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Keywords: Housing Prices, Mortgage Markets, Monetary Policy.

JEL-Classication: E22, E44, E52, G21.

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The Interaction of Mortgage Credit and Housing Prices in the US

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Introduction

Although housing price bubbles have regularly been at the root of financial and economic crises, there is surprisingly little research on the relation between real estate markets and economic crises (Gaffney, 2009). The lack of literature is astounding given the numerous real estate crises in the past. Real estate crises were at the root of the Japanese and Scandinavian financial crises in the late 1980s and early 1990s (Allen and Gale, 2000) as well as in the crises in south east Asia in the late 1990s (Collyns and Senhadji, 2002). The lack of analysis is likely due to the fact that credit - which links housing prices to financial stability and the real economy - is not sufficiently at the center of economic analysis. However, financial crises are almost always crises that both emanate from too much credit having been created before a crisis and not enough credit coming forward after a crisis (Kindleberger and Aliber, 2005; Schularick and Taylor, 2012).

The role of credit has been mainly overlooked in the traditional approach on asset and housing prices which focuses on user costs (Jorgenson, 1963; Poterba, 1984). In the user cost approach, housing prices are determined by real after tax interest rates and housing price expectations. This is why most of the literature on housing prices has looked at real interest rates (Poterba, 1984; Van Order and Dougherty, 1991) and housing price expectations (Case and Shiller, 1988; Poterba, 1991; Capozza and Seguin, 1996; Shiller, 2007) to explain actual housing price developments.

The user cost approach is also the framework within which the relation between monetary policy interest rates and housing prices is analyzed (Mishkin, 2007). Many economists (for instance Leamer (2007) and Taylor (2007; 2009)) have argued that too loose monetary policy was responsible for the built up of the US housing bubble. However, the effect of monetary policy - especially short term interest rates - on housing prices has not been found to be strong (Del Negro and Otrok, 2007; Boivin et al., 2010; Dokko et al., 2011).

The problem with the traditional user cost approach is that credit and debt and associated problems of asymmetric information and credit constraints are not considered (Bernanke and Gertler, 1995). However, those aspects might play an important role for housing prices, especially since houses are almost always financed by credit and not out of pocket. The more issues of asymmetrical information are important, the lower might be the role of interest rates alone (Stiglitz and Weiss, 1981).

But even when the relation between mortgage credit and housing prices is looked at, it is not clear ex ante how they interact: on the one hand, asset price changes could lead to changes in forthcoming credit when asset prices change economic units' equity and thus default risk (Bernanke and Gertler, 1989; Kiyotaki and Moore, 1997); on the other hand, changes in credit availability could lead to changes in asset demand and thus also changes in asset prices (Allen and Gale, 1999, 2000).

In this paper, the relation between credit and asset prices will be looked at in more detail and it will be asked how they interact. Specifically, a co-integration relationship between mortgage credit and housing prices will be estimated and tests for weak exogeneity and Granger causality will be conducted. Similar approaches have already been applied to the real estate market in Hong Kong (Gerlach and Peng, 2005), Spain (Gimeno and Martínez-Carrascal, 2010), Ireland (Fitzpatrick and McQuinn, 2007), Finland (Oikarinen, 2009) and Greece (Brissimis and Vlassopoulos, 2008).

However, such a study has not yet been conducted for the US housing market. Using two different housing price measures, two co-integration models will be estimated. In both models, mortgage credit is weakly exogenous and housing prices adjust to the long run equilibrium. Impulse-response functions, variance decompositions and a forecast exercise also hint into the direction that mortgage credit was driving housing prices and not vice versa.

The role of interest rates for credit and housing prices is less clear cut. Both long term mortgage rates and short term monetary policy rates have been added to the basic models. While they have the right sign in all models, their influence on housing prices is very low and sometimes not significant. It is thus likely that monetary policy did not play a significant role in the built up of the US housing price bubble, but deregulated financial markets and associated moral hazard problems did.

Related work has focused on credit standards as an explanatory factor for US housing prices. Duca et al. (2011) augment the standard user cost approach by a credit availability index composed of loan-to-value ratios by first-time buyers. They find that this index has high explanatory power for housing prices. From that they deduce that the lowering of credit standards might have had an important impact on housing prices.

This approach has two drawbacks however. First, the realized loan-to-value ratio captures in the first instance the *effect* of relaxed credit standards and not the relaxation itself. Second, and more importantly, the loan-to-value ratio can also be endogenous to actual housing price developments and expectations. If lenders anticipate rising housing prices, they are ready to provide more credit today in anticipation of borrowers' higher equity and lower default risk in the future. The loan-to-value ratio then is an effect of higher housing prices, not a cause. More generally, Duca et al. (2011) do not test for causality or exogeneity of the loan-to-value ratio but state from the beginning that it is exogenous. Using actual mortgage credit - as is done in the present paper - of course also uses the realized values. But here, it will be carefully looked at the possible endogeneity of this variable.

The remainder of the paper is structured as follows. In the first part, economic theories of the relation between housing prices and credit will be presented after which an overview over the empirical literature will be given. After that, a detailed analysis of the development of US mortgage markets will be given in which it will be shown that deregulation is likely to have amplified problems of moral hazard in mortgage markets which in turn might have led to higher credit growth. In the third part, the co-integration relationship between housing prices and mortgage credit will be established and estimated. Different causality and exogeneity tests will be conducted. A last part concludes.

1 The interaction between mortgage credit and house prices

Theoretical perspective on mortgage lending and housing prices

The relation between asset prices and credit is likely to be two-fold. On the one hand, only the availability of credit makes it possible for asset prices to increase, since without credit, asset purchases could not be financed and thus not be realized; on the other hand, higher asset prices are likely to lead to higher credit since asset prices act as a collateral for banks and/or increases the borrower's net wealth which makes borrowers more willing to take out credit. In the first view, credit drives asset prices; in the second view it is the other way around.

The view that conditions of credit supply drive asset prices has been stressed by Allen and Gale (1999; 2000) (in the following, this will be called the AG model). They analyse the problem of risk-shifting that arises from asymmetric information and the principle of limited liability. In their model, asset prices depend on the riskiness of an asset and the amount of credit provided to acquire the asset. The model's main assumption is that assets like real estate are not fully financed out of an investor's net wealth but by credit.

Under the condition of limited liability an incentive asymmetry results: borrowers are more likely to invest their borrowed money in the risky asset since its average yield is higher than that of a safe asset; on the other hand, the likelihood of losses are also higher. If the higher return is realized, the investor will have a net gain after paying back his loans. If the asset will yield a lower return so that he cannot pay back the credit, he will default and the bank will realize the losses. This risk-shifting problem will lead to a market price of risky assets that is higher than the fundamental value, i.e. the value that would prevail if investors would not take out credits but only invest their own money and bear all the risk.

Financial liberalization will make the risk-shifting problem more severe. It will lead to an expansion of credit supply and thus more credit to investors who are able to purchase more of the risky asset. Furthermore, financial liberalization is a regime-shift that produces uncertainty. With new financial instruments and relaxed regulation, it is not clear ex ante to what level debt can be extended. If an expansion of credit due to new institutions is anticipated by investors, today's asset prices will increase. If, however, actual credit growth is not sufficient to validate expectations, prices will fall, leading to defaults and banking crashes. In Gale's and Allen's setting, an asset's price expectations can become self-validating if sufficient credit is forthcoming.

Note that the model can be applied both to physical and financial assets. This means the process can work when households take out mortgages to buy houses; and it can work when financial intermediaries take on debt to make loans or to purchase securities. There can be a multiple-stage process in which households and other investors lend money to banks which invest in loans or bonds that finance houses. This would drive up both the bond prices - thereby lowering interest rates - and housing prices.

However, there is also another view that links asset prices and credit to each other, but exactly in the opposite way the AG model does. Bernanke and Gertler (1989) and Kiyotaki and Moore (1997) developed models in which changes in asset prices lead to changes in credit and not vice versa (in the following those are termed the BG / KM models).

Bernanke and Gertler argue that due to asymmetric information - lenders know less about borrowers' investments than borrowers themselves - lenders monitor the borrowers' equity position. The higher the borrowers' equity, the lower will be interest rates charged - the so called external finance premium - so that borrowers with more equity, i.e. with higher asset prices relative to their liabilities, will increase their borrowing capacity and thus credit. Thus, higher asset prices lead to higher net wealth and more credit.

Kyotaki and Moore (1997) have a similar approach but do not look at the *price* of credit (the interest rate), but at the *volume* of credit. Higher collateral by a borrower will not necessarily lead to lower interest rates but could also lower the credit constraints that borrowers face, again increasing their borrowing capacity.

The main difference between the AG model on the one hand and the BG model on the other hand is that AG look specifically at the financing by credit of a particular asset. BG look at any asset that can influence borrower's net wealth and thus the general provision of credit. The BG model does not make explicit that the credit has to be used to buy the asset whose price changes were responsible for changes in its equity position. A household whose house's price increases can take out a credit to finance consumption or the purchase of other securities or to pay back older debts. But he does not have to buy a house with it.

If one focuses on the relation between overall credit (consumer credit, corporate credit and mortgage credit), changes in property prices are likely to drive those credits, i.e. the BG models hold; if one only looks at the relation of mortgage credit that is explicitly taken out to finance housing, AG's model in which credit (mortgage credit) drives assets prices (house prices) seems a priori more appropriate.

Empirical Studies

Most of the empirical literature on the relation between credit and housing prices has found that housing prices drive credit and not vice versa, vindicating the BG view of lending. However, those studies mostly did not look at mortgage credit but at overall credit. None of the studies has looked explicitly at the US case so far.

A first group of studies looked at the interaction of housing prices and *overall* bank lending (Hofmann, 2004; Goodhart and Hoffmann, 2003; Davis and Zhu, 2004; Gerlach and Peng, 2005), a second group more explicitly at the role of housing prices and *mortgage* lending (Fitzpatrick and McQuinn, 2007; Brissimis and Vlassopoulos, 2008; Gimeno and Martínez-Carrascal, 2010; Oikarinen, 2009). First, the studies using overall bank lending will be summarized:

Hofmann (2004) tries to explain bank lending for 16 OECD-countries. He estimates a VAR model with the traditional variables GDP and interest rates to explain bank lending. However, both variables - GDP as a variable catching demand for credit and interest rates as a cost of credit variable - were not able to significantly explain bank lending. The two variables only become significant when property prices are added.

