Subprime Lending and the Housing Bubble:

Tail Wags Dog?

Major Coleman IV
The Paul Merage School of Business
University of California, Irvine
Irvine, CA 92697
mcoleman06@merage.uci.edu

Michael LaCour-Little
College of Business and Economics
California State University at Fullerton
Fullerton, CA 92831
mlacour-little@fullerton.edu

Kerry D. Vandell
Center for Real Estate
The Paul Merage School of Business
University of California, Irvine
Irvine, CA 92697
kvandell@merage.uci.edu

Revised Draft August 2008

Presented at the ASSA meetings, New Orleans, January 2008. We wish to thank Mark Beardsell for access to the Loan Performance data and the following individuals for comments in response to our earlier draft: Jesse Abraham, Chip Case, Susan Wachter, Peter Zorn, Frank Nothaft, Amy Crews Cutts, Nick Retsinas, Stuart Gabriel, Bill Wheaton, Phil Bromiley, and Fan Yu . We are also appreciative of the comments of the referees and editor Richard Green for greatly improving the exposition and focus of the paper. All errors are our own.

Subprime Lending and the Housing Bubble: Tail Wags Dog?

ABSTRACT

The cause of the "housing bubble" associated with the sharp rise and then drop in home prices over the period 1998-2008 has been the focus of significant policy and research attention. The dramatic increase in subprime lending during this period has been broadly blamed for these market dynamics. In this paper we empirically investigate the validity of this hypothesis vs. several other alternative explanations. A model of house price dynamics over the period 1998-2006 is specified and estimated using a cross-sectional time-series data base across 20 metropolitan areas over the period 1998-2006. Results suggest that prior to early 2004, economic fundamentals provide the primary explanation for house price dynamics. Subprime credit activity does not seem to have had much impact on subsequent house price returns at any time during the observation period, although there is strong evidence of a price-boosting effect by investor loans. However, we do find strong evidence that a credit regime shift took place in late 2003, as the GSE's were displaced in the market by private issuers of new mortgage products. Market fundamentals became insignificant in affecting house price returns, and the price-momentum conditions characteristic of a "bubble" were created. Thus, rather than causing the run-up in house prices, the subprime market may well have been a joint product, along with house price increases, (i.e., the "tail") of the changing institutional, political, and regulatory environment characteristic of the period after late 2003 (the "dog").

Subprime Lending and the Housing Bubble: Tail Wags Dog?

Introduction

Recent turmoil in the mortgage market -- in particular a contraction in liquidity beginning in August 2007, significant increases in the rates of defaults and foreclosures, the failure of a number of mortgage firms, and large losses incurred by financial institutions and investors in mortgage and mortgage-related assets[1] -- has attracted considerable attention from the media, policymakers, and analysts. It is also now widely recognized that prices in the housing market, after a number of years of very rapid growth, have been declining at an increasingly rapid rate since sometime in early 2006. As of January 2008, based on the S&P/Case-Shiller repeat sales index (CS Index), house prices nationally had fallen 12.5% year-over-year, with declines over 20% in some metropolitan areas. Figures 1 and 2 depict the CS Index in levels and as quarterly returns over the period 1998-2007 in the aggregate and by three price-level tiers.

The widespread availability of subprime loan products during this period, while arguably increasing consumption levels and homeownership rates, has been broadly blamed for this "bubble". The share of subprime mortgage products peaked at 23.5% of all mortgages originated during 2006, roughly coincident with the peak in the housing market (Inside Mortgage Finance [2007]).

In this paper we empirically investigate the claim that increased credit availability in the subprime sector drove the housing boom against five alternative explanations for the current dynamic that have been, or could be, offered: (1) economic fundamentals (e.g., employment, income, population increases) were the primary drivers of price changes; (2) the problem was not subprime lending per se, but the Fed's dramatic reductions, then increases in interest rates during the early- mid-2000's; (3) the housing "boom" was concentrated in those markets with significant supply-side restrictions, which tend to be more price-volatile; (4) the problem was not in the excess supply of credit in aggregate, or the increase in subprime per se, but rather in the increased or reduced presence of certain other mortgage products; and (5) fundamental changes in the legal/ political/ regulatory environment resulted in strong incentives for a surge in lending and securitization by private issuers under looser

[1] Large lenders reporting large losses include Countrywide, Citigroup, Freddie Mac and Fannie Mae. High profile bankruptcies included New Century and American Home Mortgage.

underwriting standards which were not sustainable.[2] To preview our results: We confirm the dominance of macroeconomic fundamentals prior to late 2003, find moderate support for the influence of supply constraints (especially in high-end markets), but find virtually no support for the proposition that subprime lending per se had much to do with subsequent price rises (although investor loans and to a degree alt-A loans clearly did). The most surprising and important result, however, was the great impact that the displacement of the GSE's by private ABS issuers in late 2003 to the end of 2006 had in disconnecting market prices from their fundamentals, boosting loan and unit-production volumes, and accelerating house price returns.

Literature Review

In the interest of brevity, we will not provide an extensive literature review here, preferring to focus on a few key papers. With respect to the measurement of house price movements, there has been substantial effort expended over the years in the creation and evaluation of alternative house price indices. Most such indices are based upon median sales prices or hedonic price estimates (e.g., FHA, NAR, DataQuick). Case and Shiller (CS) (1987, 1989) first apply the repeat-sales estimation technique, now generally regarded as the best available method for assessing house price movements over time because it is the only technique that is able econometrically to come close to eliminating the potential biases associated with uncontrolled-for variations in neighborhood or structural amenities across units.[3] We apply the CS approach in this study.

---

[2] Note that this does not exhaust all possible alternative explanations for this dynamic. Others offered include the arguments that the problem with prices was primarily in the supply of new housing, not with the availability and cost of mortgage credit, and that the problem was primarily one of fraud on the part of aggressive mortgage brokers or borrowers.

[3] Case and Shiller acknowledge that their index built upon earlier work by Bailey, Muth, and Nourse (1963) who first introduced the repeat-sales estimation methodology to the housing market. CS include all recorded sales representing a transfer of property ownership. They exclude refinancings and REO sales by lenders on defaulted loans and take into account the effects of interim property improvements on observed prices. Their primary results are available for 20 large metropolitan regions, as well as larger regional aggregations and 3 price tiers.The S&P/Case Shiller Indices are currently calculated by Fiserv, Inc., which also offers indices covering a number of zip codes (about 15% of the total) and metro areas using the Case-Shiller methodology. Since November 2006, a futures product based upon the Case-Shiller Index has been traded on the Chicago Mercantile Exchange (see http://www.cme.com/trading/prd/re/housing.html).

It should be noted that CS has been subject to criticism on the basis of potential biases originating with the fact that they include only sales of properties that have sold at least once, which could represent a biased sample. Methodologies intended to correct these shortcomings have been proposed, but none are broadly available and updated in a consistent format for many metro areas over a substantial time period.

