" real rate of interest, π_t is the rate of inflation, π_t^* is the target inflation rate, y_t is the logarithm of real GDP, and y_t^* is the logarithm of potential output.[9] Thus, the policy rate is increased when inflation exceeds the target and decreased when output falls below its potential. In his 1993 paper, Taylor proposed setting both α_1 and α_2 equal to 0.5.

The Taylor Rule can be modified to capture the proposed policy to address asset price bubbles in real estate markets as follows:

$$i_t = r_t^* + \pi_t + \alpha_1(\pi_t - \pi_t^*) + \alpha_2(y_t - y_t^*) + \alpha_3(\theta_t - \theta_t^*)$$

where θ, as defined above, is the change in total mortgage debt as a fraction of GDP, and θ_t^* is the desired change in total mortgage debt as a fraction of GDP. The coefficient α_3 will have positive sign,

9 The difference $y_t - y_t^*$ is known as the output gap.

resulting in an increase in the policy rate when the mortgage debt growth rate exceeds the target growth rate.

The size of the coefficient α_3 and the desired rate of mortgage debt growth, θ_t^*, are expected to vary from one economy to another. Among other things, they are likely to depend on financial deepening of the mortgage market. An increase of 10% in mortgage debt as a fraction of the GDP, for instance, will have different implications depending on whether total mortgage debt/GDP ratio in that country is 6% versus 60%. Other factors that could influence α_3 and θ_t^* include maximum limits on the two main underwriting criteria utilized in mortgage lending, Mortgage Payment / Income ratio and Loan-to-Value ratio, and whether the loans are recourse or non-recourse. These factors affect the probability of default and the magnitude of losses for the financial sector when the asset price bubble bursts. As a result, these factors should affect the reaction of the monetary policy to any deviation from the desired loan growth rate.

In addition to the policy rate, central banks can also use reserve requirement ratios to contain credit growth. Increasing reserve requirement ratios reduces the amount of funds available for banks to lend, and increases interest rates. Reserve requirement ratios can serve as a more effective tool than interest rates to contain credit growth, particularly in those economies where there is a strong demand for credit even at higher interest rates.[10]

6. Conclusion

Past experience and a large set of experimental studies show that asset price bubbles will be with us, regardless of the monetary policy and regulatory measures. However, this does not mean that the monetary policy and regulatory authorities cannot play any role. While the experimental evidence shows that asset price bubbles emerge even in very simple and deterministic market environments, they also show that the magnitude and duration of boom and bust cycles vary with market conditions. Thus, the monetary policy and regulatory authorities can impact the size and duration of the boom and bust cycles, hence impacting the economic damage caused by these cycles.

The problem with targeting a bubble in asset markets is that bubbles are very difficult to identify and measure. Furthermore, any attempt to burst a bubble is likely to face a great deal of criticism and resistance from politicians and the public. In this paper, I have argued that there is a more effective and less objectionable instrument for reducing boom and bust cycles and the economic impact of these cycles. This instrument involves controlling the growth of credit, rather than targeting asset price

[10] Reserve requirement ratios can also be used to differentiate between the interest rates available for foreign investors and the interest rates available for domestic borrowers. If a country is facing excessive capital inflows and strong credit growth, for instance, the central bank can lower the policy interest rates (to discourage foreign capital inflows) and at the same time increase the cost of borrowing for domestic borrowers by increasing the reserve requirement ratios. This combination of low policy rates and high reserve ratios has been used successfully by the Central Bank of Turkey to deal concurrently with strong foreign inflows and strong credit growth.

levels or changes in asset prices. Given that not all asset price bubbles are preceded by high credit growth (e.g., stock market bubbles), the proposed instrument will not be effective for some asset price bubbles. However, since the economic impact of an asset price bubble is much more profound when it is coupled with high leverage (e.g., real estate bubbles), the proposed instrument will be effective against those asset price bubbles that pose serious threat to economic activity and financial stability.

Monetary policy should not be alone in dealing with credit growth. Related government agencies can make a significant contribution with their efforts to supervise and regulate the financial system (e.g. by limiting the loan-to-value ratio and the debt-to-income ratio). Regulations alone cannot deal with bubbles effectively, and the effectiveness of monetary policy can be strengthened significantly with the help of appropriate regulations. Therefore, a good approach to credit growth and financial stability suggests a coordinated effort by monetary policy and regulatory agencies.

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Figure 1. Boom and Bust Episodes in Experimental Markets (Ikramov and Yavas, 2012)

The straight line represents the fundamental value of the asset in trading periods 1-15 of the experimental session. The curved line represents the median observed transaction prices in periods 1-15.