Hofmann argues that property prices are likely to have influenced the ups and downs in bank lending. However, he does not test whether lending itself is an explanatory variable for the other variables, i.e. whether bank credit might influence property prices or GDP. He only looks at bank lending and not specifically at mortgage lending. By looking at the broad measure lending, he is more likely to find results explainable by the BG model.

Goodhart and Hoffmann (2003) analyze 12 countries and find that property prices drive bank credit but not the other way around. Interest rate innovations have an effect on asset prices in some countries while credit is rather unresponsive to interest rate innovations.

Davis and Zhu (2004) also use a sample of countries - 17 developed economies - but study the relation between bank lending and commercial property prices. They find that property prices influence bank credit but not vice versa while they find GDP to influence both.

Gerlach and Peng (2005) study the relation between bank credit and property prices in Hong Kong using a co-integration approach. They find that income, property prices and bank credit are co-integrated. But only property prices adjust to deviations from the long-run trend. Bank credit and income are weakly exogenous. They interpret this as indications that property prices drive bank credit. Their credit measure is total bank credit of which mortgage credit is only a part. From this result one cannot deduce what the relation between mortgage credit and housing prices is. They also find that bank credit is mostly unaffected by interest rates. Thus, they question that interest rate policy is useful as an instrument to smooth boom-bust cycles in asset and credit markets.

All the studies on overall bank lending and housing prices find results consistent with the BG model according to which the increase in collateral values increases bank lending. Studies that look more specifically at the relation between mortgage credit and housing prices find results at least partly consistent with the AG model.

Fitzpatrick and McQuinn (2007) explicitly study the relation between mortgage credit and housing prices in Ireland for the period 1996 to 2002. They estimate three single-equation error correction models with mortgage credit, residential investment and housing prices as the dependent variable, respectively. They find that there is a long run mutually re-enforcing relationship between mortgage credit and housing prices and not a one-way relation.

Gimeno and Martinez-Carrascal (2010) study the case of Spain and find that both housing prices and mortgage credit adjust to deviations in the long-run relation so that there is no uni-directional influence. Oikarinen (2009) also finds a two-sided relation between mortgage credit and housing prices for Finland.

Brissimis and Vlassopoulos (2008) look at the long-run relation between mortgage lending and property prices in Greece. They find mortgage lending to be adjusting to deviations in the long-run relationship so that property prices influence mortgage lending and not vice versa in Greece.

To conclude, studies that look at the relation between property prices and overall credit find that property prices are driving credit but not vice versa which supports the BG view. On the other hand, studies that analyze the relation between housing prices and mortgage credit find two-way interactions.

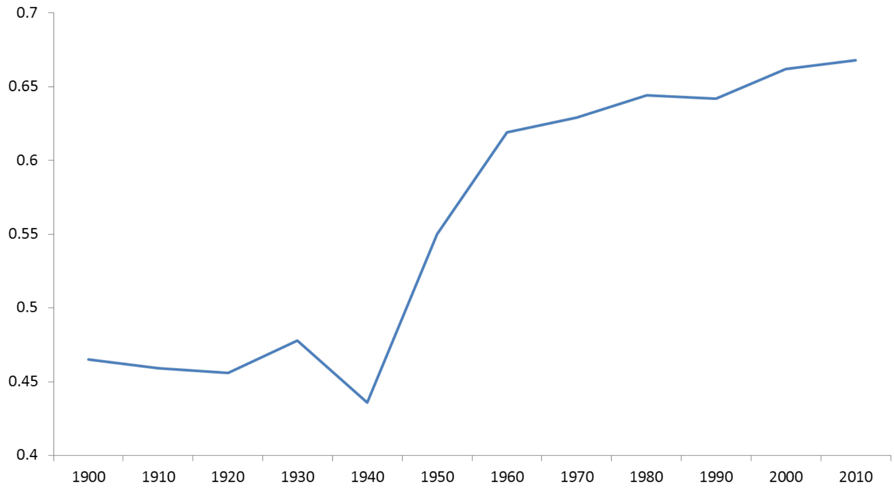
2 Deregulation and moral hazard in US mortgage markets

In this section, the development of the US mortgage market will be examined in order to find whether the pre-requisites for a credit-funded bubble postulated in the AG model can be seen in the US mortgage market, namely financial deregulation and moral hazard.

The development of the US mortgage system can be divided into three phases. The first phase can be called the "originate-to-hold" phase in which banks provided mortgages that they held until maturity. The second phase can be called "emergence of the originate-to-distribute model" in which private banks lent out mortgages that they increasingly sold to the Government sponsored enterprises (GSEs) Fannie Mae and Freddie Mac. The third phase can be called the "originate-to-distribute by investment banks"-phase in which mortgages were not only sold to the GSEs but also to investment banks. As will be argued, this development was driven by financial innovation and deregulation and has increased problems of moral hazard and limited liability.

The first phase ranged from the 1930s to the late 1960s. In that phase, especially saving and loan banks originated a standardized mortgage (with a maturity of 30 years, fixed interest rates, self-amortizing and insured) and held this mortgage until

Figure 1: Homeownership rate (as share of population)



Source: U.S. Census

maturity (for more detail on that phase, see Green and Wachter (2005)). This kind of mortgage was called a "conventional" mortgage and still is the most common mortgage in the US. The loans banks were allowed to make were strictly limited by regulation; interest rates at which they could refinance were capped (by the so called Regulation Q) and their deposits were insured (Gilbert, 1986; Sellon and Van Nahmen, 1988).

The problem of moral hazard stemming from deposit insurance was counter weighted by the strict regulation of the types of assets that savings and loans were allowed to hold (White, 1993). Further, banks had to hold the mortgages they made and were thus responsible if their mortgage portfolio led to losses. Within this phase falls the rapid expansion of home ownership in the United States, starting from a homeownership rate of 44 % in 1940 to 62 % in 1960 (figure 1). Since then, homeownership has increased, but at a much lower pace.

The second phase can be called the originate-to-distribute model, beginning in the 1970s. Increasingly, banks originated mortgages and sold those mortgages to the GSEs. The GSEs financed the purchases of mortgages by mortgage backed securities (Sellon and Van Nahmen, 1988). Those are securities whose yields are the interest payments of the underlying mortgages. With the ability to sell loans, banks could choose to receive liquidity now instead of receiving the income from interest payments. Further, since savings and loans were only allowed to take deposits and make loans in the states they were located, the sale of mortgages allowed them to tap the wider national financial market and thus make more loans. This was the upside.

On the downside, being able to sell the mortgages and living off the fees for their origination meant that banks were likely to be less vigilant about new borrowers than they were when they had to hold the mortgages until maturity themselves. Securitization increases the risks of moral hazard (Sellon and Van Nahmen, 1988). This problem was however initially mitigated by the GSE's regulations. GSEs could only buy "conforming" mortgages, i.e. mortgages that fulfill certain quality criteria like maximum loan-to-value, loan-to-income, debt-service-to-income ratios and an absolute size of the mortgage (McDonald and Thornton, 2008). Banks could only sell mortgages to the GSEs with these quality requirements.

While mortgage credits provide a stable income to banks from the interest payments, the originate-to-distribute model became more important due to both inflation and the savings and loans crisis of the mid-1980s. Inflation in an environment with fixed interest payments for long-term mortgages and fixed interest rates for demand deposits meant that banks' real earnings declined while depositors were less willing to provide liquidity to refinance banks' positions.

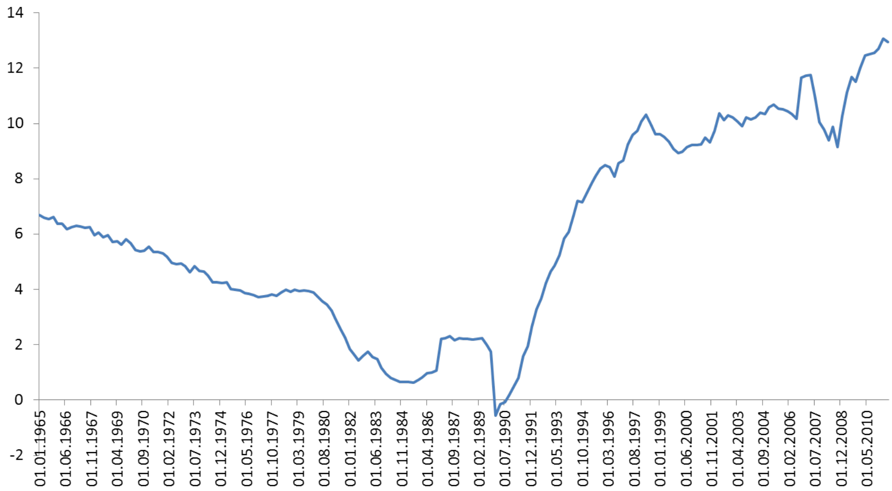
The cap of deposit interest rates by regulation Q meant that banks were cut off from deposits in times when short term interest rates rose. With the emergence of money market mutual funds that were not subject to Regulation Q, investors could get higher returns or they could invest in government securities whose yields were also not capped. The cut off from refinancing led to a cut of lending by the saving and loan industry and thus a cut of mortgage financing for households.

Further, the 1970s inflation became a problem for the banks. With fixed nominal interest rates from mortgages made before the inflation, inflation led to decreases in profitability of savings and loans and increased their liquidity problems. This mixture made many savings and loans insolvent when inflation increased and when monetary policy interest rates rose to fight inflation in the late 1970s.

However, insolvency was first not acknowledged by the Federal Savings and Loan Insurance Corporation that regulated the saving and loans industry and insured its deposits. This was also due to the fact that assets were not marked to market so that historical values were used for the accounting (White, 1993). This blinded regulators to the real problems of the banks.

Furthermore, Congress deregulated the saving and loan industry by both abolishing Regulation Q and allowing savings and loans to invest in other assets than home mortgages, like consumer loans, unsecured commercial lending and the emerg-

Figure 2: Savings institutions equity ratio (equity as share of total liabilities)



Source: Federal Reserve Flow of Funds, own calculations.