With respect to the literature on housing bubbles, there has been much recent activity owing to recent increases in the volatility of price cycles in the housing market. CS (2003) argue that the term "bubble" refers to a situation in which widespread expectations of future price increases cause prices to be temporarily elevated. In turn, the expectation of large price increases may have a strong impact on demand if households believe that home prices are very unlikely to fall, and certainly not likely to fall for long, so that there is little risk associated with a home purchase. They note, too, that the mere presence of rapid price increases is not in itself conclusive evidence of a bubble, since economic fundamentals may explain much of the observed increase. They find that that income growth alone explains the pattern of recent home price increases in most states and falling interest rates explain much of the recent run-up nationally. Likewise, McCarthy and Peach (2004) argue that the recent upturn in homes prices is largely attributable to strong market fundamentals, in particular, the growth of income and the decline in interest rates.

Himmelberg, Mayer, and Sinai (2005) also focus on the ability of economic fundamentals to explain recent house price patterns, constructing measures of the annual cost of single-family housing for 46 metropolitan areas in the United States over the period 1995-2004 and comparing those costs to the cost of renting. They argue that metrics such as the growth rate of house prices, the price-to-rent ratio, and the price-to-income ratio fail to account both for the time series pattern of real long-term interest rates and predictable differences in the long-run growth rates of house prices across local markets. They find that from the trough of 1995 to 2004, the cost of owning rose somewhat relative to the cost of renting, but not, in most cities, to levels implying that houses were overvalued.

Pavlov and Wachter, in a series of papers (2004, 2006a, 2006b), develop and test models that examine the implications of aggressive non-recourse asset-based lending that under-price default risk. They demonstrate expectations of greater asset price volatility and deeper asset price "crashes" following negative demand shocks. The causes are relaxed income constraints (on the up side) freeing up latent demand for home ownership and (on the down side) the decline in the availability of aggressive lending activities following the demand shock. Empirical tests make use of international

---

The Office of Federal Housing Enterprise Oversight (OFHEO) also produces its own repeat-sales index on a quarterly basis for 363 MSA's, 11 of which are subdivided into a total of 29 Metropolitan Divisions. (Technical details are available in Calhoun (1996)). The OFHEO index differs from Case-Shiller in that some data points used for index estimation are based on mortgage loan refinancing transactions in which an appraisal, rather than an arm's length sale, establishes property value, although recently OFHEO has made available a sale-only index. A second difference is that the OFHEO index is constructed based on properties financed solely by Fannie Mae or Freddie Mac loans which, though a large segment of the market, may not be representative of the entire market, especially in high-cost areas such as California.

data and data from Los Angeles to provide evidence of under-pricing of default risk on the upside, coupled with over-valuation of assets, along with more extreme declines afterward.

Another strand of the literature focuses on supply constraints. Glaeser, Gyourko, and Saks (2005) focus on regulatory constraints affecting the elasticity of housing supply. They argue that a declining supply elasticity resulting from increased local development regulations in certain cities has caused prices to rise excessively in recent years. These arguments are consistent with Malpezzi (1996, 1999) and Malpezzi and Maclennan (2001), that cross-sectional variation in regulatory constraints helps explain variation in house price dynamics through its effect on supply elasticity.

The above papers focus on factors unique to U.S. economic market conditions as the cause of the bubble. Shiller (2007), however, notes that the recent run-up in house prices has occurred, not just in the U.S., but also in Australia, Canada, China, France, India, Ireland, Italy, Korea, Russia, Spain, and the United Kingdom. The coincidence of housing booms across countries would seem to cast doubt on the argument that purely local phenomena, such as supply constraints, could be responsible for house price growth patterns.[4] Moreover, Shiller argues, the boom in the U.S. may be best understood as a series of regional booms, starting at different times. Shiller characterizes the boom in home prices as a classic speculative bubble, driven by extravagant expectations for future price increases, and argues that survey research measuring consumer expectations confirms this description.

More recently, Mian and Sufi (2008) use data from approximately 3,000 zip codes to examine the effect of freeing latent demand through an increase in the supply of mortgage credit driven by securitization. They measure house price movements using zip-code level Case-Shiller indices and find a positive effect of high latent demand on house price growth during 2001-2005, after controlling for income and employment growth, and other fundamentals. They measure latent demand by the percentage of home purchase loan applications denied in 1996. While Mian and Sufi argue that an increase in the supply of mortgage credit had a discernable positive effect on subsequent house price growth rates, their estimate of its magnitude is relatively small: about 10% of the aggregate house price appreciation during 2001-2005 is due to a that supply shift (Mian and Sufi, page 32). Moreover, their measure of increase in the supply of mortgage credit is represented by the increase in the volume of *all*

[4] We note that the same argument could be made cross-sectionally across MSAs within the U.S., where there exist widely varying price trends and development regulations of widely varying degrees of restrictiveness.

loans originated, not just subprime loans. This increase is found to be highly correlated with the intensity of non-agency securitization.[5]

In the paper arguably most closely related to ours, Wheaton and Nechayev (2007) (henceforth W-N) investigate whether the growth in housing prices between 1998 and 2005 can explained by increases in demand fundamentals such as population, income growth and the decline in interest rates. W-N estimate time series models for multiple markets using data from 1975 to 1998 and use those models to predict house price growth occurring during 1998-2005, finding that in all markets actual house price growth outstripped that which would be predicted by economic fundamentals by a considerable margin. They use an AR(1) model of log changes in house prices as measured by the OFHEO repeat sales indices for 59 MSA markets, controlling for total employment, total personal income divided by employments, and the 30-year fixed mortgage rate. W-N hypothesize that house price growth in excess of that implied by economic fundamentals is related to the emergence of risk-priced subprime mortgage lending and the unusual growth in the demand for second homes and/or investment properties over the time period studied. To test these hypotheses they examine cross-sectional forecast errors produced by using the economic fundamentals model to predict house price changes. Results establish a statistical association between measures of credit availability and the volume of second home purchases and the cross-sectional forecast error in house price changes, but W-N caution that inferring causality from this relationship is difficult. Later, we will compare the assumptions and results from our current effort with those of W-N.

Mortgage market trends and the changing mix of credit instruments being made available and demanded by borrowers have also received considerable attention. Using Home Mortgage Disclosure Act (HMDA) data , Avery, Brevoort, and Canner (2007) document the rapid growth of non-prime lending, the increased percentage of lending on properties that are not owner-occupied, and the increased use of simultaneous-close second liens (also called “piggybacks”). The GAO has reported to Congress on the growth of non-traditional mortgage products (GAO [2006]), and regulatory bodies have set forth guidance on risks and best practices for financial institutions engaged in such lending

5 It should be noted that Mian and Sufi’s working paper is still in draft form and has been subject to a number of criticisms, including possible omitted variable bias, sample selection bias, the reduced form nature of their model, constraints imposed by their model specification, and conclusions that extend beyond their specification and results (see for example Gabriel (2008)).

(FFIEC [2006, 2007]).[6] LaCour-Little and Yang (2007) trace the history of recent mortgage contract innovations such as interest-only and pay-option ARMs showing that such products are rationally preferred by households with lower risk aversion and in markets with greater expected house price appreciation. Gramlich (2007) details the rise of subprime lending, its role in increasing home ownership rates among traditionally under-served households, and associated risks.