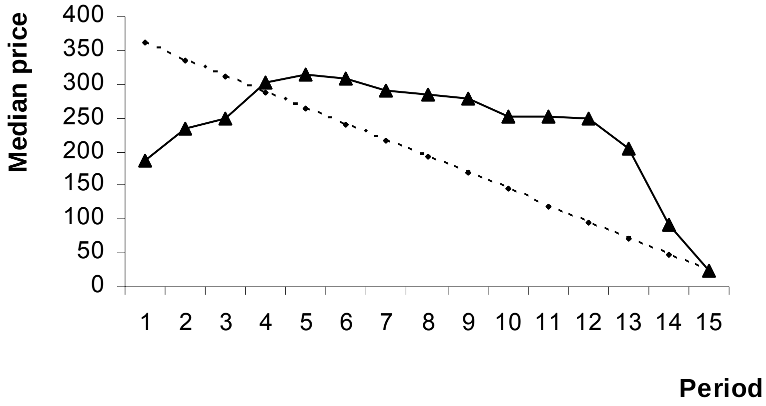
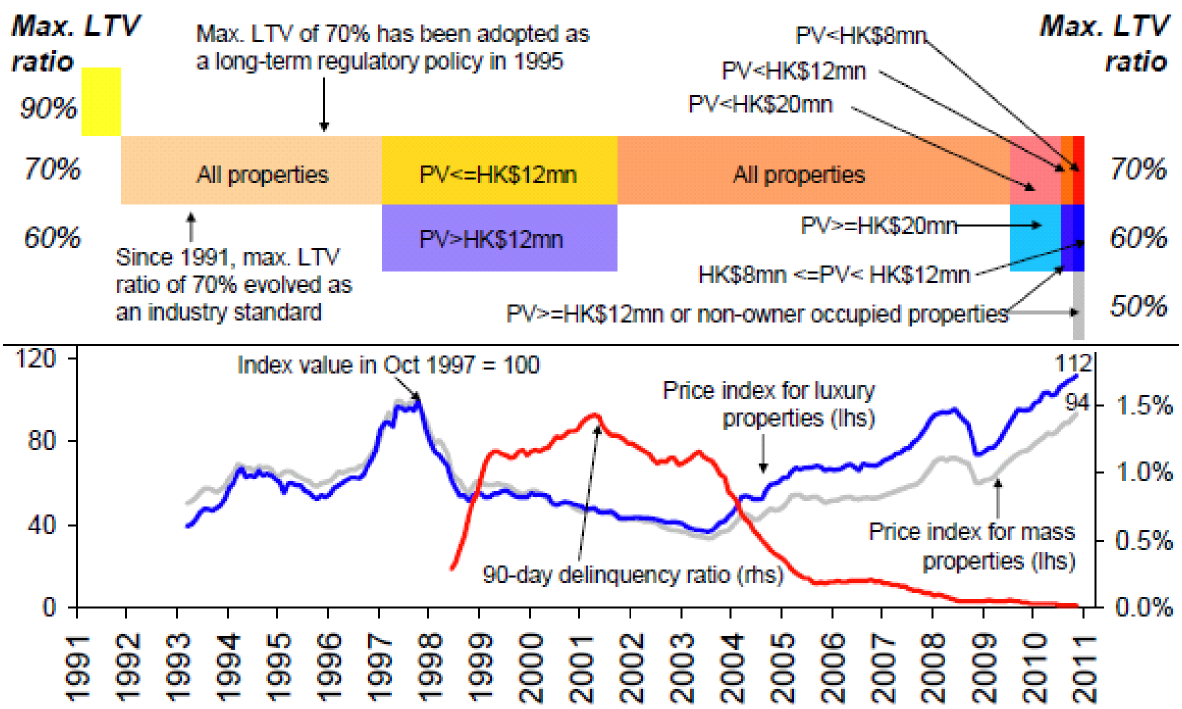


Figure 2. Loan-to-Value Ratio Limits in Hong Kong Property Markets. The graph shows the history of the maximum Loan-to-Value Ratio for different property values (PV).



Source: Wong, Fong, Li and Choi, HKMA WP 01/2011

Appendix

The appendix gives instructions for one of the experimental treatments and a screenshot of the trading platform in Ikramov and Yavas (2012a) study. In this particular treatment, the subjects were not allowed to short sell and had to pay 10% transaction fee every time they sold shares.

1. General Instructions

This is an experiment in the economics of market decision making. These instructions explain how the decisions you make determine your earnings from this session. The experiment will consist of a sequence of trading periods in which you will have the opportunity to buy and sell in a market. The currency used in the market is francs. All trading will be in terms of francs. The cash payment to you at the end of the experiment will be in dollars. The conversion rate is 100 francs to 1 dollar. In addition to any profits you earn in the market, you will also receive an additional $5 (equivalent to 500 francs) for your participation today.

2. How to Use the Computerized Market

The goods that can be bought and sold in the market are called Shares. On the left-most column of your computer screen, in top left corner, you can see the Money you have available to buy Shares and in the middle of the column, you see the number of Shares you currently have.

If you would like to offer to sell a share, use the text area entitled “Enter ask price” in the second column. In that text area you can enter the price at which you are offering to sell a share, and then select “Submit Ask Price”. Please do so now.