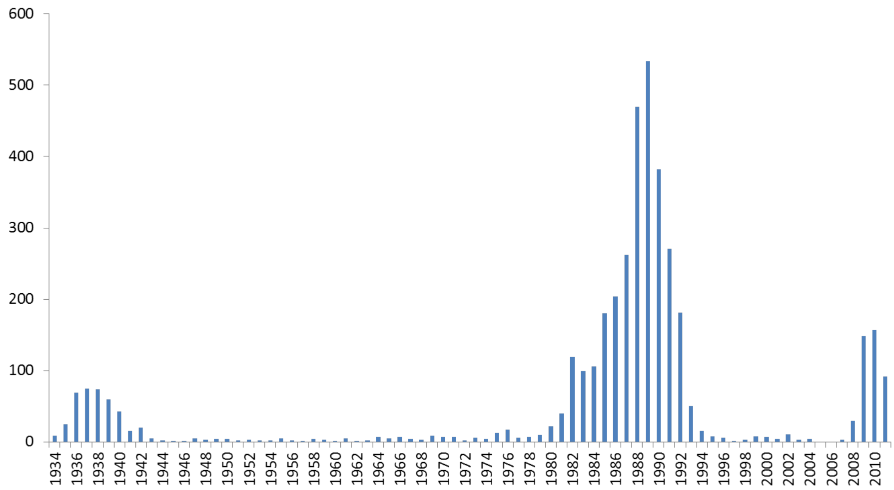
ing market of junk bonds. Minimum necessary equity ratios were lowered so that banks were allowed to have higher leverage (figure 2) (White, 1993). Maximum loan-to-value ratios were eliminated for non-residential lending (Cole et al., 1992). Both increased moral hazard problems since regulators' forbearance combined with financial deregulation is likely to have led to a "gamble for resurrection" (Admati et al., 2012), i.e. a situation in which banks increase their risk in order to avoid default. This is likely to have led both to the housing boom in the mid-1980s and then to a bust which led to the savings and loans crisis which led to more closures of banks than was the case in the Great Depression (figure 3) and a decline in the provision of mortgages by savings and loans altogether (figure 4).

While the banking crisis led to the closure of many small regional savings and loans, in 1984 a big bank - the Continental Illinois bank - was saved by the Federal Deposit Insurance Corporation (FDIC) because it was deemed "too big to fail" (TBTF). It was argued that its failure would have threatened overall financial stability. It was at this point that the "TBTF doctrine" became official policy. Combined with a strong consolidation of the banking market due to the crisis, the TBTF doctrine was an incentive to become too big to fail, thus increasing concentration in the banking market (Boyd and Graham, 1991; Jones and Critchfield, 2005). Problems of moral hazard are likely to increase by the TBTF doctrine because the incentive asymmetry increases, with profits being privatized and possible losses being shouldered by the government.

Mortgage companies stepped in the place of savings and loans. Mortgage companies do not hold mortgages but sell them and live from the fee income generated by the services associated with the provision of mortgages. According to McCarthy and Peach (2002), savings and loans originated 50 to 60 % of all mortgages between 1970 and the mid-1980s. Then, after the saving and loans crisis, mortgage companies overtook, now originating up to 60 % of all mortgages.

If a bank mainly earns money by fee income and not by income from interest, the bank has an incentive to increase the volume of mortgages since every transaction earns fess. This may lead to a potential moral hazard problem that is aggravated since they can sell off the mortgages and are not responsible for the losses in case of default. Until the 1990s, this problem was somewhat mitigated since the GSEs still were only allowed to buy conventional mortgages that were subject to strict regulation.

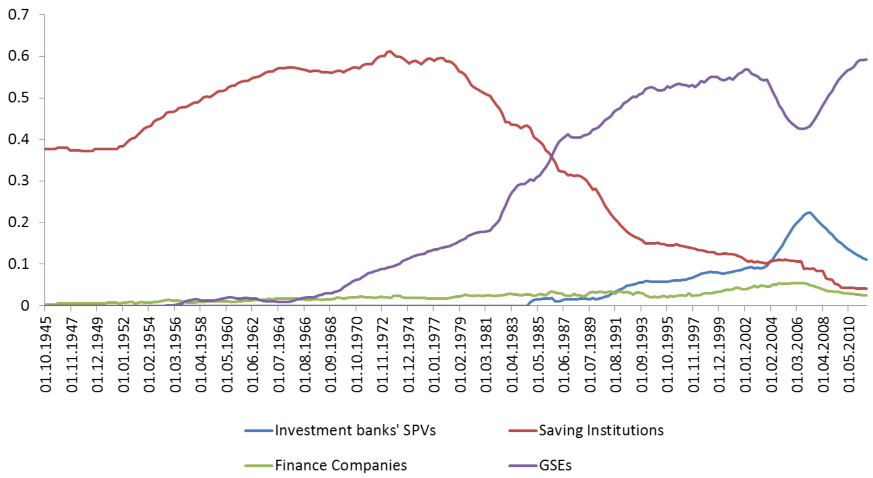
Figure 3: Number of bankrupcies of savings and commercial banks



Source: FDIC, own calculations.

The problem intensified however when private investment banks began to buy mortgages and issue mortgage backed securities (figure 4). This is the third phase of the US mortgage market. In this phase, all mortgage market regulations that were designed to prevent problems of moral hazard were loosened. While the GSEs still only bought conforming loans, other loans - notably sub-prime, i.e. non-conforming loans - were bought by investment banks and financed by private mortgage backed securities (MBS). Those private MBS (in contrast to the agency MBS, i.e. MBS issued by the GSEs) were then again packed and sold and refinanced by other liabilities like short term commercial paper.

Figure 4: Mortgage Holders in % of all Home Mortgages



Source: Federal Reserve Flow of Funds, own calculations.

Like mortgage banks which became the primary originators of mortgages in this phase, an important part of investment banks' earnings are fees they earn by organizing the issuance and transaction of financial instruments. With every issuance of a mortgage backed security or papers that repackaged those MBS, investment banks earn money.

This gave them an incentive to repackage as much loans as possible and to issue more and more securities with ever lower quality - i.e. sub-prime mortgages (Chomsisengphet and Pennington-Cross, 2006). Since conforming loans were still securitized and insured by the GSEs, investment banks were the main players in the sub-prime market. Further, the fall of the separation between commercial and investment banking in 1999 meant that commercial banks could engage in the same business which increased the incentive to buy increasingly more high-risk assets.

The development of the mortgage system is illustrated in figure 4 which shows the share of mortgages held by different financial institutions. In the late 1970s, one can see that savings and loans' share in mortgage holdings (savings institutions) declined while the share of mortgages held by the GSEs increased strongly beginning in the late 1960s and accelerated in the 1980s. The share of mortgage holdings by investment banks (held off-balance in so-called special purpose vehicles (SPVs)) began to increase in the mid-1980s and strongly accelerated in 2003.

The securitization of non-conforming mortgages without much regulation and their holdings in off-balance SPVs led to widespread moral hazard problems (Hellwig, 2009). Berndt and Gupta (2009) show that the originate-to-distribute model via securitization leads to moral hazard. They find that for securitized loans (not only mortgage loans), borrowers significantly underperform their peers in terms of the risk/return measures before the securitization and are more likely to suffer valuation losses after the securitization.

Ben-David (2010) shows that with mortgage brokers involved, there often was outright fraud in the mortgage process. In accordance with home buyers, sellers sold houses at inflated prices in order to allow home buyers to get higher mortgages. This inflation of home prices was more likely when the loan was sold by the mortgage broker. This practice was especially intensive in the sub-prime mortgage market.

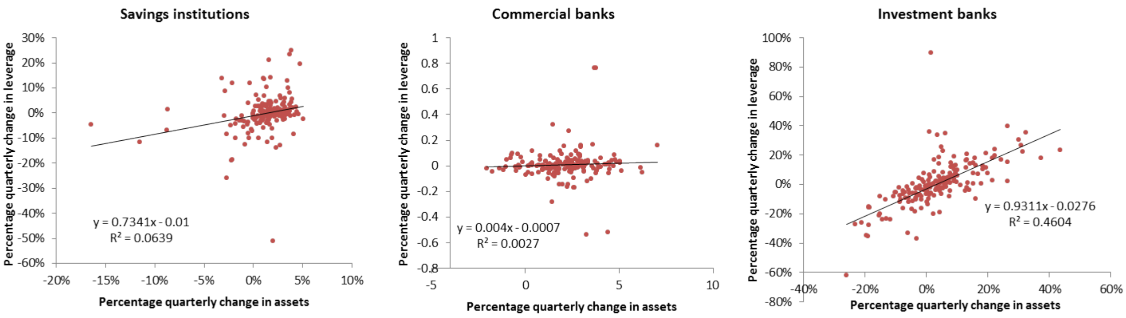
Demyanyk and Van Hemert (2009) also find that the quality of privately securitized loans to sub-prime borrowers declined monotonically since 2002 and that even the risk spread declined although borrowers became ever more riskier. The authors argue that the decline in risk spreads in the face of obviously higher risk meant that lenders that sold the mortgages were practicing moral hazard.

To sum up, there were problems of moral hazard both under the savings and loans system and the system dominated by investment banks. However, this problem is likely to have been higher in the early 2000s compared to the early 1980s. This is due to the different business models of savings and loans and investment banks.

Adrian and Shin (2009) find that investment banks increase their leverage when their assets increase, i.e. they follow a pro-cyclical business model in which rising asset prices lead to more debts and falling asset prices to less debt. This is neither the case with savings and loans nor with commercial banks. With their pro-cyclical business model, investment banks exacerbate the boom in lending and the subsequent bust. Figure 5 shows that pattern. In the figure, the percentage quarterly increase in assets and leverage is plotted for investment banks, savings institutions (mainly savings and loans) and commercial banks. Leverage is defined as assets divided by equity.

Investment banks do not originate mortgages themselves but buy mortgages in the market in order to repackage them into mortgage pools. By this they provide liquidity for the mortgage originators. By the pro-cyclical business model, they provide ample liquidity in the upturn when asset prices increase and cut liquidity when prices and thus their assets' worth decline.