Methodology and Model Specification

We are interested in a simple model for home prices that explicitly allows for changes in loan type intensities to be a leading indicator of future home prices. Starting with a structural model with both supply and demand relationships:

$$\begin{aligned} Q_{Dt} &= \alpha_t + \beta_{0,t} P_t + \beta_{1,t-\tau} L_{t-\tau} + \beta_{2,t} M_t + \beta_{3,t} K_t + \varepsilon_{Dt} \\ Q_{St} &= a_t + B_{0,t} P_t + B_{1,t} R_t + B_{2,t} C_t + \varepsilon_{St} \end{aligned} \qquad (1)$$

where:

Q_{Dt} = Quantity of housing demanded in period t

P_t = Housing prices at time t

$L_{t-\tau}$ = Vector of loan type intensity lagged τ periods.

M_t = Vector of macroeconomic, demographic, and financial controls

K_t = Cost of capital

Q_{St} = Quantity of housing supplied in period t

R_t = Housing market supply regulation

C_t = Cost to supply housing

$\beta_{n,t}, B_{n,t}$ = Structural coefficients

α_t, a_t = Intercepts

$\varepsilon_{Dt}, \varepsilon_{St}$ = Classical error terms

---

[6] Though such regulatory guidance was absent earlier, a situation that has been the subject of recent debate between Alan Greenspan, who has been accused of primary blame for the situation, and his critics (see Greenspan, *Financial Times*, April 6, 2008 (http://blogs.ft.com/wolfforum/2008/04/alan-greenspan-a-response-to-my-critics/).

we impose the equilibrium condition $Q_{Dt} = Q_{St}$, which implicitly requires market imbalances to be corrected over time by price adjustments. The result is a reduced form equation with prices as our main endogenous variable:

$$P_t = \pi_0 + \pi_{1,t-\tau} L_{t-\tau} + \pi_{2,t} M_t + \pi_{3,t} K_t + \pi_{4,t} R_t + \pi_{5,t} C_t + e_t \qquad (2)$$

where $\pi_{n,t}$ are reduced-form impact multipliers.[7]

Our priors are that the predominant effect of increased density of a particular alternative loan type intended to increase homeownership would affect prices and returns positively (i.e., $\pi_{n,t} > 0$), primarily through the demand effect.[8] But, there could also be negative influences operating in the short- and longer-run on prices and returns. We recognize that lags of only a year's duration are insufficient to reveal fully the most important possible future adverse impacts of subprime loans and other novel mortgage arrangements on the HPI. To the extent that the most important adverse impacts on house prices are revealed primarily through subsequent delinquency and default experience, such events typically take place over a longer period of time, peaking 3 to 4 years after origination, before declining again. Thus, our observation period would be too short to provide much data on such an extended lag effect. However, we note there are other near-term effects that could also cause reduced house price returns. The first of these is a supply effect in which builders may supply additional units to the market based on lower capital costs. A second is the possibility of loose, or even fraudulent, underwriting, leading to higher "early" defaults. Such a pattern has characterized the most recent cohorts of non-conforming mortgage products.[9] Finally, "flipping" of properties within a year by

---

[7] It is acknowledged that an estimate for user cost should be included in model specification. While we have not done so explicitly, virtually all the elements composing the user cost relationship are included as explanatory variables. We note that appreciation expectations are often the most vexing of user cost elements to proxy for. In our model these are considered explicitly as future house price returns.

[8] We have included mortgages intended for home purchase only in our data base and not "refi's" for the purpose of mortgage equity withdrawal (MEW) or other purposes. This is rationalized on the grounds that house prices, hence house price return trends, are revealed only upon sale. While MEW may indeed convey greater consumption/investment capability to home owners, thus in general driving the economy and probably having an indirect effect on house prices, the primary effect of the new private mortgage origination densities still works directly through the use of such financing for purchases.

[9] See Westley (2007), p. 23, for data supporting the increased presence of fraud in mortgage lending activity since 2003.

investors/ redevelopment contractors could increase the supply of homes on the market, thus driving down returns.[10]

Data

We combine data from a number of sources to construct our pooled cross-sectional time series, which includes 20 metropolitan areas for 36 quarters, 1998-2006. Our main housing market variables relate to lending activity and home prices. We obtain HMDA data for home purchase loans, both to owner-occupants and non-owner occupants, for calendar years 1998-2006. HMDA data, generally thought to be the most complete census of lending activity in the U.S., is used to construct the denominator in many of our measures of lending activity. From First American Loan Performance we obtain counts of private-market ABS home purchase loans by type, including alt-A, BC (subprime), and jumbo loans, as well as non-owner occupant (investor) loans (which could be any of the above types). We then define loan type densities for alt-A, BC, jumbo MBS, and non-owner occupant by dividing loan originations for each type by total HMDA originations. Hence, subprime density represents the percentage of total loan originations accounted for by subprime mortgages.[11]

Figure 3 summarizes our loan density distributions over our observation period by instrument. Note the substantial increase in both subprime and alt-A densities in 2003, followed by a clear decline beginning after Q1 2006. Jumbo loans, by contrast, remain relatively constant in their representation in the market, with even a slight decline after Q4 2004. We examine later whether this increase in subprime/alt-A density represents an increase in overall lending or merely a displacement of other loan types.

The national average LTV for newly originated first-lien home loans over the observation period is provided by the Federal Housing Finance Board's Monthly Interest Rate Survey (MIRS) data. It provides evidence of considerable stability over the entire period at around 80%. Because of the lack of MSA-specific LTV information in the MIRS data, we made use of LTV information from Loan

[10] Although the disincentives of short-term capital gains tax treatment within a year of acquisition would tend to reduce the incidence of such short-term flipping behavior.

[11] We recognize that the Loan Performance data contains only loans that were securitized and not the universe of such loans made. Though the vast bulk of these loans were securitized, this potentially creates a bias in our loan density variable estimates. We attempted to get additional information on such loans held in portfolio from the AFSA database compiled by HUD, which surveys the total originations by those mortgage lenders classified as "subprime", but unfortunately, such information was unavailable to the end of our observation period, an interval which we felt was insufficient to provide reliable estimates for our variables of interest.

Performance for our study, which provides the distribution of reported LTV's at origination by metro area for each quarter of the observation period. The average LTV across MSA's and over time from this data source was also remarkably stable, consistent with the MIRS data. Under the hypothesis that it is really the proportion of high-ratio loans, rather than the average LTV, that is most relevant as an explanatory factor for encouraging increased housing demand, we derived from LP a variable representing the proportion of purchase originations that had LTV's over 90% (Figure 4). Surprisingly, this variable does not increase as house prices begin rising in 2000. In fact, it drops significantly from around 37% of all loans made to about 12% by Q1 2006, when it again begins to rise, consistent with dropping house prices.

