Mortgage Securitization and U.S. Housing Prices: A Cointegration Analysis

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Abstract

This paper examines the relationship between mortgage securitization, a proxy for credit marketability, and housing prices in the United States. Using cointegration techniques, I find that for the 1987-2009 period, there exists a positive long-run equilibrium relationship between real estate prices and the securitization of mortgages. Moreover, non-agency (private-label) mortgage-backed securities (MBS) have a greater long-run impact on housing prices than agency issued MBS. The results indicate that a 10% increase in the level of non-agency MBS as a proportion of total mortgages increases housing prices by approximately 2.9%. The results hold in both a bivariate and a multivariate setting, and are robust to alternative measures of housing prices and securitization.

Keywords: Real estate; Securitization; Credit marketability; Subprime lending

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Introduction

As every household consumes housing either by renting or owning a property, fluctuations in the real estate market have significant macroeconomic effects. The high interest rate period of the 1980s, the 2001-2006 real estate bubble and the 2007-2008 market crash certainly prompted an astonishing volume of literature to understand and identify comovements between housing prices and economic variables in the long-run. The intuition behind cointegration is the following: if housing prices and some economic fundamentals are cointegrated, they are then linked by a long-run equilibrium relationship. Even though they can diverge away from this relationship, market forces act to restore equilibrium in the long-run. There is mixed evidence regarding the existence of cointegration between housing prices and economic fundamentals. Malpezzi (1999) provides evidence of an equilibrium relationship for house price-to-rent ratio and also found the regulatory environment to be an important determinant of this equilibrium. Zhou (2002) uncovers evidence of linear and non-linear cointegration between housing prices and fundamentals such as income, construction costs, and mortgage rates only for certain U.S. States. In opposition, Galin (2006) rejects the cointegration hypothesis and argues Malpezzi's unit root tests overestimate the likelihood of cointegration.

One shortcoming shared by most studies is that they do not incorporate one of the most fundamental transformations of the real estate market of the last four decades: the development of securitization. This process of pooling mortgages as securities radically changed the credit markets dynamics. From 1987 to 2007, the private issuance of mortgage-backed securities increased its market share of the mortgage market from 3 percent to 36 percent in 2007. The sector then experienced an abrupt decline to a 22 percent market share in only three years. Most studies focus on the role of the interest rate or income, but ignore the contribution of credit marketability.

This paper considers the role of securitization, a proxy for credit marketability, by testing the long-run equilibrium relationship between housing prices and the securitization of mortgages. I find a positive relationship between real estate prices and mortgage securitization. I also investigate the differences between agency and non-agency MBS in terms of their impact on the housing market.[1] The results suggest that private issuance of MBS has greater effects on real estate prices than government issuance. The remainder of this paper is organized as follows. Section 1 presents a supply and demand model of real estate prices, reviews the securitization literature and identifies the channels that link housing prices and securitization. Then, Sections 2, 3, and 4 introduce the data, the methodology, and the results. Section 5 performs robusteness tests, and Section 6 concludes.

1 The Model

1.1 A Supply and Demand Model of Real Estate

The following analysis of securitization as a long-run determinant of housing prices is based on a simple reduced-form supply and demand model of real estate introduced by Zhou (2010). The long-run housing demand curve is composed of exogenous demand shifters such as income, credit market conditions, mortgage rates, unemployment rate, etc. Furthermore, the supply curve shifters include construction costs, interest rates, and any regulation regarding construction costs. The economic fundamentals I use in this study are presented in Section 2. Mainly due to the time required to complete a transaction, tax considerations, as well as carrying and trans-

[1] The agency MBS will also be refered as government MBS, while non-agency MBS will be refered as private MBS.

action costs, the real estate market is often characterized as being inefficient. Shiller (2003) found the elasticity of supply to be low and especially downward sticky. This is mainly caused by a widening bid-ask spread when demand falls. Essentially, sellers are reluctant to cut prices and it is often perceived as a last resort option. The housing demand is given by:[2]

$$\text{Housing demand} = \left\{ \; D_t = \alpha P_t + \beta' Z_t + \mu_{td} \right. \tag{1}$$

Where Z_t is a kx1 vector of exogenous housing demand determinants, while β is k_1x1 vectors of coefficients. The housing supply is given by:

$$\text{Housing supply} \; = \left\{ \; S_t = \lambda P_t + \phi' W_t + \mu_{ts} \right. \tag{2}$$

Where W_t is a kx1 vector of exogenous housing supply determinants and ϕ is k_2x1 vectors of coefficients. The implied housing market equilibrium yields a price given by:

$$\text{Housing market equilibrium} = \left\{ \; P_t = \tfrac{-\beta'}{\alpha-\lambda} Z_t + \tfrac{\phi'}{\alpha-\lambda} W_t + \mu_t \quad D_t = S_t \right. \tag{3}$$

The resulting equilibrium price, P_t (1x1), is a linear function of supply and demand factors. Moreover, under the assumption that μ_{td} and μ_{ts} are independent and both white noise, the resulting $\mu_t = \frac{\mu_{ts}-\mu_{td}}{\alpha-\lambda}$ of the equilibrium equation (3) is also white noise.

Linear cointegration between housing prices and economic fundamentals implies that a linear combination of integrated of order one fundamentals ($I(1)$) is stationary ($I(0)$). Therefore, if cointegration exists, the residuals, μ_t, from equation (3) are white noise. A detailed explanation of the cointegration analysis and tests follows in Section 2.

[2] The set of equations could also be written in log-linear form.

1.2 Securitization: An Overview

This section presents an overview of the asset securitization process, the key players, and market dynamics and frictions.

The securitization process

As a general definition, securitization is the process through which several similar contractual debts are pooled and sold as debt securities to investors. A mortgage securitization is completed in several steps, each typically performed by specialized financial institutions. First, an approved mortgagor or borrower obtains a mortgage from a financial institution, the originator, who then pools several mortgages. A key player, the issuer (or arranger) buys and transfers the mortgage pool in a special purpose vehicle (SPV or trust). The arranger, compensated through a fee, finally consults credit rating agencies and underwrites the securities issued by the SPV. The mortgage-backed securities (MBS) are then ready to be sold to investors, often through an intermediary called the asset manager. Depending on the securities, payments on principals and interest are passed to investors each month by the main manager of the trust, the servicer.

Agency and Non-Agency Mortgage-Backed Securities

The distinction between the characteristics of the securities issued by the various originators is crucial in assessing the long-run relationship between housing prices and the securitization of mortgages. The oldest and main category of MBS is the government agency. These securities are released by either a government agency (GA), such as the Government National Mortgage Association (Ginnie Mae), or by a Government-Sponsored Enterprise (GSE). The main GSEs, well known for being insolvent and taken over by the U.S. government in the midst of the financial crisis, are the Federal Home Loan Mortgage Corporation (Freddie Mac) and the Federal

National Mortgage Association (Fannie Mae). Both the GAs and the GSEs explicitly guarantee the interest and principal payments to owners of the mortgage-backed securities. The main difference is the default risk faced by investors.[3] While the government explicitly backs the securities issued by Ginnie Mae, investors are not protected from a Fannie Mae or Freddie Mac default. Many specialists argue that most investors assumed a government bailout of the GSEs in case of insolvency. Furthermore, Ginnie Mae and GSEs are both subject to regulatory oversight. They can only securitize conforming loans, which are subject to specific underwriting guidelines. Conforming loans must meet several criteria including debt-to-income ratio limits, documentation requirements, and loan-to-value ratios.

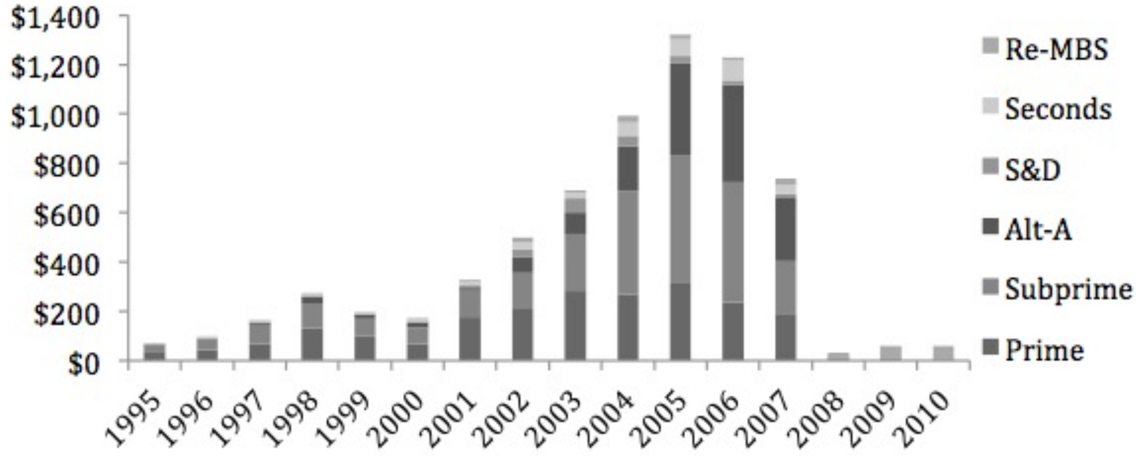
The second group, non-agency, is composed of MBS privately securitized by investment banks, various types of financial institutions or home building companies. Non-conforming loans, such as Jumbo, Alt A, and Subprime, are most often financially engineered to create exotic mortgage-backed securities. Unlike agency MBS, these non-agency securities are very heterogeneous; they often have very complex payoffs and structures. These securities are therefore not only difficult to price, but accurately assessing their true risk is extremely challenging. Many non-agency MBS do not necessarily guarantee timely payments of interest and principal. Hence, investors face an interest rate and credit risk far greater with these private-label securities. Figure 1 describes the non-agency issuance of MBS for the 1995-2010 period. More than half of private MBS are composed of non-prime riskier loans and this proportion grew considerably between 2002-2006.

A brief history of securitization

The roots of securitization lie in the volatile interest market of the 1970s. As

[3] This was before both GSEs got taken over by the U.S government.