Figure 5: Change in assets and leverage, 1965q02 - 2011q1



Source: Federal Reserve Flow of Funds, own calculations.

To sum up, the development of mortgage markets is likely to have led to ever higher levels of moral hazard over time. The main question is not which financial intermediary holds assets but what kind of asset any financial intermediary is allowed to hold. Securitization as such does not necessarily lead to moral hazard since regulation can make sure that only assets of good quality can be sold by financial institutions. This was mainly the case with the securitization via the GSEs.

Moral hazard only became a problem when lenders had an incentive to invest in high-risk/high yield markets and were also allowed to do so. This was the case of the deregulation of the savings and loans banks in the early 1980s and the securitization of non-conforming, i.e. subprime loans, by investment banks in the 2000s.

As far as the historical development of the US mortgage market is concerned, the ingredients of the AG model seem to be there: there exists limited liability both for households who can step away from their houses when they cannot pay their interest payments; but it even more so exists for banks that are either insured or are deemed “too big to fail”. This makes them more likely to invest in high yield / high risk assets and engage in moral hazard.

Due to moral hazard in an environment of deregulation, too much credit might have been extended so that housing prices were pushed away from their fundamental value. While it will not be explicitly tested to what extent there was a bubble in the housing market (its subsequent bursting being a sign that there actually was a bubble) it will be analyzed whether credit drove asset prices or vice versa.

3 Data

In the empirical part of this paper it will be tested whether housing prices have driven mortgage credit or vice versa. Co-integration relationships between housing values and mortgage credit will be estimated and a test for weak exogeneity will be conducted.

The main problem as far as the data is concerned is the compatibility of the credit series and the housing price series. While there is a wide variety of housing price series available, there is only one measure of mortgage credit available that measures all mortgages in the US economy, the change in mortgages outstanding provided by the Federal Reserve's Flow of Funds. It measures *net* mortgage changes, i.e. gross mortgages created in a period minus repayments.

In principle, the increase in *gross* mortgages would be better suited when the influence on mortgage credit on housing values is analyzed. For instance, if an existing house is sold by household A which pays off its outstanding mortgage, the purchasing household B might take out a new mortgage to finance the purchase. The net measure of mortgage borrowing could increase, decrease or stay the same:

a) it could increase if B's new mortgage would be higher than A's repayment, for instance because B needs less equity and/or A has already paid off a part of its mortgage credit;

b) it could decrease if B has more equity and needs a smaller mortgage credit than A pays off;

c) or net mortgage borrowing might not increase at all since the sum paid off by A is equal to B's new mortgage.

However, for practical purposes, it is likely that case a) holds: if there are newly constructed houses on the market which are not sold by a former owner, the net measure is likely to increase since new additional mortgages are taken out by the buyers and no repayment due to a housing purchase takes place. But even if no additional houses are constructed, a housing price change is likely to be associated with a change of net mortgages in the same direction since even if repayment and the new mortgage were equal at the former price, the new price leads to a change in mortgages.

In order to choose an appropriate housing price measure, it is important to note that mortgage credit finances the *value* of a house, i.e. its price times its quantity (price per square feet times number of square feet). This means that price-only measures (like the Shiller-Case index) cannot be used in order to gauge the effect of credit on housing values.

This is why two housing value measures will be used here and two different models with those measures will be estimated. First, the National Association of Realtors (NAR) publishes a measure of average housing prices of existing houses sold in a period. No new houses are contained in the series. Second, the US Census bureau publishes data on the average value only of new houses sold.[1] Both measures can be used as value or price measures: They measure the average price of a house, but the house can have different square feet. So we will use the term "housing value" and "housing price" interchangeably for those measures.

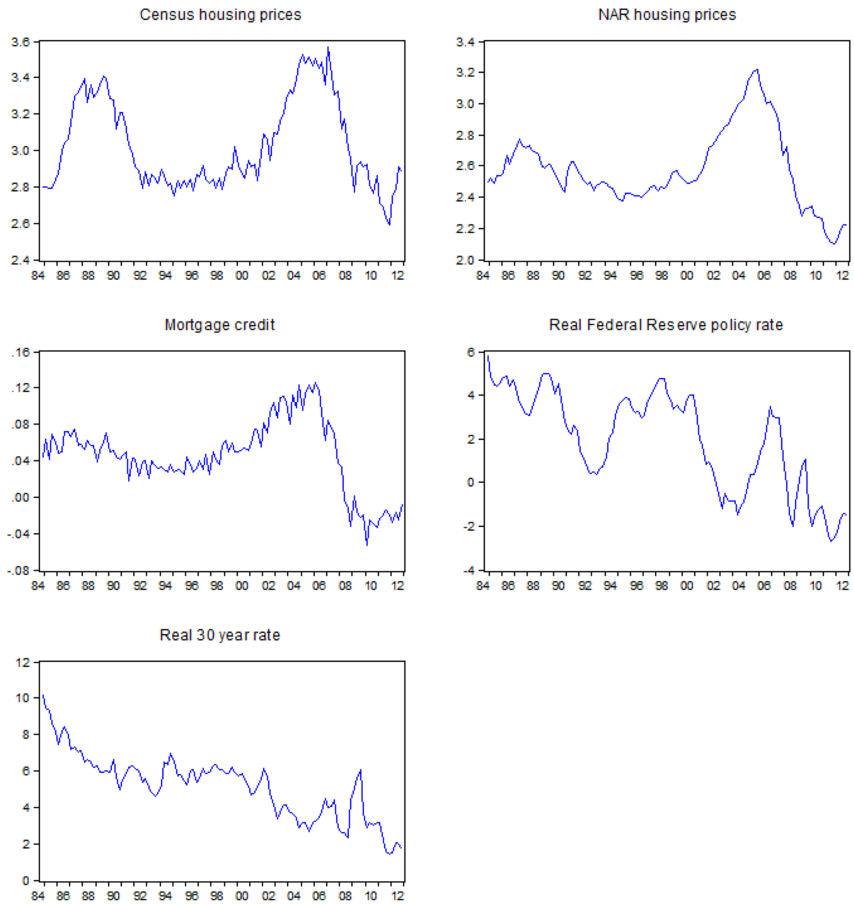
After estimating models with mortgage credit and housing prices, the models will be re-estimated adding two different interest rates, the short term effective federal funds rate and the interest rate on 30 year conventional fixed rate mortgages. This specific long-term rate of course has become less relevant for mortgage markets since the deregulation of mortgage markets has led to more mortgages with shorter maturities and flexible interest rates. However, it is reasonable to assume that the rate on conventional mortgages is a reference point for the interest rates on less conventional mortgages. Both interest rates have been transformed into real rates by subtracting the current consumer price inflation rate.

In order to avoid problems of heteroskedasticity, the mortgage data has been divided by disposable household income; the NAR and Census average housing price measures are divided by disposable household income per household. The income measure has been divided by the number of households because both housing price measures capture the average price of one house and houses are sold to households. All data is seasonally adjusted by the arima x-12 procedure. Figure 6 shows the data.

The division by household income also has the advantage that the resulting housing price to income ratio can be seen as an indicator for a housing price bubble: when housing prices diverge too markedly from income, it is likely (although not necessary) that a bubble builds up (McCarthy and Peach, 2004; Himmelberg et al., 2005). The same applies to the credit to income ratio.

[1] I have also tried a third housing value series, namely newly built single-family structures that are part of residential investment. In contrast to the NAR and Census data, no co-integration between single-family structures and mortgage credit could be established so that tests for weak exogeneity could not be performed. The data has thus not been used.

Figure 6: Data



Source: Federal Reserve Flow of Funds, U.S. Census, National Association of Realtors, Bureau of Economic Analysis, own calculations.

The sample's beginning is set at the first quarter of 1984 and its end at the fourth quarter of 2012. As has been shown in the previous section, this is the phase in which mortgage markets were liberalized and in which moral hazard is likely to have increased.

Figure 6 shows two housing bubble episodes, one from the mid-1980s to 1990 and then from 2001/2002 to 2005/2006. In the Census data, the 1980s bubble is more evident while it is more muted in the NAR data. One can also see a similar development in the mortgage data where there is a hump in the 1980s and the 2000s.

4 Estimation

In the following section, the long-term relationship between mortgage credit and housing prices will be estimated using a vector autoregression error correction model (VECM). By using this method, one can test for strong and weak exogeneity and thus how the variables interact.

By testing for weak exogeneity, one can test which of the variables adjusts to the long-run relationship between the variables. The variables that do not adjust are weakly exogenous (Engle et al., 1983). A variable's weak exogeneity does not exclude that it can still be predicted and perhaps driven by other variables in the system, i.e. it could still be Granger-caused by those variables. Only if a variable is both weakly exogenous and is not Granger-caused by other variables, it can be said to be strongly exogenous, i.e. not to be caused by any of the lags of the levels or changes of another variable.

This is why both tests for weak exogeneity and tests for Granger causality will be conducted in order to discern the interaction of the variables. Formally, a test for weak exogeneity can be conducted if there is a co-integration relationship between variables. In terms of housing price (hp) and mortgage credit (mc), a vector error correction model can be written if the variables are co-integrated:

$$\begin{pmatrix} \Delta hp_t \\ \Delta mc_t \end{pmatrix} = \mathbf{\Pi} \begin{pmatrix} hp_{t-1} \\ mc_{t-1} \end{pmatrix} + \sum_{i=1}^{k} \mathbf{\Gamma}_i \begin{pmatrix} \Delta hp_{t-i} \\ \Delta mc_{t-i} \end{pmatrix} + u_t \tag{1}$$

$\mathbf{\Pi}$ and $\mathbf{\Gamma}$ are coefficient matrices. $\mathbf{\Pi}$ can be further decomposed thus:

$$\mathbf{\Pi} = \boldsymbol{\alpha}\boldsymbol{\beta}' \tag{2}$$

The vector $\boldsymbol{\alpha}$ contains the short-run adjustment coefficients, vector $\boldsymbol{\beta}$ captures the long run co-integration coefficients. A test for the significance of the respective elements of $\boldsymbol{\alpha}$ is a test for weak exogeneity. A test for weak exogeneity is a t-test for a single coefficient being zero. If weak exogeneity is not rejected, a single-equation estimation can be used without loss of information (Engle et al., 1983).