Considered in isolation, this observation would suggest that marginal equity could not have been a significant contributing factor to house price and mortgage default dynamics over the study period. However, we must remember that the study period also saw significantly increased use of "piggy-back" second liens and "80-10-10" financing to substitute for PMI or simply withdraw equity.[12] Thus, we obtained from Loan Performance also a measure of Combined Loan-to-Value Ratio (CLTV) for all MSA's over the observation period (Figure 5)[13]. By this measure, equity erosion at origination is clearly seen to have occurred over the study period, with average CLTV's increasing from 77% in 1998 to 88% by 2006.

For our final loan-related variable, from the Federal Housing Finance Board, we use the MIRS data to obtain the national average conventional mortgage rate each quarter. Together, these loan-related variables imply we have more extensive and complete measures of mortgage lending activity than have most previous studies, in particular that of W-N.

For our housing price index, we use the Case-Shiller Index, as previously discussed, for all 20 large metropolitan areas that are readily available over our observation period, both for the total market as well as by tiers representing the top, middle, and bottom third of prices in each market (Figures 1 and 2). For the purpose of comparison with the results of W-N, we also obtain the OFHEO index for each of the quarters in our observation period. We attempt to replicate our estimation results using the

---

[12] See Charles A. Calhoun, "The Hidden Risks of Piggyback Lending," commissioned by PMI, 2005. The use of piggyback lending rose to 42 percent of home-purchase mortgage loan dollars in the first half of 2004, compared with 20 percent in 2001.

[13] The CLTV includes the outstanding balance of all liens present at the time of placement into the mortgage-backed-security. Note that data for the Boston MSA is omitted due to gaps in reporting.

OFHEO index, but found that noise from OFHEO's appraisal-based valuations, as discussed in footnote 3, significantly inflated our standard errors.

Previous researchers have pointed out the need integrate housing supply dynamics in house pricing models. To address the supply side of the housing market we use the Wharton Residential Land Use Regulation Index (WRLURI) of Gyourko, Saiz, and Summers (2007). WRLURI captures a recent snapshot of residential housing supply-side restraints specific to over 2,600 localities and major metropolitan areas. This corrects another limitation of the W-N analysis. Although the measure is cross-sectional only and does not vary over the observation period, we consider this a minor issue, given the relatively short length of the observation period and our expectation that the vast bulk of variation in land use regulatory stringency would exist cross sectionally.

For demographic and macroeconomic controls with metropolitan area granularity, we use population, per-capita income, and the unemployment rate. Population and income data come from Bureau of Economic Analysis, while unemployment data comes from the Bureau of Labor Statistics. In addition to cross-sectional controls, we include time series of the following economic and financial metrics from the aggregate US economy: all US Treasury rates, major stock indices, CPI for urban consumers, total non-farm mortgages outstanding, and GDP. Along with the effective mortgage rate (as measured by the Federal Housing Finance Board), we use the yield curve slope (10 year notes divided by 2 year notes) as measures of the cost of capital for home buyers. In addition to controlling for inflation, the CPI also functions as a basic proxy for the cost to supply housing.

Summary Statistics

Table 1 provides summary statistics for all of the data elements in our analysis. All loan count variables represent the number of loans originated in a quarter. The 20 metropolitan areas in our sample represent nearly 103 million people as of the end of 2006, over a third of the total U.S. population. Table 2 shows dramatic increases in subprime lending intensity over our observation period, compared to relatively modest increases in income and even more modest changes in population. Table 3 ranks our 20 MSAs by the percentage of loan originations that are subprime as of the fourth quarter of 2006. Note that Los Angeles, Las Vegas, and Phoenix, which had some of the most dramatic increases in home prices, all rank high in subprime intensity. However, this observed correlation does not control for the numerous other factors potentially influencing house price changes, so we cannot draw definitive conclusions from this relationship. Note for example, the high correlation between the intensity of subprime lending and both non-owner occupied lending and MSA per-capita income.

Finally, Table 4 displays the pairwise correlations for all area-specific data in our analysis. Note that the highest individual correlation with quarterly house price returns is by the non-owner occupied loan origination density, but the level of correlation is not high (0.218). The land use regulatory index (WRLURI) display the second highest correlation (0.157). The economic fundamentals variables (population, unemployment, and per capita income) individually are not highly correlated with house price returns, but that does not suggest that together they might be. We note particularly that none of the other private ABS mortgage density variables, beyond non-owner occupied loans, provide any significant degree of correlation with house price returns.

Among the explanatory variables, as expected, the highest correlations are between the private ABS share of new mortgages and its constituent mortgage types – subprime (0.633), alt-A (0.581), and non-owner occupied (0.393). Other significant correlations include the yield curve slope and the unemployment rate (0.600); jumbo prime, alt-A, and subprime origination densities and the per-capita income (0.486, 0.400, and 0.313 respectively); alt-A and subprime origination densities (0.413); and per-capita income with population (0.353), the land use regulatory index (0.363), and total private ABS shares of new mortgages (0.356). These results are consistent with expectations: Short-term rates drop during periods of higher unemployment, and private ABS issues tend to be most used in higher income MSA's (which also tend to be larger), contradicting the common notion that they are primarily concentrated in lower-income areas. The fact that the regulatory index is also highly correlated with income is consistent with the findings of Gyourko, Saiz, and Summers (2007) that strict land use controls are the product of wealthy jurisdictions.

Results

Pre-testing shows our model is accurately characterized as an AR(1) process. Looking at correlograms for price levels in our main reduced form model, we find very strong serial correlation with a pattern characterized by first degree autocorrelation. When we take quarterly changes in home prices, autocorrelation is still quite persistent. Finally, when we take quarterly returns in home prices, we find lower but non-negligible indications of autocorrelation (and a very mild degree of second order autocorrelation). Table 5 shows the correlograms and initial Durbin-Watson statistics of our main specification for price levels, changes and returns. These initial tests suggest that the housing market exhibits return momentum, not just price momentum, but that this momentum mostly occurs within a year.

We use an iterative EGLS approach to address autocorrelation in housing price index returns as well as possible simultaneous trends between prices and independent variables during our sample period. The Prais-Winsten estimates of ρ in the AR(1) error structure confirm the presence of autocorrelation in returns found in the pre-testing (Table 5). While the momentum in returns indicates that including lagged returns as an explanatory variable would help predict future returns, including a lagged endogenous variable would make our Prais-Winsten estimates of ρ in the AR(1) error structure inconsistent. One possible solution would be to use lags of the macroeconomic variables to create an instrumental variable for lagged prices. We already control for macroeconomic variables contemporaneously and we want to be able to pick up any predictive power the proportions of loan type, especially subprime intensities, may have—whether it comes from interaction with macroeconomic phenomena or has a direct relationship with home prices.

Since we are interested in testing if subprime lending intensity has predictive power of any economic significance, we focus on the sign and magnitude of the impact multipliers in the reduced-form results to measure economic significance. Because of heterogeneity in local demographics and economics, it is possible that impact multipliers will vary across cities. Since the urban economic literature agrees on the directional relationship between home prices and macroeconomic variables such as unemployment, population, and income, we pool our data across cities to measure the reduced-form model on the national level. We assume that any variance between cities not captured by population, income, unemployment, or residential land use regulation will not cause variation in the direction prices move with respect to various loan type densities.