Figure 1: Non-Agency MBS Issuance, 1995-2010



[a] Source: Inside Mortgage Finance, "2011 Mortgage Market Statistical Annual", 2:31;
[b] Most prime mortgages are also conforming loans. Alt-A and Subprime (riskier) loans accounted for most private-label MBS issuance and volume growth from 2002-2007.
[c] All figures are in real year=2010 USD (Billions).

financial institutions tended to operate regionally, they were vulnerable to local economic conditions and faced high interest rate risks on their loan portfolios. A significant step towards globalization was taken in 1970 when Ginnie Mae bundled together thousands of mortgages to create the first mortgage-backed security. Banks could suddenly reduce their exposure to local economic shocks, save on the monitoring costs of the underlying cash flows, while reducing their capital requirements. More importantly, it allowed banks to adjust their portfolios so that the maturity of its deposits matched that of its assets, thereby reducing their exposures to changes in the interest rate. Until the early 1980s, the securitization market consisted almost entirely of agency MBS (GA and GSE). After Fannie Mae issued the first collateralized debt obligation (CDO), which divides the cash flows and risk levels into tranches, market agents realized all the flexibility and possibilities associated with securitization. A wave of financial innovations started and the private MBS sector started to gain market share.

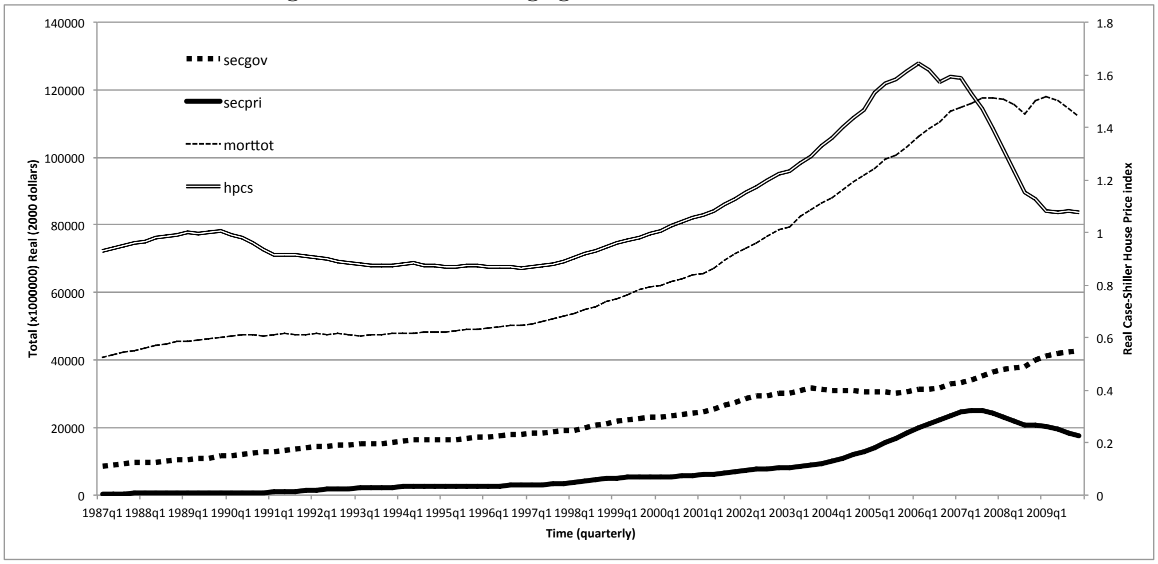
Throughout the 1990s and early 2000s, GSEs and government agencies were still the dominant and most influential players in the MBS market. In 2003, 62 percent of the mortgages were conforming loans. Starting in early 2000, the market power shifted from GSEs to private issuers for several reasons. The higher concentration in the mortgage origination market and the higher demand for non-conforming loans brought the conforming loan market share down to 33 percent in 2006. As the housing market started to collapse in late 2006, the risk associated with private label MBS was unveiled and the market for non-agency mortgage-backed securities essentially vanished. Thanks to the federal government takeover of Fannie Mae and Freddie Mac in September 2008 and the establishment of policies aimed at driving up the demand for housing, the agency MBS market recovered after 2006.

Figure 2 presents the evolution of the mortgage, securitization, and housing market for the 1987-2009 period. Figure 3 displays similar information, but agency and non-agency MBS are represented as a share of the total mortgage market. The agency market share grew from 1987 to 2002 and then declined considerably for four consecutive years. This market then recovered when the housing bubble collapsed in late 2006. Both the level and market share of non-agency MBS follow the pattern of the Case-Shiller House Price index very closely.

1.3 Securitization as a Long-Run Determinant of Housing Prices

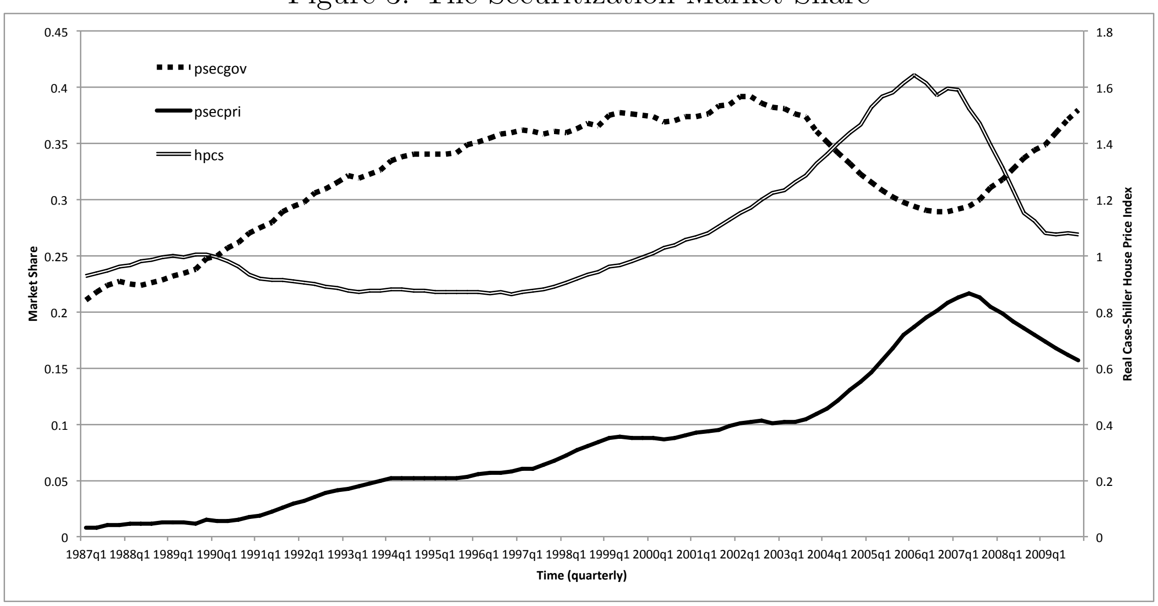
There are several channels through which securitization and housing prices can affect each other. First, securitization influences the housing market through credit marketability. Katz (1997) argues securitization has deepened, and broadened, the mortgage market. In traditional banking, when a bank has a loan on its balance sheet, its capital requirement increases. A higher capital requirement reduces the financial institution's ability to lend further. In the case of mortgage-backed

Figure 2: The Mortgage Securitization Market



[a] Source: Board of Governors of the Federal Reserve system.
[b] All the variables are expressed in real year=2000 dollar.

Figure 3: The Securitization Market Share



[a] Source: Board of Governors of the Federal Reserve system.
[b] All the variables are expressed in real year=2000 dollar.

securities, newly issued loans are quickly sold to investors, thus removing the capital requirement constraint. In the securitization process, financial institutions, as intermediaries between investors and homebuyers, reduce informational barriers. This is mainly due to the fact that financial institutions specialize in lending and benefit from economies of scale. Moreover, with securitization, investors can hold shares of a diversified loan portfolio. This greater credit marketability allows an expansion of the mortgage market, and equivalently, a shift of the housing demand curve. Empirically, Meen (2008) finds that credit rationing has large effects on the user cost. The relatively modest reductions of the U.K. mortgage interest rates in 2008 were insufficient to offset the effects of the shortage of mortgage funds. This highlights the importance of the link between credit marketability and housing prices.

Second, the effects of securitization on the housing market go beyond the more "complete" credit market explanation. Mortgage-backed securities can increase the demand for housing directly by allowing several types of borrowers, most of whom would not receive a mortgage approval in traditional banking, to enter the market. While higher income and lower interest rates are expected to increase demand for real estate, this new level of consumption depends heavily on the ability to get a mortgage approval (i.e the supply of loans). Ashcraft and Schuermann (2008) argue that the availability of subprime loans and non-conventional borrowing options such as home equity lines of credit (HELOC) has allowed agents to speculate on real estate. Moreover, at the MSA level, Goetzmann (2011) finds past home-price increases are associated with more subprime applications, higher loan-to-income ratio, and lower loan-to-value ratio of both prime and subprime mortgage applications. Barlevy and Fisher (2011) find that the use of backloaded payments, specifically interest-only (IO) mortgages between 2000 and 2008, was highly concentrated in cities that experienced large boom-bust cycles. They provide evidence that IO loans are not a proxy for other mortgage characteristics such as subprime, securitization, or high leverage. Moreover, at the city level, they find a positive significant relationship between the share of mortgages privately securitized and house price appreciation, but not a significant relationship after controlling for the share of IOs.

Third, several factors and frictions can amplify the effects of securitization on the housing market. As pointed out by Levitin and Wachter (2012), by acting as intermediaries, banks do not bear the risks of the mortgages they issue and have an incentive to loosen lending standards.The results in Keys et al.'s (2010) also suggest that existing securitization practices adversely affect the screening incentives of subprime lenders. Moreover, rating agencies, which are paid by the security issuers, have an incentive to assign higher ratings to secure future business. As noted by Shiller (2003), irrational expectations about future price appreciation foster the housing demand from homebuyers and also from investors looking for the high returns provided by mortgage-backed securities. These factors all tend to further increase the demand for housing (i.e higher prices).