Granger non-causality means that a variable cannot be predicted by the past values of the levels or changes of another variable (Johansen, 1992). This can be tested by a Wald test for the joint significance of the various respective coefficients contained in the $\mathbf{\Pi}$ and $\mathbf{\Gamma}$ matrices.

4.1 Co-integration relationships

Before estimating the co-integration relationship, the variables' order of integration has to be established. To this end, augmented dickey fuller tests for the existence of a unit root are conducted. For the housing price measures and mortgage credit a constant is used but no trend since the variables do not seem to have a deterministic trend as can be seen from figure 6. On the other hand, for the two interest rates a constant and a trend is used due to their clearly visible trend. The lag length is established by the modified Akaike criterion (Ng and Perron, 2001). As table 1 shows, for all variables the null hypothesis of a unit root is accepted in levels but rejected in first differences. I thus assume the variables to be integrated at order one.

Table 1: Unit root tests

Variable		t-statistic	Prob.*
NAR housing prices	level, 2 lags	-1.69	0.44
	first difference, 9 lags	-2.27	0.02
Census housing prices	level, 2 lags	-1.86	0.35
	first difference, 11 lags	-2.29	0.02
Mortgage credit	level, 1 lag	-0.97	0.76
	first difference, 8 lags	-2.23	0.03
Federal Fund rate	level, 4 lags	-2.24	0.46
	first difference, 0 lags	-7.73	0.00
30 year conventional rate	level, 4 lags	-2.81	0.20
	first difference, 0 lags	-9.63	0.00

* MacKinnon (1996) one-sided p-values

Next, it will be tested whether the variables are co-integrated using the Johansen procedure (Johansen, 1991). For each model, two lags are chosen. This lag length eliminates serial correlation. Table 2 shows the results of the Trace and Lmax test. Both tests indicate a single co-integration relation between the two variables in both models.

Table 2: Johanson co-integration tests

Rank	Eigenvalue	Trace-test	p-value*	Lmax-test	p-value*
		With NAR data			
0	0.18	27.08	0.00	22.89	0.00
1	0.04	4.19	0.38	4.19	0.38
		With Census data			
0	0.13	20.51	0.05	16.58	0.04
1	0.03	3.93	0.42	3.93	0.42

*MacKinnon-Haug-Michelis (1999) p-values

Table 3 shows the results of the residual tests. The residuals do not show autocorrelation. However, in the model using the NAR data, the normality of the residuals is rejected and there is evidence for heteroskedasticity.

Table 3: Residual tests

	Autocorrelation, 3 lags LM-Stat	Normality Jarque Bera joint test	Homoskedasticity White test (χ^2)
NAR data	2.19 (0.70)	52.21 (0.00)	53.46 (0.00)
Census data	5.30 (0.26)	8.77 (0.46)	37.49 (0.16)

Finally, table 4 shows the coefficients for the long-run relation, as contained in vector $\boldsymbol{\beta}$, and for the short run coefficients from vector $\boldsymbol{\alpha}$ for the two models. Note that the coefficient for the respective housing price measure is normalized to one and thus not reported here.

Table 4: Normalized long-term relations and adjustment parameters (t-values in parantheses)

cointegrating coefficients		Adjustment coefficients	
mc	c	Δhp	Δmc
NAR data			
-6.25	-2.28	-0.19	-0.01
(-11.23)	(-69.31)	(-4.91)	(-0.58)
Census data			
-5.25	-2.78	-0.15	-0.01
(-4.64)	(-41.93)	(-3.68)	(-1.93)

One can see that the quantitative results for the NAR and the Census data are similar. This indicates that the results of the models are mutually consistent although both housing price variables measure different concepts (existing houses with the NAR, new houses with the Census data) and come from different sources.

In the models, the respective housing price measure adjusts to the long-run relation and is thus endogenous. In the model with the NAR data, the adjustment coefficient in the equation for changes in mortgage borrowing is both small and not significant so that weak exogeneity cannot be rejected.

The model with the Census data is more problematic: the adjustment coefficient for changes in mortgages is negative, so that mortgage borrowing increases when the level of mortgage borrowing overshoots its equilibrium relation with housing prices. This means that it plays a destabilizing role for the long-run relationship.[2] However, given the small sign of the coefficient and that it is only significant at the 10 % level, the problem does not appear to be big. Later results will confirm that mortgage credit does not seem to play a big role in the Census model, so that mortgage credit can be assumed to be weakly exogenous in both models.

[2]Note that in the long-run relation, the coefficient have been normalized so that the coefficient for housing prices is unity. Consequently, a *negative* adjustment coefficient for housing price changes and a *positive* coefficient for changes in mortgage borrowing indicate the right adjustment.

Further, Granger tests for the significance of the lagged variables in the co-integration model are conducted in order to establish whether the variables Granger-cause each other. With two lags, the co-integrated system consists of those two equations:

$$\Delta hp_t = \alpha_1(1 - \beta_1 mc_{t-1} - \beta_2) + \gamma_{1,1}\Delta hp_{t-1} + \gamma_{1,2}\Delta hp_{t-2} + \gamma_{1,3}\Delta mc_{t-1} + \gamma_{1,4}\Delta mc_{t-2} \tag{3}$$

and

$$\Delta mc_t = \alpha_2(1 - \beta_1 mc_{t-1} - \beta_2) + \gamma_{2,1}\Delta hp_{t-1} + \gamma_{2,2}\Delta hp_{t-2} + \gamma_{2,3}\Delta mc_{t-1} + \gamma_{2,4}\Delta mc_{t-2} \tag{4}$$

For the housing price equation, the test for Granger non-causation is a Wald test for the joint significance of the coefficients $\alpha_1\beta_1$, $\gamma_{1,3}$ and $\gamma_{1,4}$. Equivalently, the Wald test for mortgage credit is a test for joint significance of α_2, $\gamma_{2,1}$ and $\gamma_{2,2}$. Table 5 shows the test results. As can be seen, Granger non-causality is rejected for all variables in both models so that no strong exogeneity of mortgage credit can be established.

Table 5: Granger tests (χ^2 statistic)

Dependent variable	NAR data	Census data
Δhp	18.06 (0.00)	9.33 (0.03)
Δmc	11.01 (0.01)	7.03 (0.07)

To conclude so far, it seems that housing prices adjust to the long-run relationship while housing prices do not. This does not exclude that lagged levels and differences of housing prices have a role for mortgage credit however. One cannot conclude that mortgage credit is driving housing prices so far. This is why some more tests and exercises with the data will be conducted to better gauge the interaction between the two variables.

4.2 Stability

In order to see whether there were structural changes in the relationships between the variables, a stability analysis will be conducted. In order to do that, the models' adjustment coefficients are recursively estimated. Figures 7a and 7b show the recursive estimates. On the figures' left hand side are the adjustment coefficients for the changes in housing prices, on the right hand are the adjustment coefficients for changes in mortgage borrowing (the coefficients for the difference lagged variables are not shown).

Figure 7a: NAR model, stability of adjustment coefficients

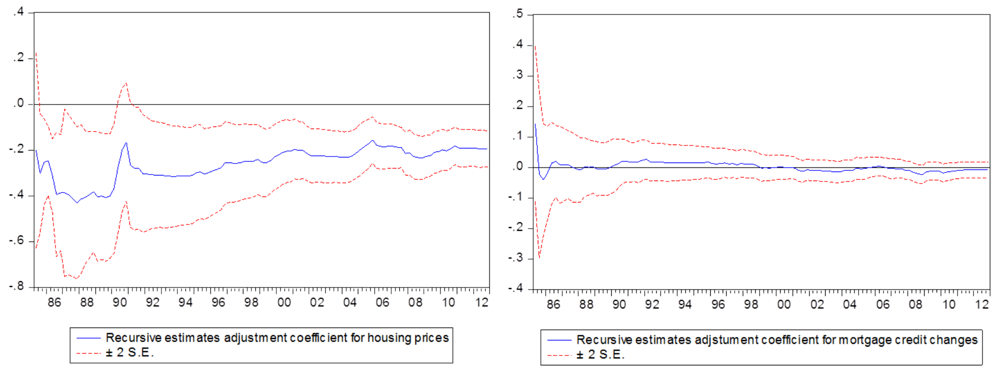
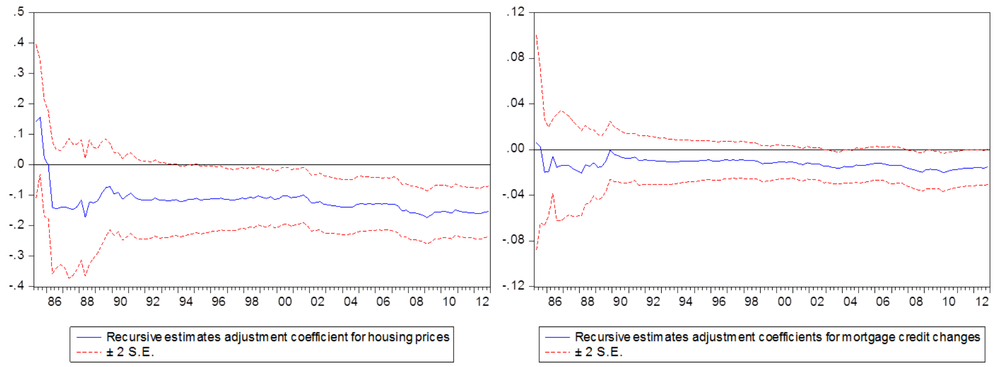


Figure 7b: Census model, stability of adjustment coefficients



The adjustment coefficients seem reasonably stable and confirm the implications of the co-integration model. As far as the adjustment coefficients for housing prices are concerned, in the NAR model, the adjustment becomes weaker in time, while it becomes larger with Census data. While the adjustment coefficients for mortgage credit are also quite stable, they are much closer to zero. In the NAR model, the value zero is always within the confidence interval. In the Census model, the confidence interval is only slightly below zero after 2006. This further hints to the validity the previous assumption that mortgage credit is weakly exogenous in the Census model.

4.3 Impulse-response functions and variance decomposition

In order to better gauge the dynamics of the housing price / mortgage credit interaction, impulse response functions and variance decompositions are computed. Figures 8a and 8b show the impulse-response functions. The Cholesky ordering is that housing prices have a contemporaneous effect on mortgage credit but not vice versa. This ordering does not affect the results.