We estimated four separate sets of specifications for our single-equation reduced-form model described above. In order to properly handle the presence of an AR(1) error structure, we used the Prais-Winsten method to estimate ρ, then undertook OLS on the Cochrane-Orcutt transformation. We clustered by MSA and used heteroskedastic-robust t-statistics. Note that all R^2 estimates need to be untransformed from the Cochrane-Orcutt transformation to get absolute measures of goodness of fit. But they can be used, as is, for comparing models.

Model 1: Our base model

Model 1 is our base model, used to test the fundamental relationship between subprime lending and house prices. Controlling for contemporaneous macro factors, and including MSA fixed effects, we tested the effect of the past mix of types of mortgage originations on current home prices. Four variations of Model 1 were estimated. Model 1a used quarterly *returns* in the Case-Shiller house price index (HPI) as the dependent variable:

> Case-Shiller HPI returns = f(lagged loan-type intensity [Percentage by count of jumbo vs. alt-A vs. subprime vs. non-owner occupied], mortgage market conditions [CLTV at origination, aggregate mortgage balance, average mortgage rate], macro controls [Real GDP, aggregate personal savings, S&P500 index, slope of yield curve (10 yr./2 yr.), MSA population, MSA unemployment rate, MSA income, urban CPI], and supply constraint [MSA Wharton land use regulatory index]) (3)

Model 1b employed the same explanatory variables but used the quarterly *change* in the Case-Shiller index as the dependent variable. Model 1c used the *level* of the Case-Shiller index as the dependent variable, and Model 1d used the *OFHEO* index quarterly *returns* as the dependent variable.

In comparing Models 1a – 1d, we found that Model 1a, which used HPI *returns* as the dependent variable, generally did the best job of correcting for serial correlation (lowest ρ value), hence having the most reliable (i.e., least inflated) t-statistics, however Model 1b also had a slightly higher R^2.[14] Model 1d, which used the OFHEO index, had the worst fit, likely due to the noise in the data from appraised value transactions under refinancing. We thus confine our discussion to the results from Model 1a, found in Table 6.[15] To examine the possibility that the impact of subprime loan activity could be concentrated differentially at the low end of the market, we ran model 1a both for the aggregate CS index and the CS index stratified into price terciles.

First, with respect to the impact of the loan-type mix, we found that the relative intensity of jumbo prime activity had a significant cyclic relationship with future home prices. In the short run (6 months or less) more jumbos were associated with lower index returns. But a year out, an increase in the jumbo proportion of loans increased returns. The economic magnitude of this effect was moderate: A 1% increase in proportion of jumbos correlated with a -0.17% quarterly return in the aggregate HPI

[14] W-N also found superiority in the model specification using price index returns.

[15] Results for the other models are available from the authors.

after six months, but a +0.24% increase after a year. This cyclic effect appears to be more extreme in the higher-price ranges. On the other hand, the percent of loans that were alt-A had a significant positive contemporary relationship with home prices (+0.12%), offset by a negative marginally-significant relationship with home prices a year later (-0.08%). This effect was strongest in the mid-price tier. These results suggest that alt-A and jumbos have opposite temporal cycles with respect to their relationship between quarterly returns and home prices, though similar in magnitude.

The non-owner occupied mortgage market was found similar in pattern to the alt-A market, though significantly greater in magnitude. The percent of loans that were non-owner occupied had a significant positive relationship with home prices over 0-6 months (peaking at +0.33% after 3 months in the aggregate model). But over 9-12 months this relationship reversed and there was a significant negative effect of a similar magnitude (-0.26% after 12 months). These effects were of comparable magnitude across all price tiers. Thus, while contemporaneously and in the short run the non--owner occupied home buyers bid up home prices, they had a significant negative effect over the longer run that tended to offset it. The extent to which this pattern may have had anything to do with any intent to "flip" properties after a year is unclear.

Significantly, we found in Model 1a (and virtually always throughout our analysis) the percent of originated loans that were subprime had virtually no statistical significance on future home prices over any interval or price tier, and even the point estimates were small in economic terms. The only partial exception is a small (+0.04 to +0.08%) and barely significant positive contemporaneous effect that persists across price tiers (but is insignificant in the aggregate). This finding runs contrary to the hypothesis that subprime lending per se was largely responsible for the run-up in the HPI ending in 2006. Since non-owner occupant loans could be either subprime, jumbo, or alt-A, subprime could be still operating interactively through the investor loans, but there is little significant evidence of a direct effect, even in the lowest price tier. The CLTV seemed to be significantly associated with house price changes only in the lowest price tier, and that relationship was negative. A 1% increase in the CLTV was associated with a 0.16% decline in contemporaneous quarterly HPI returns in the lowest tercile of the market. This is contrary to expectations that more lenient loan terms would drive house prices higher through demand effects unless one believes increased credit availability could represent an "oversupply" of credit, shifting the housing supply curve outward and downward and reducing prices.

Although our results show no evidence of subprime intensity having an effect on future housing returns, a potential endogeneity between subprime intensity and housing returns should be noted. Our main question has to do with subprime's effect on home prices, but a separate question is, "how do housing returns effect subprime intensity?" Given the high levels of autocorrelation in housing returns it is possible that lenders relax (tighten) their lending standards when housing returns are positive (negative) since the borrower probably can (cannot) sell or refinance if mortgage payments become burdensome. In this case, subprime intensity could appear to have an effect on future home prices when it is merely the byproduct of past housing returns. We find that the level of subprime intensity is indeed positively related to past housing returns (Table 7), although the degree of serial correlation in subprime intensity inflates the statistical significance. This endogeneity provides empirical support to our assertion that subprime did not itself contribute to the run-up in housing prices in the mid 2000's, and strengthens our argument that subprime intensity should not be considered a primary causal factor in housing returns.

With respect to our mortgage market and macro economic variables, we found that the aggregate level of mortgage lending, population growth, and the unemployment rate were the main variables driving home prices. These operated primarily in the mid-tier and high-tier markets. Surprisingly, the level of mortgage interest rates was not found to have a significant relationship with home prices. Over our sample period the Fed raised, lowed and raised again the Fed Funds rate but house prices had a single increasing trend until 2006Q3. The negative significant coefficient on aggregate home mortgage debt outstanding, especially at the high end of the market, is interesting and unexpected, although it is consistent with the results for CLTV above, in which increased credit availability represents an "oversupply" of credit, driving down prices.[16]

Finally, we observe that the supply constraint index (WRLURI) is correctly positively signed and significant. This significance is entirely at the high end of the market, however. Restrictive land

[16] We note that the pairwise correlation with each of CLTV with each of the loan type origination intensities is as follows: subprime 0.5011, jumbo prime -0.3174, alt-A 0.3195, and non-owner occupied 0.4894. The high correlations with subprime and non-owner occupied would be expected to lower the significance of their coefficients. The non-owner occupied coefficients are still highly significant in spite of this, reinforcing the strength of this loan type in influencing house price returns. Model 1a was run with both LTV and CLTV as explanatory variables. In both cases, the coefficients for subprime remained largely insignificant, suggesting the strength of the negative CLTV effect on house price returns relative to the subprime intensity effect.