Finally, there exist other indirect relationships that link securitization and housing prices. Kolari, Fraser, and Anari (1998) find mortgage yields tend to decline with the growth of securitization. Lower mortgage yields usually coincide with lower mortgage rates, thereby stimulating real estate investments. Also, Estrella's (2002) results indicate that securitization diminishes the degree to which a given change in monetary policy can influence real output. He argues this does not originate from of a loss of control over the interest rate, but from non-interest rate effects, such as the liquidity and credit channels. The same phenomenon might occur in real estate, where securitization could act as a buffer to a change of the interest rate. When estimating an OLS regression with housing prices as the dependent variable, Shiller (2003) finds insignificant coefficients for the mortgage rates. This contradicts standard economic theory since mortgage payments represent the main cost of buying a home.

The preceding analysis raises important questions. Does an increase in mortgage securitization have the same effect as an equivalent increase in non-securitized mortgages? If this is the case, housing prices are probably cointegrated with the amount of mortgages on the market and not necessarily with securitization specifically. Furthermore, Levitin and Wachter (2012) argue the last housing bubble can be explained mainly by an oversupply of mispriced mortgage finance coming from unregulated private-label mortgage-backed securities (non-agency MBS). Pavlov and Wachter (2010) find regions with a high concentration of aggressive lending instruments experienced larger price increases and declines than the ones with a low concentration. If this holds, non-agency MBS should a have larger effect on housing prices than agency MBS. I consider these issues by testing separately for cointegration between housing prices and the respective market share of agency and non-agency MBS.

2 Methodology

2.1 Data

The securitization data used in this study is constructed according to the procedure followed by Estrella (2002). The data is available from the Board of Governors of the Federal Reserve System Flow of Funds database. The total value of agency MBS, *secgov*, is the sum of agency and GSE-backed mortgage pools. The total value of non-agency securitized mortgages, *secpri*, is the outstanding dollar volume of MBS issued by asset-backed security issuers. The market value of all mortgages, *morttot*, is obtained by summing the mortgage liabilities of the market agents. The variable, *sectot*, is equal to the sum of *secpri* and *secgov*. The percentage of agency-securitized mortgages, *psecgov*, is simply the ratio $secgov/morttot$. I obtain the percentage of non-agency securitized mortgages, *psecpri*, by calculating the ratio *secpri*/*morttot*. This raw securitization data is not seasonally adjusted. An analysis using the Arima X-12 software revealed no seasonal pattern.[4] For house prices, I use the seasonally adjusted composite S&P Case-Shiller National Housing Price index. The Case-Shiller index is calculated from data on repeat sales of single-family homes.

I use quarterly data starting in the first quarter of 1987[5] until the fourth quarter of 2009. I also obtain the respective consumer price index that includes all items less shelter from the U.S. Bureau of Labor Statistics and use it to convert variables to real values.[6] I also consider most of the real estate fundamental determinants used by Meen (2002), Shiller (2003), Malpezzi (1998), Zhou (2010), and Hwuang and Quigley (2006). I consider building costs, interest rates, the output gap, GDP, productivity, a financial obligation ratio, the unemployment rate, personal disposable income per capita, and population. Aside from the unemployment rate, the interest rates and the various securitization variables (in levels), the variables are all log-transformed. A detailed summary of all the variables, the transformations and the sources is presented in Table 12 and Table 13 of the Appendix. Table 1 presents some descriptive statistics of the variables: the number of observations, the mean, the standard deviation, and the minimum and maximum values.

2.2 Cointegration analysis

Unit root tests

A valid cointegration test requires each variable to be non-stationary in level, but stationary in first-difference (Integrated of order 1). I test the order of integration using two widely used tests: the Augmented Dickey Fuller (ADF) test and the

[4]The Arima X-12 performs two different F-tests to detect the presence of seasonality: a test for the presence of seasonality assuming stability and a moving seasonality test.

[5]Many securitization series start in 1987.

[6]The same method was used by Zhou(2010).

Table 1: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
hpcs	92	1.08	0.23	0.86	1.64
hpoecd	92	0.77	0.13	0.64	1.05
hprent	92	0.86	0.11	0.69	1.15
secgov	92	22.5	9.4	8.6	42.6
secpri	92	7.5	7.7	0.3	25.1
sectot	92	29.9	16.7	8.9	61.6
morttot	92	7.46	7.67	0.30	25.13
psecgov	92	0.32	0.05	0.21	0.39
psecpri	92	0.09	0.06	0.01	0.22
cpihp	92	97.0	16.5	67.2	128.5
cost	92	1.03	0.04	0.95	1.13
mort30rate	92	7.61	1.60	4.92	10.85
fedrate	92	4.54	2.33	0.12	9.73
govbondrate	92	5.95	1.70	2.74	9.21
outgap	92	-49.3	253.9	-1016.4	384.3
gdp	92	92.0	15.9	68.6	117.3
productivity	92	99.8	15.4	78.7	128.2
for	92	0.10	0.01	0.09	0.11
unemployment	92	5.6	1.3	3.8	10.8
incomepc	92	27444	3621	21929	33824
population	92	275	20.1	241	308

[a] All the variables are expressed in real year=2000 dollar
[b] To facilitate interpretation, the variables presented are not log-transformed
[c] All variables are quarterly: 1987q1-2009q4

Phillips-Perron (PP) test for a unit root. In short, if we fail to reject the null hypothesis of a unit root in level and reject the null hypothesis of a unit root in first-difference, we can conclude the variable is integrated of order one. Both the ADF and PP test involve an estimation of the following regression:

$$\Delta y_t = \gamma y_{t-1} + \alpha t_t + c + \mu_t$$

We reject the null hypothesis of a unit root if $\gamma = 0$. The critical values for the test statistic can be found in Davidson and Mackinnon (1991). To ensure an appropriate specification for the ADF tests, I choose the optimal number of lags to include using the Schwarz Information Criterion (SIC). Ivanov and Killia (2001) provide evidence of more accurate results using the SIC with quarterly data and a small sample size. Then, I estimate the model with a deterministic time trend and a drift. To select a parsimonious model, if the trend is not significant, I estimate the model only with a constant. I finally eliminate the constant from the regression if it is not significant. In ADF tests, I correct for autocorrelation by including additional lags of Δy_t. The Phillips-Perron test employs a similar approach, but instead of adding lags of the dependent variable to correct for serial correlation, it uses the Newey-West heteroskedasticity and autocorrelation-consistent covariance matrix estimator. I use the same approach as the ADF case to handle the deterministic time trend and the drift term.

Cointegration tests

Two types of approach are widely used to test for cointegration. First, the Engel-Granger test investigates, using a single equation, whether the residuals from the possibly cointegrated equation are stationary.[7] The Johansen approach uses the following model written in vector error correction form:

$$\Delta Y_t = \Pi Y_{t-1} + \Gamma_1 \Delta Y_{t-1} + \Gamma_2 \Delta Y_{t-2} + ... + \Gamma_j \Delta Y_{t-j} + c + \epsilon_t$$

Where:

Y_t is a vector of jx1 integrated of order one variables,

Γ_1, Γ_2, Γ_j, Π are jxj matrices of unknown parameters.

c is a jx1 vector of drift terms and

ϵ_t is a jx1 is a vector of residuals

The matrix Π can be expressed as $\Pi = \alpha\beta'$, where α represents the speed of

[7] This corresponds to the supply and demand model presented in Section 1.

adjustment to the long-run equilibrium and β is the error correction coefficient matrix representing the long-run equilibrium. Both α and β are matrices with p rows and r (rank of matrix Π) columns. The main goal behind the test is to determine the rank of the matrix Π, which represents the number of cointegrating relationships. Johansen's (1988) test obtains a likelihood ratio, called the trace statistic:

$Trace = -T \sum_{i=1}^{k+1} ln(1 - \hat{\Lambda}_i)$ for the multivariate case

$Trace = -Tln(1 - \hat{\Lambda}_{max})$ for the bivariate case

The null hypothesis is that the number of cointegrating relationships is lower or equal to r. The alternative is that there are more than r cointegrating relationships. The null is rejected if the trace statistic is greater than the critical value of the test statistic. Details regarding the Johansen method and the test's critical values can be found in Johansen (1988) and Hamilton (1994). I select the optimal number of lags to include in the Johansen test according the SIC statistics, which was proven superior in small samples of quarterly data.[8] If I find no cointegration, I perform the test with a different number of lags, usually higher, according to the AIC statistics. If the test is negative again, I conclude there is enough evidence to reject the presence of a cointegrating relationship.

The second method, the Engel-Granger approach, is very similar to the ADF test for a unit root previously described. As Zhou (2010) remarks, this method has low power in a small samples and does not incorporate system dynamics. For these reasons, this paper strictly uses the Johansen Likelihood Ratio Test for the multivariate models. For bivariate cointegration tests, I use both techniques for comparison and robustness purposes.

[8]Ivanov and Killia (2001)

3 Empirical Results: Bivariate Analysis

3.1 Unit Root Tests

Table 2 presents the results from both Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) tests for unit root. The results from the ADF tests indicate that all the variables are non-stationary in level at the 5 percent level of significance, except for *psectot*. Similar results are obtained with PP tests, but are not reported in Table 2. In first-difference, using the Phillips-Perron approach, we reject the null hypothesis of a unit root for all the variables; however, for the ADF tests in first-difference, we fail to reject the null of non-stationarity for several variables. I further investigate the autocorrelation function and the partial autocorrelation function of the variables by visual inspection. The first lags are far below one and all the series oscillate around a mean of 0; although, some periods of high volatility are present. I conclude there is enough evidence to assume for the rest of the analysis that the variables are integrated of order one. Under this assumption, a Johansen Test is appropriate.