In both models, a one-time mortgage shock leads to a permanent increase in housing prices. On the other hand, a housing price shock does not significantly affect mortgages (although in the NAR model, there is a significant and positive influence once in the third quarter after the shock). While not significant, in the Census model, a housing price shock leads to a *fall* of mortgage borrowing. The wrong sign for the adjustment of mortgage borrowing in the Census model does not destabilize the relationship: all variables in the Census model converge to a fixed long-term value after the shock.

Figure 8a: NAR model, with 95 % confidence interval

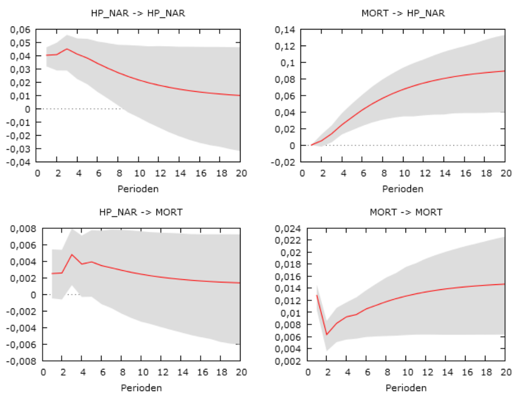
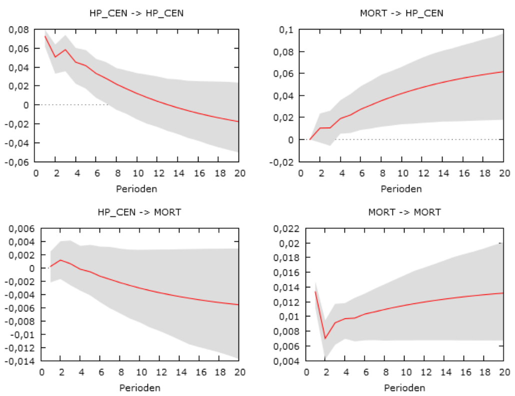


Figure 8b: Census model, with 95 % confidence interval



Figures 9a and 9b show the variance decompositions, using the same ordering as in the impulse-response functions. In both the NAR and the Census model, the variation of mortgages explain a large part of the variation of housing prices while housing price variation does hardly explain the variation of mortgages. As with the test for weak exogeneity, those results hint to the more important role of mortgage prices in driving the housing price dynamic than vice versa.

Figure 9a: NAR model

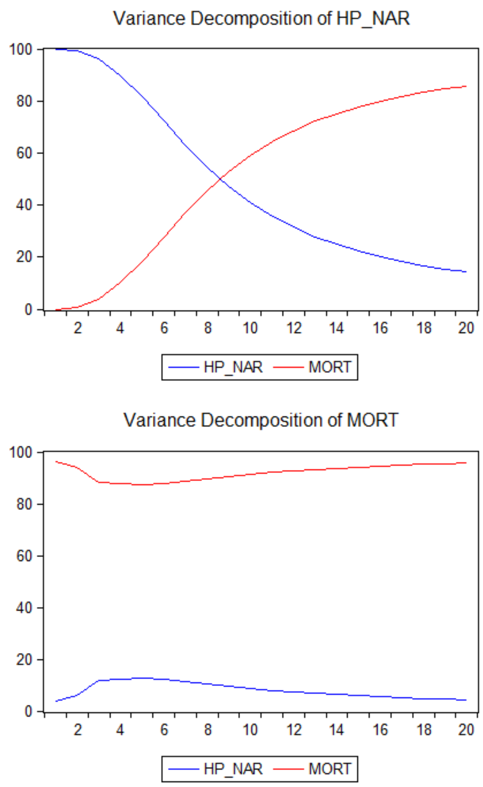
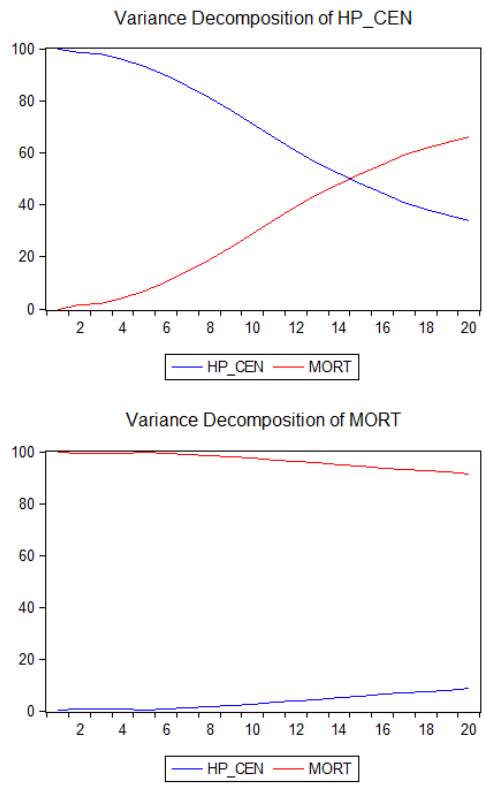


Figure 9b: Census model



4.4 Out of sample forecast

A further test is to use an out-of-sample forecast for the two variables. Using this exercice one can see which of the two variables can be better forecast using the respective other variable.

For the forecast, the models are re-estimated and the sample is shortened so that it ends at the fourth quarter of 2001. This is before both the built up and the subsequent bust of the housing price bubble. Housing prices and mortgage credit are then forecast until the fourth quarter of 2012.

Note however that this is not a strict out-of-sample forecast. The forecasts will be done using the single equations of the two system equation. Not the entire system will be used for the forecast: in the equation for housing prices, actual mortgage credit is used as the exogenous variable; in the equation for mortgage credit, actual housing prices are used as the exogenous variable. But the lags of the respective endogenous variable are the past forecast values, not the actual values.

By this exercise, the stability of the system can be further tested and the degree to which a variable explains the other variable can be better evaluated. The coefficients of the estimation until the fourth quarter of 2001 are shown in table 6. In the NAR model, mortgage borrowing is again weakly exogenous, like in the full sample (table 4). The Johansen test accepts co-integration at the 5 % level (not reported). In contrast to the full sample estimation, in the Census model, mortgage borrowing is not at all significant and thus weakly exogenous. But the variables in the Census model are hardly co-integrated anymore (slightly higher than the 10 % level).

Table 6: Normalized long-term relations and adjustment parameters (t-values in parantheses), 1984q1 - 2001q4

cointegrating coefficients		Adjustment coefficients	
mc	c	Δhp	Δmc
NAR data			
-7.13	-2.20	-0.29	-0.00
(-6.01)	(-38.99)	(-4.31)	(-0.10)
Census data			
-17.69	-2.17	-0.15	-0.00
(-4.03)	(-10.41)	(-3.70)	(-0.13)

Both models (figures 10a and 10b) predict a strong rise in housing prices and also the subsequent bust. Housing prices are well forecast in the NAR model although actual housing prices are above the confidence intervals when prices peak. The strong decline when the bubble burst is well captured. But predicted prices undershoot actual prices from 2009 until the sample's end.

In the Census model, predicted housing prices both significantly overshoot actual prices when the bubble built up and undershoot it afterward. This is likely to be the result of the hump from the mid-1980s to the early 1990s in the Census data (figure 6) which is less big in the NAR housing price measure and might have led to a too high estimated sensitivity of housing prices to mortgage borrowing in the sample.

The models have a harder time to forecast mortgage credit based on housing prices. In both models, the forecast mortgage credit hardly moves at all and the strong boom-bust dynamic of the actual mortgage credit development cannot be seen. Overall, those results further indicate that mortgage credit is more likely to drive housing prices than vice versa.

4.5 The role of interest rates

In the following section, the role of interest rates is more closely looked at. The models have been estimated in the same way as before, only adding the short term effective federal funds rate and the 30 year interest rate for conventional fixed rate

Figure 10a: NAR model

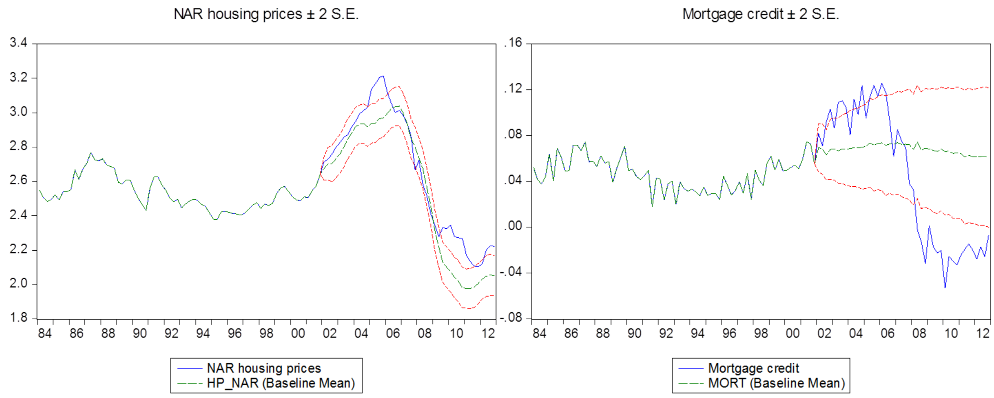
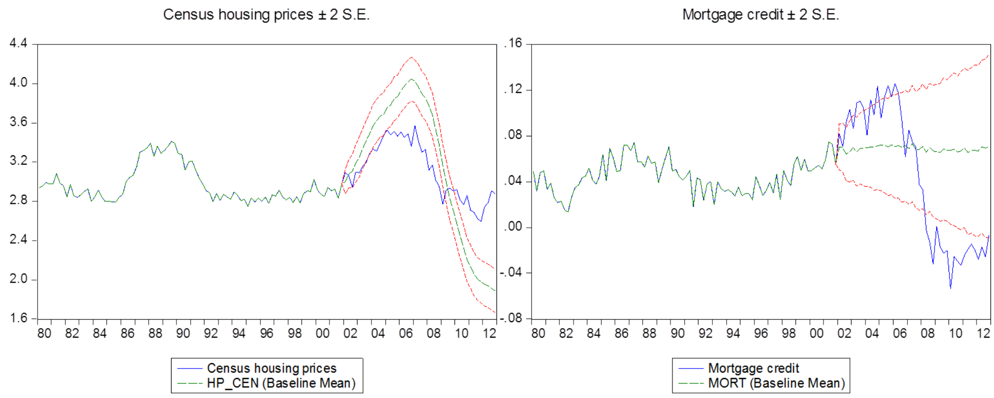


Figure 10b: Census model



mortgages, respectively. Remember that housing prices and mortgage credit are expressed as a share of disposable income. Adding interest rates to the model means that they are used not to explain credit and/or housing prices as such, but both as a share of disposable income. The housing price / income ratio has the advantage that it can be used as a proxy for housing price bubbles: if housing prices increase more than disposable income, this might indicate a housing price bubble.