We examined the extent to which CLTV increases were due to higher first-, or increased use of "piggyback" and other second-lien programs. LTV remained relatively constant over the observation period, both for the GSE's and the broader market. The inability of the GSE's and other first-lien holders to identify the existence of second liens in many cases has been identified as an issue of significant policy concern.

use regulatory policy does not appear to drive low- or middle-tier house prices upward, a result that has relevance for restrictive housing supply policies.[17]

Model 2: GSE-to-private ABS regime shift

As shown Figure 6, Freddie Mac and Fannie Mae exhibited two different regimes of behavior during our observation period.[18] Before 2004, they were active issuers and purchasers of conventional conforming mortgages and MBS securities (regime I), typically responsible for over 50% of net new lending each quarter. However, at this time and until 2006, their activity level dropped considerably (regime II), to close to zero by 2006Q4. At the same time, the net increment to mortgage debt outstanding reached record highs in the period 2004 through the first two quarters of 2006, with evidence of at least partial replacement of the GSE's during this period by private label issuers. From 2002Q4 to 2005Q1, the private ABS issuers' share of market activity rose from less than 10% to over 50%. However, after early 2007, as house prices stagnated, defaults increased, and problems of illiquidity in the private ABS market set in, regime III was initiated -- the GSE's became the only game in town as new private ABS issues disappeared and total net new mortgage origination volume plummeted.

The reasons for the GSE's absence from the market during this period are many and complex. First is the fact that they were experiencing considerable political problems in Washington. Accounting irregularities resulted in pressure that ultimately led to the resignation of their senior officers, Leland Brendsel of Freddie Mac in June 2003 and Franklin Raines of Fannie Mae in December 2004. As a result of the revision in their books, both were required to provide a substantial capital infusion and maintain higher capital levels. Ongoing accusations of lack of safety and soundness, caused by alleged lack of proper hedging mechanisms and their being "too big," resulted -- in their weakened political

---

[17] It should be noted that the Wharton Land Use Regulatory Index varied by MSA only and was considered constant over time and across house-price tiers. This could have obscured possible effects temporally and across individual MSA submarkets.

[18] We formally evaluated whether the regime shift in our observation period is significant and the optimal break point by constructing a Chow test that tested the linear restriction that the regression coefficients are the same as in our base model 1a. Our loan intensity coefficients and macroeconomic/ mortgage market coefficients are tested separately. Macroeconomic/ mortgage market coefficients demonstrate the largest statistical significance at a 2003Q3 break point, while loan intensity coefficients do so slightly earlier, at 2003Q2. Results are available from the authors.

state -- in pledges to reduce the growth of their retained portfolios.[19] In addition, their maximum lending limit for single-family loans became highly constraining, especially in expensive high-growth states such as California, in the face of continuing increases in house prices nationwide, resulting in their being able to purchase increasingly fewer loans.[20] An additional constraint was a requirement by OFHEO in November, 2004, to increase their participation in affordable housing initiatives, including the purchase of subprime and other MBS products as well as investments in Section 42 LIHTC multifamily developments.[21] Increases in demand for private-label subprime pools at this time would be expected to further exacerbate "bubble" conditions through demand effects.

However, the explanation for GSE withdrawal from a dominant mortgage origination position in early 2004 is more complex than simply political and regulatory pressures. The GSE's actually loosened their underwriting standards to a degree during this period, through the reduction of documentation requirements and other means, and attempted to compete aggressively with the private-label ABS issuers, but were unsuccessful because credit spreads became so tight.[22] Recently, Fed Chairman Ben Bernanke and former Chairman Alan Greenspan have cited the rapid spread of weakened underwriting standards among the mortgage originators supporting the private ABS issuance market starting in 2005 (see Greenspan [2008]). Indirectly, our data suggests this started as early as

---

[19] Their retained loan portfolio was a source of ongoing policy controversy and was proposed to be capped in the Administration's FY2004 budget. In May 2006, Fannie Mae agreed to an OFHEO requirement that it restrict growth of its portfolio to the level of December 31, 2005 (OFHEO, 2006). In July 2006, Freddie Mac agreed not to increase its retained portfolio beyond its level of June 30, 2006 (Syron, 2006). Retained portfolio restrictions for the GSE's were enacted into law in 2008.

[20] The limit was raised from $300,700 to $322,700 as of January 1, 2003, then in increments up to only $333,700 in 2004, $359,650 in 2005, and $417,000 in 2006, where it remained until the recent Housing and Economic Recovery Act of 2008, permitting an increase to $625,500 (*Mortgage Banking* Magazine, various issues).

[21] Leonnig (2008). We note that many of these pressures brought to bear on the GSEs can be traced back to a long-standing opposition to the further development and dominance of the GSEs by the Republican-dominated Congress and Administration, who advocated on behalf of banks and other private financial institutions as their being ably suited to take on Freddie and Fannie's role without the "implicit government subsidy" created by their implicit Federal government guarantee on their debt. See Thomas (2003) for a concise statement of the Republican issues with respect to the continued dominance of the GSE's. See also Jaffee and Quigley (2007), Hamilton (2008), Stevenson (2000), Tierney (2003), McLean (2005), and Muolo and Padilla (2008) for less partisan discussions of the recent challenges to the dominance of the GSE's.

[22] Possible explanations for their self-imposed limits on how far they could go to maintain market share vary, but include their mandated "safety and soundness" standards, whether imposed internally or externally through OFHEO, Congress, and the Administration. This constraint, in turn, could be explained either by politics or by proper risk management safeguards imposed in earlier times by responsible policymakers and regulators.

late 2003. Evidence, too, grew of fraud on the part of certain mortgage brokers, lenders, appraisers, and borrowers in the way of falsified applications and other documentation.[23]

The significant withdrawal of the GSEs from the conventional conforming market is shown in Figure 6 to have led to a significant substitution effect, in which the private-issue ABS and RMBS market supplanted that of the conventional conforming RMBS market for new originations during this period.[24] This is a little-recognized fact: The residential mortgage sector experienced a double shock during our observation period. Overall lending volume to the sector increased to record levels, peaking at a net quarterly additions of around $301 billion by 2006 Q2, while at the same time the percent of net additions to outstanding mortgage balances represented by private ABS issuers rose from an average of 13% of the market in the period 1998 to 2003 to an average of 47% in 2004 and 2005.[25] At the same time, the GSE share dropped from an average of 54% of the market in the 1998-2003 period to under 7% in2004-05.[26] A natural question of concern is the extent to which such a regime change had on the housing market, and specifically house prices.