3.2 Bivariate Cointegration Tests

Table 3 presents the results from Johansen and Engel-Granger cointegration tests. As mentioned in Section 2, the Johansen test enjoys greater power than its counterpart. This might partially explain why several variables tested are cointegrated only with the Johansen method. Mortgage securitization appears to be an important long-run determinant of real estate prices. In level, government securitized mortgages and the total amount of mortgages on the market are cointegrated with housing prices. More importantly, the market share of agency and non-agency MBS also share a long-run relationship with housing prices. Several housing fundamentals also appear to be individually cointegrated with housing prices. This contradicts

Table 2: Unit-Root Tests

	Dickey-Fuller	Dickey-Fuller	Phillips-Perron
Variable	Level	First-Difference	First-Difference
hpcs	$-1.623(1)$	$-1.989^{**}(2)$	-2.754^{***}
secgov	$3.886(4)$	$-2.298^{c}(4)$	-5.514^{***tc}
secpri	$-3.230^{*tc}(1)$	$-1.599(1)$	-1.845^{*}
sectot	$-1.862^{tc}(1)$	$-1.291(7)$	-4.117^{***c}
morttot	$-3.073^{tc}(1)$	$-1.050(0)$	-3.127^{***}
psecgov	$-1.030(3)$	$-1.709^{*}(2)$	-3.422^{***}
psecpri	$-1.632^{c}(2)$	$-1.703^{*}(3)$	-7.747^{***tc}
psectot	$-2.944^{***}(2)$	$-2.368^{**}(2)$	-6.096^{***tc}
cost	$-1.600(1)$	$-2.192^{**}(7)$	-6.160^{***}
mort30rate	$-2.248^{tc}(9)$	$-6.953^{***}(4)$	-15.88^{***}
fedrate	$-2.243^{tc}(8)$	$-6.155^{***}(4)$	-15.61^{***}
govbondrate	$-1.780^{tc}(11)$	$-6.888^{***}(0)$	-15.98^{***}
outgap	$-1.372(1)$	$-3.618^{***}(4)$	-5.462^{***}
gdp	$3.687(1)$	$-1.271(8)$	-5.819^{***tc}
productivity	$-1.798^{tc}(0)$	$-1.949^{c}(8)$	-9.014^{***}
for	$-0.350^{\prime}(2)$	$-2.368^{**}(4)$	-7.390^{***}
unemployment	$0.403(1)$	$-1.810^{*}(4)$	-3.540^{***}
incomepc	$2.683(3)$	$-0.871(4)$	-10.461^{***}
population	$-0.559^{tc}(9)$	$-4.726^{***tc}(8)$	-4.426^{***tc}

[a] (*) denotes 10% significance, (**)=5%, (***)=1%
[b] The null hypothesis of the test statistic: A unit-root is present (non-stationarity).
[c] (1) refers to the chosen number of lags.
[d] c indicates an intercept was included.
[e] t indicates a trend was included.
[f] All the variables are transformed according to Table 12 of the Appendix.

several studies that find no cointegration between housing prices and its determinants.

3.3 Bivariate VECM Estimation

Table 4 presents the estimated normalized coefficients of the cointegrating equation of different bivariate vector error correction models. The long-run relationship between housing prices and various measures of securitization can be written as:

$hpcs = 0.0654 * psecgov + 0.303$ Agency MBS market share of the mortgage market

Table 3: Bivariate Cointegration Tests - Housing Prices and Fundamentals

Variable	Johansen Test	Engel-Granger Test
	Rank	Rank
secgov	1(2)	1(1)
secpri	1(1)	1(3)
sectot	1(2)	0
morttot	1(3)	1(3)
psecgov	1(2)	0
psecpri	$1^{aic}(9)$	1(3)
psectot	0	1(3)
cost	1(2)	0
mort30rate	1(2)	0
fedrate	1(8)	0
govbondrate	1(2)	0
outgap	1(4)	0
gdp	1(4)	$1^{aic}(7)$
productivity	0	$1^{aic}(3)$
for	$1^{aic}(8)$	0
unemployment	$1^{aic}(4)$	0
incomepc	$1^{aic}(9)$	0
population	1(6)	0

[a] 1 indicates cointegration is present, 0 indicates no cointegration.
[b] (1) refers to the chosen number of lags.
[c] The number of lags is chosen according to the SIC statistics. When no cointegration is found, a higher number of lags is tried according to the AIC statistics. This case is denoted by ^{aic}.

$hpcs = 0.292 * psecpri + .639$ Non-agency MBS market share

$hpcs = 0.022 * secgov - 0.339$ Agency MBS in level

$hpcs = 0.027 * secpri - 0.142$ Non-agency MBS in level

$hpcs = 0.004 * morttot - 0.345$ Total mortgage market in level

Several important conclusions can be drawn from these results. First, there is a clear positive relationship between housing prices and mortgage securitization. If the level of non-agency MBS increases by 100 billion, house prices tend to increase by approximately 2.7 percent. Similarly a 100 billion increase in agency MBS results in a 2.2 percent house price increase. If the same increase occurs in the overall mortgage market, prices will adjust positively by approximately 0.4 percent. All coefficients are significant at the 5% level of significance. Another indication that securitization has a more important effect on housing prices than simple non-securitized mortgages can be seen through the cointegrating equations of the agency and non-agency market share. If the level of non-agency securitized mortgages over the total mortgage market increases by 10% (e.g. from 50 to 55%), housing prices will increase by approximately 2.9%. The same percentage increase of the level of agency MBS over the total mortgage market leads to an increase of only 0.0654%.[9] This higher effect of privately securitized mortgages potentially indicates that the nature of the loans composing the security is very important. More precisely, riskier loans such as Subprime, Alt A or Jumbo might have larger long-run effects on real estate prices than conforming loans.

3.4 Bivariate Impulse Response Functions

I investigate the time path of the relationship between housing prices and securitization by generating impulse response functions (IRF). An IRF describes the response of a variable after s periods ($Y_{i,t+s}$) to a one unit shock to another variable at time t ($Y_{j,t}$). For example, a possible IRF graphs the effects of an unpredicted change in the level of securitization on housing prices overtime. With standard IRFs, it is difficult to interpret the effects of a particular shock because the residuals of each equation are contemporaneously correlated. This contemporaneous correlation implies that a shock to the securitization market is accompanied simultaneously by a shock to housing prices. To allow a causal interpretation of impulse response functions, we use a Cholesky Orthogonalization where we orthogonalize the variance covariance matrix of the errors. These transformed innovations are uncorrelated both across time and

[9] The coefficient is not signicantly different than zero.

Table 4: Bivariate VECM Estimation-Cointegrating Equation

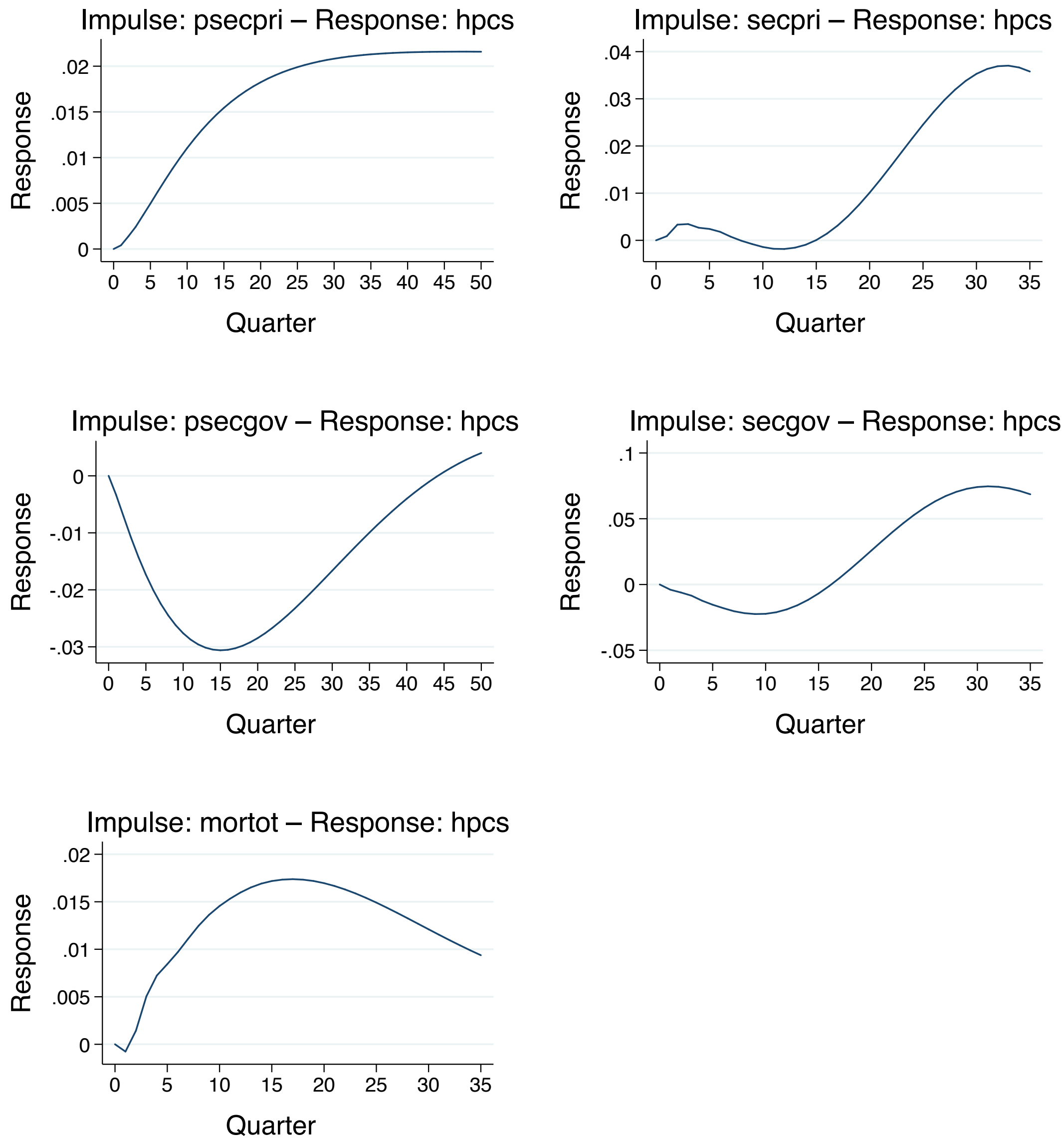
Variables	Beta coefficient	Std. Err.	C.I lower	C.I upper
psecpri-hpcs				
psecpri	-0.292^{*}	0.102	-0.492	-0.092
cons	-0.639^{*}	0.270	-1.167	-0.110
psecgov-hpcs				
psecgov	-0.0654	0.291	-0.636	0.505
cons	-0.303	0.331	-0.952	0.345
secpriv-hpcs				
secpri	-0.027^{*}	0.003	-0.034	-0.020
cons	0.142^{*}	0.028	0.086	0.198
secgov-hpcs				
secgov	-0.022^{*}	0.003	-0.028	-0.016
cons	0.339^{*}	0.067	0.207	0.471
morttot-hpcs				
morttot	-0.004^{*}	0.001	-0.006	-0.002
cons	0.345^{*}	0.044	0.258	0.432

[a] A Johansen normalization restriction of 1 is imposed to hpcs.
[b] (*) indicates the coefficient is significant at the 5% level of significance.
[c] The *psecpri* and *psecgov* VECM are estimated with 3 lags.
[d] The *secpri*, *secgov* and *morttot* VECM are estimated with 4 lags.

across equations.[10] Figure 4 presents graphically the response of housing prices to a one unit positive shock to the orthogonalized innovations of the securitization variable. A shock to *psecpri* translates immediately into a house price increase. The process reaches its full effect only after 40 quarters. The housing price response to a similar shock to *psecgov* is negative for approximately 15 quarters and dies after 40 quarters. Also, a shock to both agency and non-agency MBS in level takes about 10 quarters to translate into higher real estate prices. A shock to the level of mortgages affects prices positively right away and for several quarters. Overall, these results indicate that securitization does not have a transitory effect on housing prices, but rather a permanent effect.