Table 7 shows the results. The coefficients from the model with and without interest rates hardly differ (compare to table 3). In all models, interest rates have the expected (negative) sign. But only in the NAR model do interest rates enter the long-run relation significantly. Further, in all models, interest rates do not adjust to the long-run relation since the adjustment coefficient is not significant at all. Also, tests for co-integration (not reported) show that the variables in the NAR model are still co-integrated with both interest rates; in the Census model, only the model with short-term interest rates shows co-integration.

Table 7: Normalized cointegrating coefficients (standard error in parentheses)

cointegrating coefficients			Adjustment coefficients		
mc	i	c	Δhp	Δmc	Δi
NAR data, short term rate					
-6.57	0.02	-2.32	-0.27	-0.01	-0.02
(-16.57)	(3.71)	(-95.34)	(-5.98)	(-0.47)	(-0.04)
NAR data, long term rate					
-6.44	0.02	-2.38	-0.22	-0.00	-0.34
(-13.30)	(2.05)	(-41.34)	(-4.92)	(-0.14)	(-0.56)
Census data, short term rate					
-5.46	0.02	-2.83	-0.18	-0.02	0.07
(-5.35)	(1.28)	(-45.53)	(-4.12)	(-1.96)	(0.19)
Census data, long term rate					
-5.33	0.02	-2.86	-0.17	-0.01	-0.07
(-4.95)	(0.81)	(-22.50)	(-3.73)	(-1.78)	(-0.22)

Given the very low coefficient of interest rates, it seems that they hardly play a role in the model. To evaluate the effect of an alternative path of monetary policy rates, a counter-factual scenario is computed based on the housing price equation in the NAR model. The alternative interest rate, i, is computed according to the Taylor rule (2007) and computed thus:

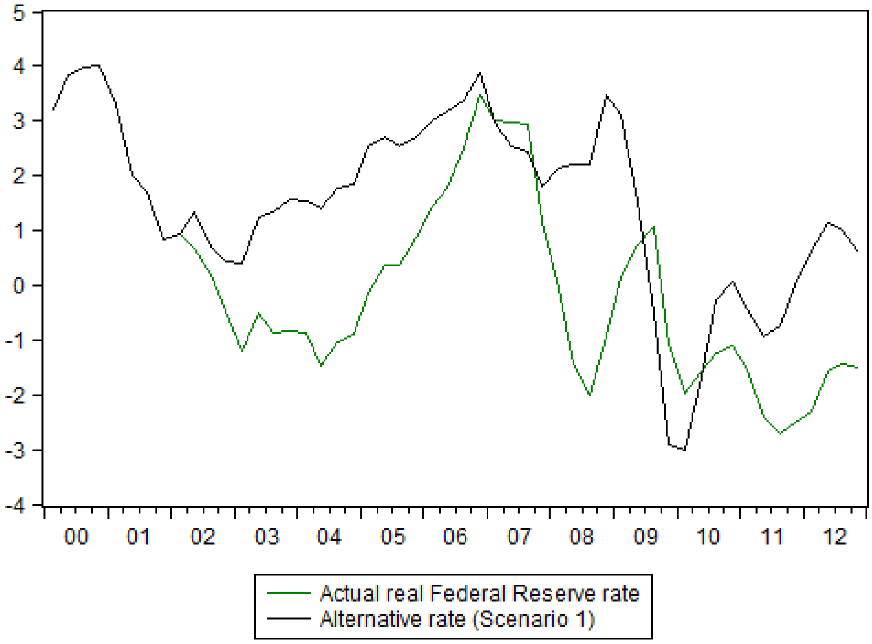
$$i = c + 1.5\pi + 0.5(\frac{y - y*}{y*}) \tag{5}$$

Here, y is GDP and $y*$ is potential GDP as computed by the Congressional Budget Office (CBO, 2014). The constant c is chosen - as in Taylor - so as to equate the actual and the alternative interest rate in the first quarter of 2002. Since the Federal Reserve sets interest rates relatively smoothly and does not mechanically adjust interest rates in accordance with a Taylor rule, the alternative interest rate has been smoothed by using a four-quarter moving average. Since real interest rates have been used in the estimation, the actual inflation rate is also subtracted from the alternative interest rate path.

This is obviously problematic since an alternative interest rate path would also have changed inflation. But results hardly differ if the above model is estimated with nominal interest rates and an alternative nominal monetary interest rate path is chosen. Further, the counter-factual model is only computed to better understand the magnitudes involved of alternative interest rates and less as a rigorous counter-factual exercise. The actual and the alternative interest rate path are shown in figure 11.

Figure 12 shows actual NAR housing prices, the baseline scenario in which housing prices are dynamically forecast given actual interest rates and mortgage credit

Figure 11: Alternative monetary policy interest rates

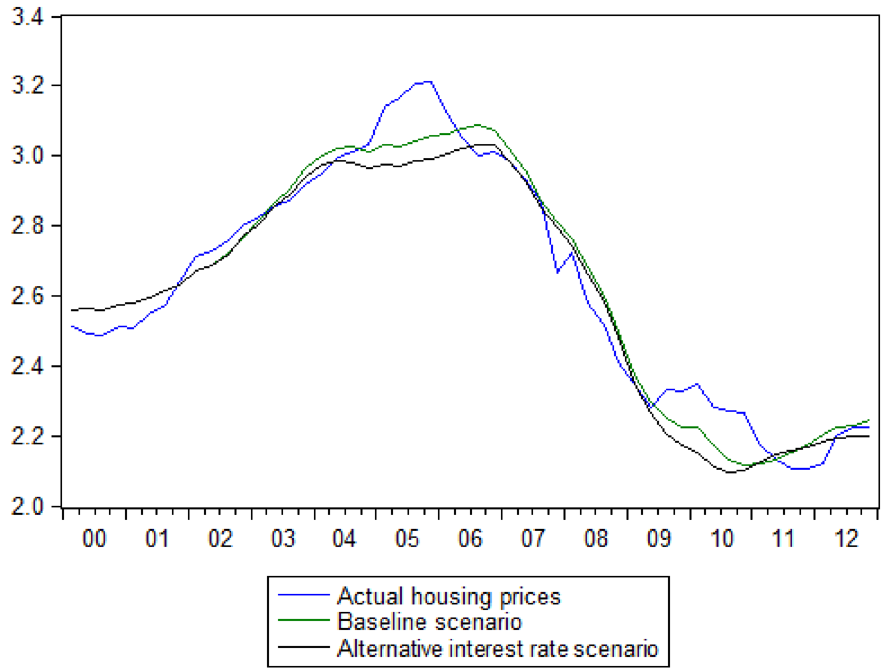


and the scenario with the alternative interest rate path. One can clearly see that there are hardly any differences between the baseline scenario and the alternative scenario although short term interest rates differ markedly. Neither the boom nor the subsequent bust would have been avoided.

This contrasts sharply with Taylor's conclusion that interest rates were key to understanding the housing boom. This might have different reasons. First, Taylor did not look at housing prices, but at the number of housing starts. No prices were used in his estimation but housing starts were strongly correlated with prices. Second, Taylor did not use mortgage credit in his specification. Further, since he did not publish his specification, it is also not clear how he reached his results. Different lag length, the use or non-use of lagged endogenous variables etc. are likely to make a difference for his results and for his counterfactual simulation. As already indicated, Taylor's results on the role of monetary policy are also in stark contrast to findings by many other authors who hardly find an important role for monetary policy rates (Gerlach and Peng, 2005; Del Negro and Otrok, 2007; Boivin et al., 2010; Dokko et al., 2011).

To conclude, the use of interest rates in the estimations does not improve markedly the explanatory power of the model and does not seem to be a key to understand the

Figure 12: Counter-factual interest rate path and housing prices



boom and bust in housing prices. The finding could be explained by a strong role of non-interest related conditions and standards for both the demand and supply of mortgage credit. Those could be income, maximum loan-to-value and income-to-value ratios etc., i.e. by variations of credit rationing. This is consistent with the argument that the deregulation of mortgage markets reduced exactly this rationing of credit as the shift from the conventional mortgage to more exotic mortgages in the last 30 years has shown.

Conclusion

The paper has investigated the question whether housing prices have driven mortgage credit or vice versa since the liberalization of the US mortgage market at the beginning of the 1980s. It has been argued that the liberalization is likely to have led to problems of moral hazard which is likely to have made it more attractive for lenders to increase their credit supply. This in turn might have incited purchasers of houses to increase their demand for housing beyond the point where housing prices are justified by fundamental values. Liberalized mortgage markets are thus likely to have led to the housing price bubble.

To test this hypothesis, two different models have been estimated with two different housing value measures. The results seems to vindicate the view that mortgage credit has indeed driven housing prices. Mortgage credit is weakly exogenous and does not adjust to the long-run relation between housing prices and credit. This indicates that it drives the long-run relation. But housing prices still Granger-cause mortgage credit so that there is no one-way interaction.

Impulse-response functions show that mortgage price shocks cause a response by housing prices but not vice versa. A variance decomposition shows that the variance of housing prices is due to mortgage credit but not the other way around. Finally, a forecast test shows that the dynamic of housing prices is better forecast when explained by mortgage credit than if mortgage credit is forecast by housing prices.

Contrary to assertions by Tayler (2007; 2009) or Leamer (2007), neither short-term monetary policy interest rates nor long-term mortgage market interest rates have an important effect on housing prices or mortgages, at least in the specification chosen. This is a finding that is consistent with the literature (Gerlach and Peng, 2005; Del Negro and Otrok, 2007; Boivin et al., 2010; Dokko et al., 2011).