To address this question, we ran our model stratified for the two regime periods 1998Q1 to 2003Q3 and 2003Q4 to 2006Q4. Our results are shown in Models 2a and 2b (Table 8), which represent Model 1a but run only over the segmented observation periods. *We note first and most importantly, that our goodness of fit measures for both models improved when we split our data into the two regimes, especially for the second regime period, suggesting that the change in GSE activity did have a significant impact on house prices.*

In regime I, before the GSE pullback, we see that most of the macroeconomic fundamentals, including the unemployment rate and income variables, are significant and of the correct sign. This model has the lowest estimated value for ρ of all the models (demonstrating the least autocorrelation), possibly an indication of a market that was not experiencing rising demand based on past increases in

---

[23] See Luhby, (2008).

[24] In fact, the effect was even stronger than a "substitution" effect. The total volume of net new home mortgage lending peaked at $1.106 trillion in 2005, up from $798.9 billion in 2003, before dropping back to $706.6 billion by 2007 (Figure 6).

[25] The ABS presence in the market actually dropped to a negative 4% in 2000 Q1, reflecting the fallout from the liquidity crisis precipitated originally by the Russian bond default. In 2005 Q1 it rose to a record 57% of the market.

[26] The GSE's share dropped to as low as negative 2% of the market in 2003 Q4, during the height of the fallout from their accounting irregularity investigations. We note that when the bubble burst, with originations dropping after 2006 Q2, the GSEs' share of net new lending began rising rapidly, to reach 150% of quarterly flows by 2007 Q4. The private ABS issuer share, on the other hand, did not break until 2007 Q2, but dropped rapidly, from almost 50% of net new additions in 2007 Q1 to -60% in 2007 Q4 (in other words, rapid de-leveraging was going on while positions were being liquidated).

prices (i.e., not a "bubble" market). In regime II, however, the macroeconomic fundamentals (income and unemployment) lost their significance. Other factors were driving HPI returns. This model had the highest estimated value of ρ, suggesting that regime II exhibited the highest degree of momentum in housing returns, a "bubble" characteristic.[27]

During regime I, the jumbo MBS, alt-A, non-owner occupied, and subprime loan percentages have basically the same pattern of results as in model 1a, though generally at somewhat lower significance levels. Subprime loans retain their positive marginally-significant contemporaneous effect on prices, though the coefficient is somewhat higher than in the 3-tier models (+0.17% vs. +0.04 to +0.08%). However, lagged coefficients, though insignificant, tended to offset this effect in the aggregate during regime I.

The impact of the loan percentage variables appears to diminish considerably during regime II, with the exception of the non-owner occupied loan density, which increases the magnitude and significance of its first-positive, then-negative effect on returns. The only other loan type whose origination density seems to show significant impact on returns is a contemporaneous positive effect (+0.24%) by alt-A mortgages. We note that the prior indication of modest significance of the origination density of subprime lending on house price returns during regime I disappears entirely during regime II.

We note finally one other variable that displayed a highly significant impact during regime II but not during regime I, when the GSE's still dominated the market. The steepness of the yield curve (ratio of 10-year to 2-year Treasury yields to maturity) displays a coefficient of -3.99, implying the flattening of the yield curve after the Fed began raising rates in 2004 had a strong accelerating effect on house prices. This would normally be expected to dampen demand by borrowers seeking low-rate ARM loans, but instead we saw a substantial increase in loan volume after the Fed's actions to raise rates. This could be interpreted as a "rush to the exit" by borrowers seeking to beat future increases, but perhaps a more defensible explanation is on the supply side: ABS lenders had a great hunger for yield, which drove both the softening of underwriting standards and the creation of new "teaser rate" ARM's or other mortgage products (such as "2-28's") that could provide greater initial access to credit to previously marginal borrowers, but higher expected yields going forward. This effect more than

[27] We note that, while real GDP was found to positively effect house prices, as expected, especially in the high end of the market over the entire observation period, its influence was found anomalously to be negative (although small in magnitude) during regime II (2004-06). This result suggests again other intervening factors were at play which were reflective of a market in deisequilibrium.

offset the increased short-term rate effect, especially since the long rate remained relatively constant over the period, which served as the primary basis for cap rate formation in the housing market.

In other words, if the I-banks and hedge funds had a hunger for spread during this period of a flat yield curve, then their demand could have been fueling subprime and other alternative mortgage activity. MBS spreads general tightened over this period, indicating increased demand from the high-finance community. Our primary conclusion to be drawn from the dominant GSE- vs. dominant private-ABS-regimes is that the primary driver of house price returns during the GSE-dominant years tended to be economic fundamentals, with some indication of short-term, largely offsetting effects from jumbos, subprime, and non-owner occupied investor loans. However, in the ABS-dominant years, with one exception, the loan-density related effects largely disappeared, as did the effects of economic fundamentals. Non-owner occupied loans and the hunger for yields by private ABS issuers exploiting the dynamics of the yield curve (while ex post found to be under-pricing risk) drove house price returns to new highs, which did not abate until 2006. Subprime lending activity per se was not the primary culprit in driving house prices higher. Rather both were the products of an economic environment and permissive regulatory environment that allowed the house price market dynamic to play out.[28]

Testing for Robustness

A number of additional model specifications were estimated as a robustness test to ascertain the extent to which our results as stated above may be associated with specific relationships that might modify our interpretations. Specifically, we tested for four separate possible hypotheses: The impacts of loan origination densities across instruments upon Case-Shiller House Price Returns (CS HPR's) are mediated by (1) local and temporal economic fundamentals; (2) the magnitude of subprime penetration at the peak of the housing bubble (in quintiles); (3) the magnitude of house price returns over the observation period (in quintiles) ; and (4) the interaction between the magnitude of subprime penetration (lowest vs. highest) and the house price tier (lowest vs. highest). These estimations are

[28] We should clarify several points with respect the emergence of the various underwriting criteria and private-issue mortgage designs during the 2000's. 2/28 loans had been a staple of subprime lenders for a number of years and their "teaser rates" were relatively high even before 2003 (Foote, et al. (2008)). However, their volume was not as high as later, and their problems were not apparent, given continuing appreciation in the housing market in the earlier years. Option-ARM's did increase after 2003 and offered low down payments, but this increase was almost wholly in the alt-A prime market, allowing otherwise-qualified borrowers to qualify for mortgages in areas becoming unaffordable. Because option-ARM's tended to be held in portfolio, rather than placd into securities (e.g., Golden West Savings), the Loan Performance data, which is based upon securitized product only, may be biased downward in terms of origination intensity.

intended to evaluate the extent to which the impact of lending activity density may vary across certain clusters of MSA's. We note below the significant finds from this exercise; full estimation results are available from the authors.

First, we consider the interaction effects with economic fundamentals. We ask whether subprime lending concentration, found to be insignificant in our base model, can become important in certain low-growth (or high-growth) MSA's. Subprime insignificance persists, however, across all economic interaction specifications. The strong significance we found of non-owner occupied lending activity on house price returns for the most part disappears with consideration of the economic interaction terms, suggesting a consistent effect across MSA's of all economic conditions. Jumbo loan activity, however, displays both direct and interaction effects with economic fundamentals.