[10] More details regarding impulse response functions are available in Hamilton (1994) and StataCorp. (2009).

Figure 4: Bivariate Orthogonalized Impulse Response Function



[a]The impulse response functions represent the response of housing prices to a one unit shock to the orthogonalized residuals of one variable.
[b]The software used for the analysis, Stata 12, does not calculate confidence intervals for VECM estimations.

3.5 Bivariate Granger Analysis

Table 5 presents the results from short-run Granger causality tests on several bivariate VECM. Unlike the interpretation of the parameters in the cointegrating equation, Granger causality does not refer to the standard causation. A variable x Granger causes y if past values (information) of x help forecast future values of y (i.e. usually one period ahead). Short-run Granger causality is associated with the statistical significance of the first-difference lagged coefficients[11] of the VEC representation. Granger causality for *psecgov* and *secgov* is significant in both directions.

As mentionned in Section 1, several theorical models predict a negative relationship between GDP and securitization. During a recession, it is usually harder for banks to obtain external funding to meet the capital requirement associated with a new mortgage and rely more heavily on securitization. The results presented in Table 5 support this view. GDP Granger causes government securitization and the second lag first difference coefficient is negative.[12] Following a decrease in GDP, the model forecasts a market share increase of government securitized mortgages. This is not the case for non-agency MBS as there is no evidence of Granger causality between *gdp* and *psecpri*.

While several studies consider income to be an important determinant of housing prices, the results presented in Table 3 do not support the existence of a long-run relationship. Cointegration is found only with a very high number of lags suggested by the AIC. Further investigation reveals that housing prices Granger cause income, but not the reverse. If the typical household's response to higher income is to consume housing of superior quality rather than simply buying a second home, no cointegration should be found after correcting for housing quality.[13] This hypothesis is consistent with the results obtained using the Case-Shiller House Price index, which is a quality-

[11]Granger is present if the coefficients are jointly sigificantly different than zero.

[12]Of all the short-run parameters, only the second lag of the first-difference of *gdp* in the *psecgov* equation is significant.

[13]The demand curve for housing does not shift in this case and housing prices are unaffected by the change in income.

adjusted house price index.

Table 5: Bivariate Granger Causality Tests

Short-Run
hpcs-psecpri
hpcs-secpri
hpcs$\Longleftrightarrow$psecgov
hpcs$\Longleftrightarrow$secgov
hpcs$\Longrightarrow$morttot
gdp$\Longrightarrow$psecgov^e
gdp-psecpri^e
hpcs$\Longrightarrow$incomepc^e

[a] Each Granger causality test is performed after estimating a bivariate VECM with 3 lags.
[b] The short-run Granger causality test is a Wald test on the short-run coefficients using the 5% level of significance.
[c] A$\Longrightarrow$B indicates that A Granger causes B. We reject the null hypothesis that the short-run coefficients of the variable A in the B equation are equal to zero.
[d] A-B indicates an absence of Granger causality.
[e] The variables are cointegrated when using the number of lags suggested by the AIC statistics.

4 Empirical Results: Multivariate Analysis

4.1 Multivariate Johansen Tests

The goal of this section is to incorporate securitization in a more complete and realistic multivariate real estate model. To be included in the multivariate VECM, a house price fundamental had to be cointegrated with housing prices in the bivariate setting. I finally selected the model that displayed desirable properties regarding the stability of the parameters in the cointegrating equations, normality of the residuals, serial correlation, and significance of the various parameters. In a multivariate framework, the Johansen cointegration test reveals only how many cointegrating relationships exist, but does not indicate which variables are cointegrated. I follow the procedure proposed by Zhou (2010) to evaluate the contribution of securitization to the chosen real estate model. First, I estimate the rank of the VECM with the following variables: housing prices, financial obligation ratio, 30 year mortgage rate, and building cost. Then, I estimate the same model with the extra securitization variable *psecpri*.[14] The results are presented in Table 6. In Panel A, without the securitization variable, the rank of the matrix Π is 2. When securitization is included, the number of cointegrating relationships increases to 3. This clearly indicates that securitization belongs to the long-run equilibrium model of real estate prices.

Table 6: Multivariate Johansen Cointegration Tests

Maximum Rank	Eigenvalue	Trace Statistic	5% Critical Value
Panel A: Multivariate VECM without securitization			
0	.	109.64	47.21
1	0.53	41.64	29.68
2*	0.27	12.74*	15.41
3	0.08	5.66	3.76
4	0.06		
Panel B: Multivariate VECM including securitization			
0		145.94	68.52
1	0.56	73.01	47.21
2	0.34	36.10	29.68
3*	0.25	10.51*	15.41
4	0.06	4.52	3.76
5	0.05		

[a] The variables common to both VECM are: *hpcs mort30rate*, *cost*, *for*.
[b] (*) Denotes the number of cointegrating relationships at the 5% level of significance.
[c] 2 lags are included in both Johansen tests.
[d] The variable *psecpri* is excluded in Panel A, but included in Panel B.

4.2 Multivariate VECM Estimation

The estimation results of the Panel B model are presented in Table 7.[15] All the coefficients in the cointegrating equations are significant except for *psecpri* in the

[14] *psecpri* is chosen as a proxy for credit marketability in the multivariate VECM model because of the more robust and consistent results obtained in the bivariate analysis.
[15] The complete estimation results are presented in Table 11 of the Appendix

second equation. The first cointegrating equation relating housing prices and its determinants can be rewritten as:

$$hpcs = .24 * psecpri + .27 * mort30rate + 3.15 * for + 6.86$$

The securitization coefficient, 0.24, is again positive, significant, and only slightly lower than the coefficient obtained in the bivariate case (.29). According to these results, a 10 percent increase in the level of non-agency MBS over the total mortgage market results in a 2.4 percent increase in housing prices in the long-run. The positive long-run relationship between housing prices and the 30 year mortgage rate was not anticipated. A mortgage rate increase inflates the mortgage payments and is therefore expected to negatively affect housing prices. There is also a positive relationship between housing prices and the financial obligation ratio. There was no *a priori* expectation regarding the sign of the relationship. The reason is that an over-consumption of housing and other consumption goods fueled by consumer debt can induce inflationary pressures. On the other hand, a financial obligation ratio above a certain threshold limits consumers ability to borrow, thereby reducing the demand for housing. A more detailed analysis of the short-run and long-run dynamics follows with impulse response functions.

4.3 Multivariate Impulse Response Functions

Figure 5 presents an orthogonalized impulse response function for each of the variables included in the VECM. The real estate price response to a positive shock to the market share of non-agency MBS is very similar to the bivariate case. The positive house price response is immediate and permanent. It takes about thirty quarters for the full effect to be reached. I also include an IRF analysis of fundamental determinants of housing prices. A positive shock to building costs

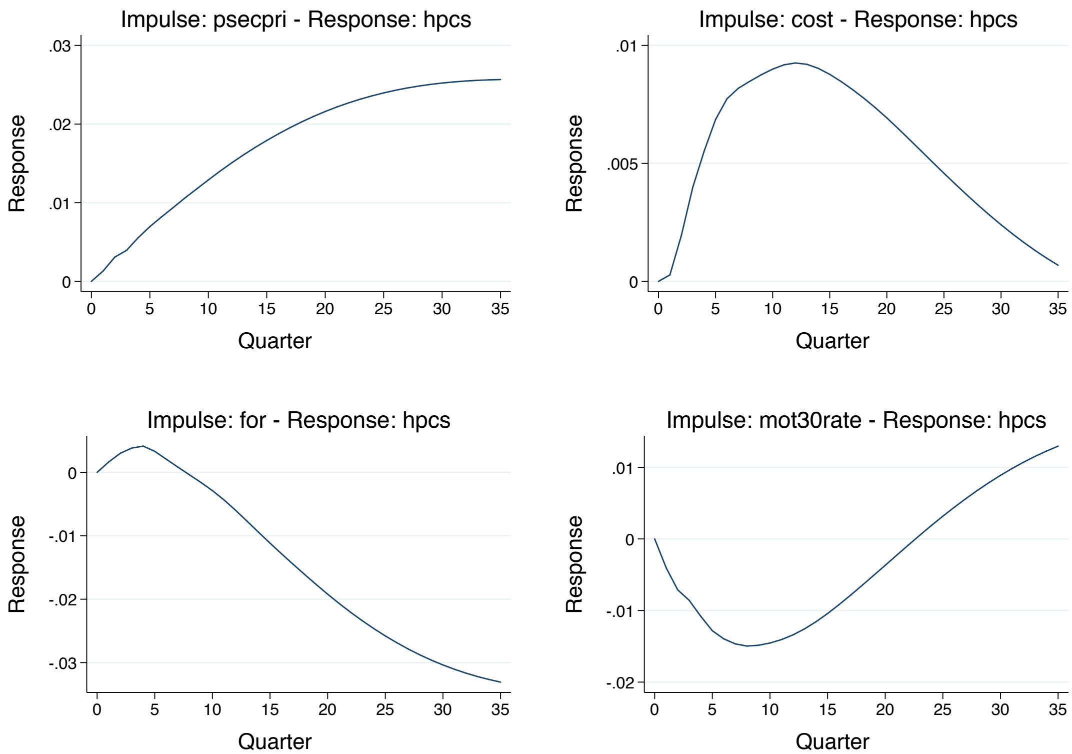
Table 7: Multivariate VECM Estimation-Cointegrating Equations