You will notice that nine numbers, one submitted by each participant, now appear in the third column from the left, entitled “Ask Price”. The lowest ask price will always be on the bottom of that list and will be highlighted. If you press “Buy”, the button at the bottom of this column, you will buy one share for the lowest current ask price. You can also highlight one of the other prices if you wish to buy at a price other than the lowest.

Please purchase a share now by highlighting a price and selecting “Buy”. Since each of you had put a share for sale and attempted to buy a share, if all were successful, you all have the same number of shares you started out with. This is because you bought one share and sold one share.

When you buy a share, your Money decreases by the purchase price. When you sell a share, your Money increases by 90% of the sales price (this will be explained later).

You may make an offer to purchase a unit by selecting “Submit bid price.”

Please do so now. Type a number in the text area "Enter bid price." Then press the red button labeled "Submit Bid Price".

You can sell to the person who submitted an offer if you highlight the offer, and select "Sell". Please do so now for one of the offers.

3. Specific Instructions for this Experiment

The experiment will consist of 15 four-minute trading periods. In each period, there will be a market in which you may buy and sell shares. Shares are assets with a life of 15 periods, and your inventory of shares carries over from one trading period to the next. You may receive dividends for each share in your inventory at the end of each of the 15 trading periods.

At the end of each trading period, including period 15, the experimenter will roll a four-sided die to determine the dividend for the period. Each period, each share you hold at the end of the period:

earns you a dividend of 0 francs if the die reads 1

earns you a dividend of 8 francs if the die reads 2

earns you a dividend of 28 francs if the die reads 3

earns you a dividend of 60 francs if the die reads 4

Each of the four numbers on the die is equally likely. The average dividend in each period is 24. The dividend is added to your cash balance automatically.

After the dividend is paid at the end of period 15, there will be no further earnings possible from shares.

4. Selling more Shares than you Own

In this market, you cannot sell more shares than you own. That is, you may not own a negative number of shares.

5. Commissions

In this market, when you SELL a share, you pay 10 percent of the selling price as "sales commission". For example, if A sells one share to B for 60 francs, then B pays A 60 francs, but A only receives 54 francs (60 – 60*10% = 54). You may think of this as the experimenter acting as a broker who charges sellers (but not buyers) a 10 percent commission. Thus, when you sell a share, 10% of the selling price is automatically deducted from your Money.

6. Average Holding Value Table

You can use your **AVERAGE HOLDING VALUE TABLE** to help you make decisions. There are 5 columns in the table. The first column, labeled Ending Period, indicates the last trading period of the experiment. The second column, labeled Current Period, indicates the period during which the average holding value is being calculated. The third column gives the number of holding periods from the period in the second column until the end of the experiment. The fourth column, labeled Average Dividend per Period, gives the average amount that the dividend will be in each period for each unit held in your inventory. The fifth column, labeled Average Holding Value Per Unit of Inventory, gives the average value for each unit held in your inventory from now until the end of the experiment. That is, for each unit you hold in your inventory for the remainder of the experiment, you will earn on average the amount listed in column 5.

Suppose for example that there are 7 periods remaining. Since the dividend on a Share has a 25% chance of being 0, a 25% chance of being 8, a 25% chance of being 28 and a 25% chance of being 60 in any period, the dividend is on average 24 per period for each Share. If you hold a Share for 7 periods, the total dividend for the Share over the 7 periods is on average 7*24 = 168.

Therefore, the total value of holding a Share over the 7 periods is on average 168.

AVERAGE HOLDING VALUE TABLE

Ending Period	Current Period	Number of Holding Periods	Average Dividend Per Period	Average Holding Value Per Share in Inventory
15	1	15	24	360
15	2	14	24	336
15	3	13	24	312
15	4	12	24	288
15	5	11	24	264
15	6	10	24	240
15	7	9	24	216
15	8	8	24	192
15	9	7	24	168
15	10	6	24	144
15	11	5	24	120
15	12	4	24	96
15	13	3	24	72
15	14	2	24	48
15	15	1	24	24

7. Your Earnings

Your earnings for the experiment will equal the amount of cash that you have at the end of period 15, after the last dividend has been paid, plus the $5 you receive for participating. The amount of cash you will have is equal to:

The money you have at the beginning of the experiment

+ dividends you receive for the shares you own

+ money received from sales of shares

- money spent on purchases of shares

You will now play in three practice periods. Your actions in the practice periods do not count toward your earnings and do not influence your position later in the experiment. The goal of the practice periods is only to master the use of the interface. Please be sure that you have successfully submitted bid prices and ask prices. Also be sure that you have accepted both bid and ask prices. While you are selling a share, notice the 10% difference between your selling price and the money you actually receive. It is important that you do not talk or in any way try to communicate with other people during the experiment. If you violate the rules, you will be asked to leave the experiment. You are free to ask questions, by raising your hand, at any time during the experiment.

A Screenshot of the Trading Platform