Overall, more research is necessary to better understand the link between housing and the mortgage market. Especially important would be more disaggregated mortgage measures to better distinguish the effect of gross mortgages and repayments on housing markets.

References

Admati, Anat R., Pater M. DeMarzo, Martin F. Hellwig, and Paul Pfleiderer, "Fallacies, Irrelevant Facts, and Myths in the Discussion of Capital Regulation: Why Bank Equity is Not Expensive," *Rock Center for Corporate Governance at Stanford University Working Paper*, 2012, (86).

Adrian, Tobias and Hyun Song Shin, "Liquidity and Leverage," *Journal of Financial Intermediation*, 2009.

Allen, Franklin and Douglas Gale, "Bubbles, Crises, and Policy," *Oxford Review of Economic Policy*, 1999, *15* (3), 9–18.

_ **and** _ , "Bubbles and Crises," *The Economic Journal*, 2000, *110* (460), 236–255.

Ben-David, Itzhak, "Financial Constraints and Inflated Home Prices during the Real-Estate Boom," *Working Paper*, 2010.

Bernanke, Ben and Mark Gertler, "Agency Costs, Net Worth, and Business Fluctuations," *The American Economic Review*, 1989, *79* (1), 14–31.

Bernanke, Ben S. and Mark Gertler, "Inside the Black Box: The Credit Channel of Monetary Policy Transmission," *The Journal of Economic Perspectives*, 1995, *9* (4), 27–48.

Berndt, Antje and Anurag Gupta, "Moral Hazard and Adverse Selection in the Originate-to-Distribute Model of Bank Credit," *Journal of Monetary Economics*, 2009, *56* (5), 725–743.

Boivin, Jean, Michael T. Kiley, and Frederic S. Mishkin, "How has the Monetary Transmission Mechanism Evolved over Time?," *NBER Working Paper*, 2010, (15879).

Boyd, John H. and Stanley L. Graham, "Investigating the Banking Consolidation Trend," *Federal Reserve Bank of Minneapolis Quarterly Review*, 1991, (Spring).

Brissimis, Sophocles N. and Thomas Vlassopoulos, "The Interaction between Mortgage Financing and Housing Prices in Greece," *The Journal of Real Estate Finance and Economics*, 2008, *39* (2), 146–164.

Capozza, Dennis R. and Paul J. Seguin, "Expectations, Efficiency, and Euphoria in the Housing Market," *Regional Science and Urban Economics*, 1996, *26*, 369–386.

Case, Karl E. and Robert J. Shiller, "The Behavior of Home Buyers in Boom and Post-Boom Markets," *New England Economic Review*, 1988, (November), 29–46.

CBO, *The Budget and Economic Outlook: 2014 to 2024*, Congressional Budget Office, 2014.

Chomsisengphet, Souphala and Anthony Pennington-Cross, "The Evolution of the Subprime Mortgage Market," *Federal Reserve Bank of St. Louis Review*, 2006, *88* (1), 31–56.

Cole, Rebel A., Joseph A. McKenzie, and Richard A. Brown, "Moral Hazard, Portfolio Allocation, and Asset Returns for Thrift Institutions," *Journal of Financial Services Research*, 1992, *5* (4), 315–339.

Collyns, Charles and Abdelhak Senhadji, "Lending Booms, Real Estate Bubbles and the Asian Crisis," *IMF Working Paper*, 2002, (20).

Davis, Philip and Haibin Zhu, "Bank Lending and Commercial Property Cycles: Some Cross-Country Evidence," *BIS Working Paper*, 2004, (150).

Demyanyk, Yuliya and Otto Van Hemert, "Understanding the Subprime Mortgage Crisis," *Review of Financial Studies*, 2009.

Dokko, Jane, Brian M. Doyle, Michael T. Kiley, Jinill Kim, Shane Sherlund, Jae Sim, and Skander Van Den Heuvel, "Monetary Policy and the Global Housing Bubble," *Economic Policy*, 2011, *26* (66), 237–287.

Duca, John, John N. Muellbauer, and Anthony Murphy, "House Prices and Credit Constraints: Making Sense of the US Experience," *The Economic Journal*, 2011, *121* (May), 533–551.

Engle, Robert F., David F. Hendry, and Jean-Francois Richard, "Exogeneity," *Econometrica*, 1983, *51* (2), 277–304.

Fitzpatrick, Trevor and Kieran McQuinn, "House Prices and Mortgage Credit: Empirical Evidence for Ireland," *The Manchester School*, 2007, *75* (1), 82–103.

Gaffney, Mason, "The Role of Land Markets in Economic Crises," *American Journal of Economics and Sociology*, 2009, *68* (4), 855–888.

Gerlach, Stefan and Wensheng Peng, "Bank Lending and Property Prices in Hong Kong," *Journal of Banking & Finance*, 2005, *29* (2), 461–481.

Gilbert, R. Alton, "Requiem for Regulation Q: What it Did and why It Passed away," *Federal Reserve Bank of St. Louis Review*, 1986, pp. 22–37.

Gimeno, Ricardo and Carmen Martínez-Carrascal, "The Relationship between House Prices and House Purchase Loans: The Spanish Case," *Journal of Banking & Finance*, 2010, *34*, 1849–1855.

Goodhart, Charles and Mathias Hoffmann, "Deflation, Credit and Asset Prices," *HKIMR Working Paper*, 2003, (13).

Green, Richard K. and Susan M. Wachter, "The American Mortgage in Historical and International Context," *Journal of Economic Perspectives*, 2005, *19* (4), 93–114.

Hellwig, Martin F., "Systemic Risk in the Financial Sector: An Analysis of the Subprime-Mortgage Financial Crisis," *De Economist*, 2009, *157*, 129–207.

Himmelberg, Charles, Christopher Mayer, and Todd Sinai, "Assessing High House Prices: Bubbles, Fundamentals and Misperceptions," *Journal of Economic Perspectives*, 2005, *19* (4), 67–92.

Hofmann, Boris, "The Determinants of Bank Credit in Industrialized Countries: Do Property Prices Matter?," *International Finance*, 2004, *7* (2), 203–234.

Johansen, Søren, "Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models," *Econometrica*, 1991, *59* (6), 1551–1580.

_ , "Testing Weak Exogeneity and the Order of Cointegration in UK Money Demand Data," *Journal of Policy Modeling*, 1992, *14* (3), 313–334.

Jones, Kenneth D. and Tim Critchfield, "Consolidation in the U.S. Banking Industry: Is the "Long, Strange Trip" About to End?," *FDIC Banking Review*, 2005, *17* (4), 31–61.

Jorgenson, Dale W., "Capital Theory and Investment Behavior," *The American Economic Review*, 1963, *53* (2), 247–259.

Kindleberger, Charles P. and Robert Aliber, *Manias, Panics, and Crashes*, New Jersey: Wiley, 2005.

Kiyotaki, Nobuhiro and John Moore, "Credit Cycles," *Journal of Political Economy*, 1997, *105* (2), 211–248.

Leamer, Edward, "Housing is the Business Cycle," in Federal Reserve Bank of Kansas City, ed., *Housing, Housing Finance, and Monetary Policy*, 2007, pp. 149–233.

McCarthy, Jonathan and Richard W. Peach, "Monetary Transmission to Residential Investment," *FRBNY Economic Policy Review*, 2002, pp. 139–158.

_ **and** _ , "Are Home Prices the Next Bubble?," *FRBNY Economic Policy Review*, 2004, *December*, 1–17.

McDonald, Daniel J. and Daniel L. Thornton, "A Primer on the Mortgage Market and Mortgage Finance," *Federal Reserve Bank of St. Louis Review*, 2008, *90* (1), 31–45.

Mishkin, Frederic S., "Housing and the Monetary Transmission Mechanism," in Federal Reserve Bank of Kansas City, ed., *Housing, Housing Finance, and Monetary Policy*, 2007, pp. 359–413.

Negro, Marco Del and Christopher Otrok, "99 Luftballons: Monetary Policy and the House Price Boom across U.S. States," *Journal of Montetary Economics*, 2007, *54*, 1962–1985.

Ng, Serena and Pierre Perron, "Lag Length Selection and the Construction of Unit Root Tests with Good Size and Power," *Econometrica*, 2001, *69* (6), 1519–1554.

Oikarinen, Elias, "Interaction Between Housing Prices and Household Borrowing: The Finnish Case," *Journal of Banking & Finance*, 2009, *33* (4), 747–756.

Order, Robert Van and Ann Dougherty, "Housing Demand and Real Interest Rates," *Journal of Urban Economics*, 1991, *29*, 191–201.

Poterba, James M., "Tax Subsidies to Owner-Occupied Housing: An Asset-Market Approach," *The Quarterly Journal of Economics*, 1984, *99* (4), 729–752.

_ , "House Price Dynamics: The Role of Tax Policy and Demography," *Brookings Paper on Economic Activity*, 1991, *2*, 143–183.

Schularick, Moritz and Alan M. Taylor, "Credit Booms Gone Bust: Monetary Policy, Leverage Cycles, and Financial Crises, 1870-2008," *American Economic Review*, 2012, *102* (2), 1029–1061.

Sellon, Gordon H. and Deana Van Nahmen, "The Securitization of Housing Finance," *Economic Review*, 1988, (July/August).

Shiller, Robert J., "Understanding Recent Trends in House Prices and Home Ownership," in Federal Reserve Bank of Kansas City, ed., *Housing, Housing Finance, and Monetary Policy*, 2007, pp. 89–123.

Stiglitz, Joseph E. and Andrew Weiss, "Credit Rationing in Markets with Imperfect Information," *American Economic Review*, 1981, *71* (3), 393–410.

Taylor, John, "Housing and Monetary Policy," *NBER Working Paper*, 2007, (13682).

_ , "The Financial Crisis and the Policy Responses: An Empirical Analysis of what went wrong," *NBER Working Paper*, 2009, (14631).

White, Lawrence J., "A Cautionary Tale of Deregulation Gone Awry: The S&L Debacle," *Southern Economic Journal*, 1993, *59* (3), 496–514.

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