Variables	Beta coefficient	Std. Err.	C.I lower	C.I upper
First cointegrating equation				
hpcs	1	.	.	.
cost	0 (omitted)		.	.
for	-3.15*	1.20	-5.50	-0.80
psecpri	-0.24*	0.08	-0.39	-0.09
mort30rate	-0.27*	0.04	-0.34	-0.19
cons	-6.86*	2.78	-12.31	-1.42
Second cointegrating equation				
hpcs	0 (omitted)			
cost	1			
for	-3.62*	0.78	-5.15	-2.09
psecpri	-0.07	0.05	-0.17	0.03
mort30rate	-0.15*	0.03	-0.20	-0.10
cons	-8.06*	1.81	-11.61	-4.51

[a] A normalization restriction of 1 is imposed to *hpcs* in the first cointegrating equation.
[a] A normalization restriction of 1 is imposed to *cost* in the second cointegrating eq.
[b] (*) indicates that the coefficient is significant at the 5% level of significance.
[c] The VECM is estimated with 3 lags and a rank of 2.
[d] A VECM of rank 2 was chosen because it has better properties regarding the stability of the parameters, stationarity of cointegrating equations and normality of the residuals.
[e] There was serial correlation in the residuals with fewer than 3 lags.

increases the forecasted housing prices for approximately 3 years. Then, perhaps due to a supply or demand adjustment, the effect vanishes slowly to reach zero after 35 quarters. Therefore, the effect is transitory. Also, a positive shock to the financial obligation ratio predicts a positive house price response for about four quarters. A significant decrease is observed thereafter. An intuitive explanation is that a sudden increase in consumer debt causes an immediate shift of the demand curve (inflationary pressures), but eventually, the higher debt level reduces consumers' capacity to consume real estate considerably. Finally, as expected, a positive interest rate shock, by increasing mortgage payments, forecasts a decrease in housing prices for 10 quarters. Interestingly, prices then increase for several years. This might be due to a market adjustment to the higher rates in the form of financial innovations or policy change. It could also be attributable to increased savings in response to higher interest rates.

Figure 5: Multivariate Orthogonalized Impulse Response Function



[a]The impulse response functions represent the response of housing prices to a one unit shock to the innovations of one variable.

4.4 Multivariate Granger Causality Analysis

Table 8 outlines the results from short-run Granger causality tests based on the multivariate VECM estimated in Section 4.2. In this multivariate setting, *psecpri* positively Granger causes housing prices.[16] More precisely, an increase in the ratio of non-agency MBS over the total mortgage market leads to an increase of the short-term housing prices forecasts. Also, there exists a bidirectional negative Granger causality

[16]The positive or negative Granger causality is based on the sign of the short-term coefficients presented in Table 11.

between house prices and the thirty year mortgage rate. Finally, an increase of *psecpri* predicts an increase of the 30 year mortgage rate in the following two quarters.

Table 8: Multivariate Granger Causality Tests

Short-Run
hpcs$\Longleftarrow$psecpri
hpcs-cost
hpcs$\Longleftrightarrow$mort30rate
hpcs$\Longleftarrow$for
mort30rate$\Longleftarrow$psecpri
psecpri-for

[a] Each Granger causality test is performed after estimating the multivariate VECM of rank 2 with the following variables: $hpcs$, $psecpri$, $mort30rate$, $cost$, for.

[b] The short-run Granger causality test is a Wald test on the short-run coefficients using the 10% level of significance.

[c] A$\Longrightarrow$B indicates that A Granger causes B. We reject the null hypothesis that the short-run coefficients of the variable A in the B equation are jointly equal to zero.

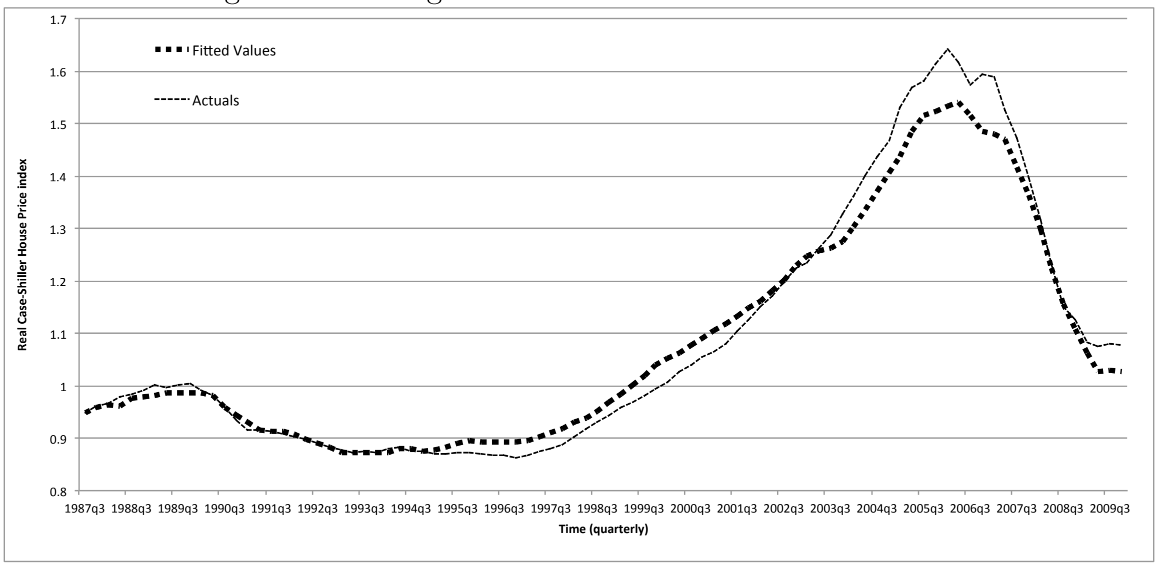
[d] A-B indicates an absence of Granger causality.

[e] Only the most relevant results are included.

4.5 Model Fit

This subsection evaluates how the chosen multivariate error correction model fits the data. Figure 6 presents a time series of both realized housing prices and the fitted values of the main VECM of rank 2. The fitted values from the house price equation follows the actual values very closely, especially for the 1987-1994 period. The model also captures most of the housing bubble and reaches a peak only 6% below the actual maximum value. Furthermore, the timing of the crash and the following downward trend are also captured. The fitted values reach a plateau after the crash that is approximately 3.5% below the actual.

Figure 6: Housing Prices - Fitted Values Versus Actuals



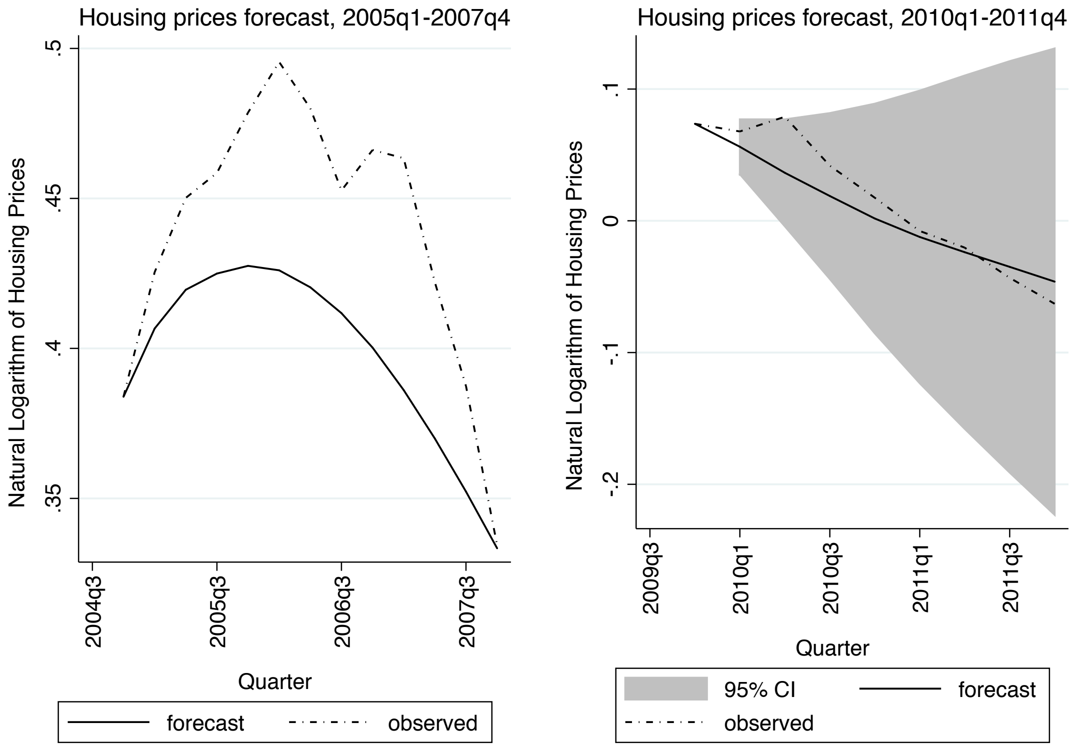
[a]The fitted values originate from the multivariate VECM of rank 2 presented in the previous section.
[b]The fitted values originally obtained were expressed as first-differences of the log-transformed real Case-Shiller House Price index. To facilitate interpretation, the values are converted back in level.

4.6 Dynamic Forecast

To further analyze the performance of the chosen multivariate VECM[17], I perform two dynamic forecasts of housing prices. The left panel of Figure 7 looks at the model's forecast of the 2007 real estate market crash. Starting just before the price decline in the first quarter of 2005, the twelve period forecast is fairly accurate. Both the forecasted values and the actual values start to decline in the first quarter of 2006. Also, the observed and the forecasted curves converge to the same level in the third quarter of 2007, but the forecasted peak is lower than the actual highest level experienced. The right panel is an eight period out-of-sample forecast. Clearly, the observed and the forecasted values, despite small deviations, are very close.

[17]The VECM has rank 2 and includes the following variables :$hpcs$, $psecpri$, $mort30rate$, $cost$, for, 3 lags of each variable (1987q4-2009q4).

Figure 7: Housing Prices Forecasts - Multivariate VECM



[a]The forecasted values originate from the multivariate VECM of rank 2 presented in the previous sections.
[b]The vertical axis is the natural logarithm of the real Case-Shiller House Price index.
[c]The left panel is a dynamic 12 quarters ahead forecast starting at time 2005q1.
[d]The right panel is a dynamic 8 quarters out of sample forecast.

5 Robustness Tests

Table 9 presents bivariate cointegration tests with alternative measures of housing prices and securitization. OECD housing prices and the OECD house price-to-rent ratio are both cointegrated with *psecpri*. Moreover, the total securitization for all consumer loans, which is a more general measure than mortgage securitization, is also cointegrated with housing prices.

Table 10 presents a bivariate VECM estimation of the models introduced in Table 9. Writing the cointegrating relationships explicitly yields:

Table 9: Bivariate cointegration tests using alternative measures of housing prices and securitization

Variables	Johansen Test	Engel-Granger Test
	Rank	Rank
hpoecd-psecpri	$1^{aic}(9)$	$1^{aic}(6)^{d}$
hprent-psecpri	$1^{aic}(7)$	1
hpcs-totalsec	1(2)	1(1)

[a] 1 indicates cointegration is present, 0 indicates no cointegration.
[b] (1) refers to the chosen number of lags.
[c] The number of lags is chosen according to the SIC statistics. When no cointegration is found, a higher number of lags is tried according to the AIC statistics. This case is denoted by ^{aic}.
[d] Significant at the 10% level of significance.

$hpoecd = 0.35 * psecpri + 0.49$ With OECD housing prices

$hprent = 0.09 * psecpri - .24$ With OECD house price-to-rent ratio

$hpcs = 0.08 * totalsec - 0.18$ With total securitized consumer loans

The first equation can be directly compared with the same equation that used the Case-Shiller House Price index instead of the OECD house price index. Using OECD housing prices, a 10% increase in the level of non-agency mortgage-backed securities as a proportion of total mortgages increases housing prices by approximately 3.5%. With the Case-Shiller index, the increase was 2.9%. These percentages are very close. Moreover, it is worth noting that there is again a positive relationship between housing prices and securitization.

The house price response to a shock to the residuals of each securitization variable is presented in Figure 8. The OECD housing price response and price-to-rent ratio is very similar to the previous Case-Shiller IRF. The effect is immediate and permanent. The response of a shock to the level of securitized consumer loans is also very similar to the shocks presented in Figure 4. The key similarity is that the shock leads to a positive real estate forecast in about twelve quarters.

Table 10: Bivariate VECM estimation-Cointegration equation-Alternative measures of securitization and housing prices

Variables	Beta coefficient	Std. Err.	C.I lower	C.I upper
psecpri-hpoecd				
hpoecd	-0.35^{*}	0.12	-0.59	-0.12
cons	-0.49	0.32	-1.12	0.15
psecgov-hprent				
hprent	-0.09	0.07	-0.23	0.05
cons	0.24	0.18	-0.11	0.60
totalsec-hpcs				
totalsec	-0.08^{*}	0.02	-0.12	-0.05
cons	0.18	0.08	0.03	0.34

[a] A Johansen normalization restriction of 1 is imposed to the house price variable.
[b] (*) denotes 5% significance.
[c] The *totalsec* and *hprent* VECM are estimated with 3 lags.
[d] The *hpoecd* VECM is estimated with 4 lags.

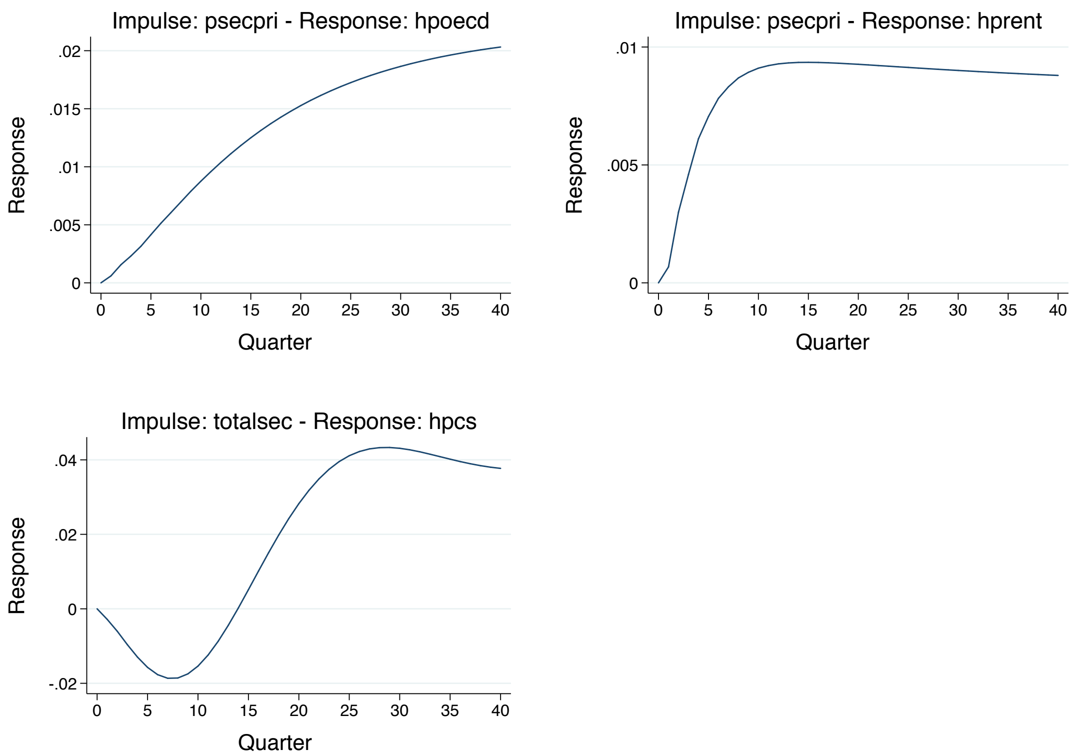
These cointegration tests, VECM estimations, and impulse response functions with alternative measures of securitization and housing prices provide strong support to the results presented in Section 3 and 4.

6 Discussion and Concluding Remarks

6.1 Discussion

The results outlined in this study have important implications and they enhance our understanding of the U.S. housing dynamics. The evolution of the securitization market is useful, at least partially, in explaining the variation in housing prices of the last 25 years. The non-agency MBS market share grew very modestly until around 1992 and began to increase at a higher rate thereafter. In real terms, housing prices remained fairly stable from 1987 to 1995 and started to increase slowly in 1996. The results suggest prices can respond to a change in securitization both immediately and with a considerable lag. In early 2000, the private sectors' MBS

Figure 8: Orthogonalized Impulse Response Function - Alternative Measures of Securitization and Housing Prices



[a]The impulse response functions represent the response of house prices to a one unit shock to the residuals of the securitization variables.

market share exploded in parallel with an unprecedented housing boom. Most of the factors that can magnify the effects of non-agency MBS on the housing market were present: irrational expectations, high demand for subprime credit, a wave of financial innovations, low monitoring standards, and a lax regulatory environment. During the housing collapse, the non-agency MBS market essentially vanished. The government's main response during the crisis was to support the agency MBS market. The effects on housing prices were moderate; prices stabilized only halfway through 2008. This study suggests that changes in agency MBS have a relatively small impact on real estate prices in comparison to non-agency MBS. Consequently, a policy oriented toward the issuance of non-agency MBS could have been more effective to support real estate prices.[18]

More importantly, this paper supports the view that policy makers should monitor and regulate the securitization market. Any major deviation of securitization from the long-run equilibrium, especially regarding private-label mortgage-backed securities, can have significant macroeconomic effects. Due to the type of analysis performed, it is not possible to draw direct inferences about the reasons why non-agency MBS have a stronger influence on real estate prices than agency MBS. Nevertheless, it is very likely to originate from the types of loans being securitized and also from the fundamental differences between government-sponsored enterprise and private MBS issuers. First, several studies have already established that aggressive mortgage instruments magnified the housing price movements during the housing boom and the market collapse. This is partially attributable to the fact that most of the speculation in real estate is done through non-conventional mortgages, such as backloaded payments.[19] Since agency MBS are composed almost exclusively of conforming loans, the private-label MBS category is very likely where most of the speculation takes place. Second, private asset-backed security issuers are numerous, very heterogeneous, and lightly regulated in comparison to GSEs. This can foster excessive risk-taking among private issuers and make them more vulnerable to business cycles and changes in consumer confidence.

6.2 Conclusion

To conclude, this paper employs cointegration techniques to study the long-run relationship between housing prices and the securitization of mortgages, a proxy of

[18]This is the case if the only goal is to support real estate prices. Supporting non-agency MBS issuance was not a desirable policy in this case for obvious reasons.

[19]Barlevy and Fisher (2011) provide evidence at the city level.

credit marketability. I find strong evidence of cointegration between mortgage securitization and real estate prices. The most influential category of securitized mortgages appears to be non-agency issued mortgage-backed securities. A 10% increase in the level of non-agency mortgage-backed securities over the total amount of mortgages causes a 2.9% housing price increase. The results are robust to alternative measures of securitization and housing prices. The analysis contributes to the financial and housing market literature and supports the view that the structure of the mortgage finance market is a key determinant of the housing market dynamics.

A Appendix

Table 11 presents the complete estimation results of the main multivariate VECM, Table 12 provides a description of the variables used and finally, Table 13 provides the data sources.

Table 11: Multivariate VECM Estimation-Complete Output

Sample: 1987q4-2009q4		No of observation: 89		Log likelihood: 891.11	
AIC: -18.50		HQIC: -17.73		SBIC: -16.60	
Equation	Parms	RMSE	R-squared	Chi Squared	P-Value
D.hpcs	12	0.0106	0.7736	259.63	0.00
D.cost	12	0.0072	0.5704	100.90	0.00
D.for	12	0.0103	0.3146	34.877	0.00
D.psecpri	12	0.0419	0.5334	86.865	0.00
D.mort30rate	12	2.4085	0.6232	125.71	0.00
Variable	Coefficient	Std. Err.	P-Value	C.I. Lower	C.I. Upper
D.hpcs					
ce1	-0.0173	0.0053	0.0010	-0.0277	-0.0069
ce2	0.0017	0.0008	0.0400	0.0001	0.0033
LD.hpcs	0.8287	0.1382	0.0000	0.5579	1.0996
L2D.hpcs	-0.2076	0.1535	0.1760	-0.5085	0.0933
LD.psecpri	0.0271	0.0238	0.2550	-0.0196	0.0738
L2D.psecpri	0.0362	0.0238	0.1290	-0.0105	0.0829
LD.cost	0.1972	0.1803	0.2740	-0.1562	0.5505
L2D.cost	0.1401	0.1676	0.4030	-0.1883	0.4685
LD.mort30rate	-0.0015	0.0007	0.0280	-0.0028	-0.0002
L2D.mort30rate	-0.0007	0.0005	0.1820	-0.0017	0.0003
LD.for	0.2889	0.1234	0.0190	0.0472	0.5307
L2D.for	0.2327	0.1296	0.0720	-0.0212	0.4867
D.psecpri					
ce1	0.0096	0.0210	0.6490	-0.0316	0.0508
ce2	-0.0012	0.0033	0.7170	-0.0077	0.0053
LD.hpcs	0.4603	0.5489	0.4020	-0.6155	1.5361
L2D.hpcs	-0.3065	0.6099	0.6150	-1.5018	0.8889
LD.psecpri	0.1399	0.0946	0.1390	-0.0455	0.3254
L2D.psecpri	0.5365	0.0947	0.0000	0.3510	0.7221
LD.cost	0.0790	0.7162	0.9120	-1.3246	1.4827
L2D.cost	-0.7528	0.6656	0.2580	-2.0573	0.5518
LD.mort30rate	0.0008	0.0027	0.7620	-0.0045	0.0061
L2D.mort30rate	0.0012	0.0020	0.5630	-0.0028	0.0051
LD.for	0.2046	0.4900	0.6760	-0.7558	1.1650
L2D.for	0.2978	0.5147	0.5630	-0.7110	1.3065
D.cost					

ce1	0.0102	0.0036	0.0050	0.0031	0.0172
ce2	-0.0023	0.0006	0.0000	-0.0034	-0.0012
LD.hpcs	-0.0222	0.0941	0.8130	-0.2067	0.1622
L2D.hpcs	-0.0133	0.1046	0.8990	-0.2183	0.1917
LD.psecpri	-0.0217	0.0162	0.1810	-0.0535	0.0101
L2D.psecpri	0.0396	0.0162	0.0150	0.0078	0.0715
LD.cost	0.5760	0.1228	0.0000	0.3353	0.8167
L2D.	-0.0674	0.1141	0.5550	-0.2911	0.1563
LD.mort30rate	0.0004	0.0005	0.4340	-0.0005	0.0013
L2D.mort30rate	0.0003	0.0003	0.3580	-0.0004	0.0010
LD.for	-0.1784	0.0840	0.0340	-0.3430	-0.0137
L2D.for	-0.0577	0.0883	0.5130	-0.2307	0.1153
D.mort30rate					
ce1	-0.8582	1.2074	0.4770	-3.2247	1.5083
ce2	-0.3748	0.1893	0.0480	-0.7459	-0.0036
LD.hpcs	-61.3545	31.5280	0.0520	-123.1483	0.4393
L2D.hpcs	-36.9371	35.0326	0.2920	-105.5998	31.7256
LD.psecpri	7.1125	5.4343	0.1910	-3.5386	17.7636
L2D.psecpri	16.8340	5.4372	0.0020	6.1772	27.4908
LD.cost	43.5785	41.1360	0.2890	-37.0467	124.2036
L2D.cost	42.8369	38.2322	0.2630	-32.0968	117.7706
LD.mort30rate	0.0324	0.1557	0.8350	-0.2727	0.3376
L2D.mort30rate	-0.1280	0.1148	0.2650	-0.3530	0.0971
LD.for	88.2345	28.1457	0.0020	33.0699	143.3990
L2D.for	6.5448	29.5627	0.8250	-51.3970	64.4867
D.for					
ce1	0.0101	0.0051	0.0500	0.0000	0.0202
ce2	-0.0020	0.0008	0.0120	-0.0036	-0.0004
LD.hpcs	0.1748	0.1343	0.1930	-0.0885	0.4380
L2D.hpcs	-0.0607	0.1493	0.6840	-0.3532	0.2319
LD.psecpri	-0.0186	0.0232	0.4210	-0.0640	0.0267
L2D.psecpri	0.0034	0.0232	0.8850	-0.0420	0.0488
LD.cost	0.1228	0.1753	0.4840	-0.2207	0.4663
L2D.cost	0.1935	0.1629	0.2350	-0.1258	0.5127
LD.mort30rate	0.0007	0.0007	0.2880	-0.0006	0.0020
L2D.mort30rate	0.0002	0.0005	0.7270	-0.0008	0.0011
LD.for	0.0839	0.1199	0.4840	-0.1512	0.3189
L2D.for	0.1883	0.1260	0.1350	-0.0586	0.4352

[1]This is the complete estimation output from the VECM of rank 2 with the following variables: $hpcs$, $psecpri$, $mort30rate$, $cost$, for.

[2]The cointegrating equations results are presented in Table 7.

Table 12: Description of the Variables

Variable	Description	Transformations[1]
hpcs	S&P and Shiller National U.S. Housing Price index	log-sa-cpihp
hpoecd	OECD measure of housing prices	log-sa-cpihp
hprent	Price to rent ratio (real)	log-sa-cpihp
secgov	Total GSE and Government Agencies securitized home mortgages	sa-cpihp
secpri	Total privately securitized home mortgages	sa-cpihp
sectot	secgov+secpri	sa-cpihp
totalsec	Total Securitization for all Consumer Loans	sa-cpihp
morttot	Dollar value of all home mortgages	sa-cpihp
psecgov	(Total government securitized home mortgages)/(Total home mortgages)	log-sa
psecpri	(Total privately securitized home mortgages)/(Total home mortgages)	log-sa
cpihp	Consumer price index for all urban consumer: all items less shelter	sa
cost	Producer Price Index: Intermediate inputs and components for construction	infcpihp
mort30rate[2]	30-Year Conventional Mortgage Rate, annual	infcpihp
fedrate[2]	Effective Federal Funds Rate	infcpihp
govbondrate[2]	Interest rate, Government Securities, Government Bonds for United States	cpihp
outgap	Output gap= GDP-Potential GDP	log-sa-cpihp
gdp	Gross domestic product	log-sa-cpihp
unemployment	Unemployment rate for fulltime workers	sa
productivity	Productivity-Real output/hr	log-sa-cpihp
for[a]	Financial obligation ratio	log-sa
incomepc	Real Disposable Personal Income: Per capita	log-sa-cpi
population	Total Population: All Ages including Armed Forces Overseas	log-cpi

[1] Transformations: log-natural logarithm, sa-seasonally adjusted, cpihp-converted to real using cpihp.
[2] Interest rates are converted to real by substrating the nominal rate by the inflation rate.
[3] All variables are quarterly: 1987q1-2009q4.

[a] The financial obligation ratio (for) is an estimate of the ratio of debt payments to disposable personal income. Debt payments consist of the estimated required payments on outstanding mortgage and consumer debt, automobile lease payments, rental payments on tenant-occupied property, homeowners' insurance, and property tax payments.

Table 13: Data Sources

Variable	Data Sources	Date
hpcs	Standard and Poors. U.S. National Housing Price Index Levels	01/03/2012
hpoecd	OECD iLibrary	01/05/2012
hprent	OECD iLibrary	01/05/2012
secgov	Board of Governors of the Federal Reserve system-Flow of Funds database	05/05/2012
secpri	Board of Governors of the Federal Reserve system-Flow of Funds database	05/05/2012
totalsec	Federal Reserve Economic Data (FREDUSE) - Code: TOTALSEC	01/04/2012
morttot	Board of Governors of the Federal Reserve system-Flow of Funds database	05/05/2012
psecgov	Board of Governors of the Federal Reserve system-Flow of Funds database	05/05/2012
psecpri	Board of Governors of the Federal Reserve system-Flow of Funds database	05/05/2012
cpihp	Federal Reserve Economic Data (FREDUSE) - Code: CUSR0000SA0L2	05/05/2012
cost	Bureau of Labor Statistics - Procuder Price Indexes	01/04/2012
mort30rate	Federal Reserve Economic Data (FREDUSE) - Code: MORTG	05/05/2012
fedrate	Federal Reserve Economic Data (FREDUSE) - Code: FEDFUNDS	05/05/2012
govbondrate	Federal Reserve Economic Data (FREDUSE) - Code: INTGSBUSM193N	05/05/2012
outgap	Federal Reserve Economic Data (FREDUSE) - Code: GDPPOT and GDPC1	01/06/2012
gdp	Federal Reserve Economic Data (FREDUSE) - Code: GDP	01/06/2012
unemployment	Bureau of Labor Statistics - Code: LNS14100000	01/04/2012
productivity	Bureau of Labor Statistics - Code: PRS85006093	01/04/2012
for	Federal Reserve Economic Data (FREDUSE) - Code: CUSR0000SA0L2	01/04/2012
incomepc	Federal Reserve Economic Data (FREDUSE) - Code: A229RX0	01/04/2012
population	Federal Reserve Economic Data (FREDUSE) - Code: A229RX0	01/04/2012

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