With respect to interaction with the degree of subprime penetration, insignificance was again persistent across all quintiles, in particular the quintile representing the highest degree of subprime origination density. Non-owner occupied lending activity, however, did appear to become more economically and statistically significant in the higher quintiles of subprime lending. This again reinforces the robustness of our previous results – the importance of non-owner occupied lending and lack of importance of subprime lending per se in affecting house price returns.

With respect to interaction with the level of "hotness" (i.e., appreciation) of the MSA housing market, we find the density of subprime lending has no effect in the lowest three quintiles, but a negative effect in months 9-12 in the fourth quintile and a positive effect in the highest quintile ("hottest") markets. Further examining the 5^{th} quintile, we find that subprime's effect is strongest among the highest-end homes (third price tier). The coefficient is highly significant and of high economic importance: a 10% increase in subprime density leads to a 2.4 percent increase in quarterly return after a year (roughly double). This result is counterintuitive, as one would have expected subprime credit availability to have driven up lower-priced homes in less "hot" markets, but it seems that the effect was primarily felt in the already "hot" markets and at the higher end of the housing stock. We note parenthetically that there is some evidence supporting possible "flipping" effects among those using non-owner occupied loans, as the initial gains created by subprime availability are entirely reversed out over a year.

Finally, with respect to interaction with both house price tier (lowest vs. highest) and degree of subprime penetration n (lowest vs. highest), we find that subprime lending is most influential among the lowest-priced homes where there is the least subprime concentration. The coefficient is highly significant and of high economic importance; an increase of 10% in subprime concentration increases house price quarterly returns by 3.1% (over double) over a year.

Overall, we find that our previous results are relatively robust, but that subprime lending density can make a greater positive difference in returns at the margin among the lowest price homes if the level of such lending is low to begin with. Otherwise subprime lending has little direct effect on low-end house price returns. Non-owner occupied lending activity, however, remains important in driving returns, especially so in areas where subprime lending activity is already high.

Conclusions and policy implications:

Our analysis, though closely related to that of Wheaton and Nebchayev (W-N, 2007) in purpose, differs from theirs in important respects. Whereas their observation period extended to only 2005, we were able to incorporate information through 2006, thus capturing at least he beginning of the "bubble burst". Our analysis was also a pooled, cross-sectional analysis of MSAs; we did not run separate MSA analyses to evaluate the effects of the economic fundamentals variables, then a separate analysis on the 2005 forecast errors to get at the effects of lending and other non-fundamental variables. We made use of the Case-Shiller House Price Index (HPI), rather than the OFHEO Index, which we found introduced considerable noise, likely due to OFHEO's inclusion of appraisal-based value estimates from the inclusion of refinancings. We also had available information from Loan Performance, which provided loan origination information over time by MSA by loan type, whereas W-N had to use proxies for subprime loan originations and were not able to consider such other loan types as jumbos, ARMs, or alt-As. Finally, we were able to include certain supply, as well as demand-side variables, which they did not consider, specifically a proxy for residential construction costs and a land use regulatory index.

Our results confirm certain of the findings of W-N with respect to the influence of fundamental economic factors on house price dynamics during the run-up of the early 2000's. Specifically, we found that the size of the MSA, population growth, employment (unemployment rates in our models), and per capita incomes drive house prices in the expected directions, at least in the early years of our observation period, through 2003. In addition, we confirm their findings with respect to certain lending-related factors that were present during the observation period: specifically, our non-owner occupied loan origination intensity variable, corresponding roughly with their variable for second or investment home loans, was found to be significant

In certain other respects, however, we found evidence contrary to or unavailable in W-N's initial findings. Surprisingly, mortgage interest rates were not found to have a significant relationship with house prices when other factors were taken into account. The construction cost index for housing, proxied in this study by the CPI index, was found to have a marginally significant positive influence on house prices, but only during regime I (1998-2003) when economic fundamentals were most influential. A second supply variable, the Wharton Land Use Regulatory Index (WRLURI) also tended to drive up prices, but only in the highest tercile of the market. The composite LTV (CLTV) was significant only among the lowest-priced homes and during regime II (2004-2006), and in both cases its effect was negative (i.e., high LTV's, rather than driving further price increases through their demand effects, may have positively influenced housing supply, thus driving down prices). This result is contrary to W-N's positive LTI (loan-to-income) variable effect, used as a proxy for "looser" lending standards on house prices.

Some of our most interesting results derived from our availability of the Loan Performance data, which provided a detailed breakdown of loan originations by type. These results suggested that the pattern of contemporaneous and lagged effects of different loan-type originations on house prices was complex, and varied both by loan type and lag-length. The percent of jumbo and alt-A loans both had significant cyclical relationships with house price returns, though in different directions. Jumbos were associated with initially lower price index returns (6 months or less) but the effect turned positive and significant after a year. Alt-A loans behaved in an opposite fashion: contemporaneously and within a short period they were associated with an increase in house prices, a relationship which turned negative after a year. In both cases, the effects are relatively small to moderate in magnitude.

The non-owner occupied loan market, which we already indicated coincided with W-N's finding of significance of investor loans in affecting house price returns, displayed a similar relationship to that of the alt-A market, with a positive relationship up to 3 months out, dropping to a negative relationship of comparable magnitude after 12 months. The magnitudes of the effects were significantly higher than those in the jumbo and alt-A markets. Importantly, and contrary to the conclusions of W-N, we found very little evidence of an increased concentration of subprime lending *per se* having any significant impact on house price index returns, with the exception of a small contemporaneous effect and during regime I (1998-2003). These results are seemingly in contrast to Pavlov and Wachter (2004, 2006a, 2006b) if we confine our consideration to the subprime sector alone. But considering the entire set of private ABS loans (including in particular non-owner occupied and alt-A loan origination densities) suggests that loan-origination density effects taken together were still found to be associated with higher house price returns.[29]

The most important and heretofore unrecognized impact of lending patterns on subsequent house price returns was found to originate with the regime-shift which occurred in early 2004, with the squeezing out of the GSE's from the market, both because of political, regulatory, and economic factors. The resulting reshuffling of supply of mortgage capital in the market, resulted in both a record increase in total lending volume after 2003 and a substantial substitution of alternative private instruments for conventional conforming GSE loans. This was particularly true of the alt-A, subprime, and non-owner occupied investor products. We find that the dominance of economic fundamentals and other market characteristics in driving house price returns to be more significant in the earlier years, before the GSE pullback. After the pullback, not only were economic fundamentals less important, the measures of autocorrelation present in our model estimates suggested this period possessed the highest degree of momentum in house prices – a "bubble" characteristic.

The dominant policy conclusion that can be drawn from the findings of this paper is that the existence of subprime loan products alone may not merit primary blame for the problems currently being experienced in the housing and mortgage markets. Rather, political and regulatory actions and economic conditions -- which led to a disruption in traditional flows of credit into the market and the relative absence of the GSE's during the period 2004-06 -- permitted the spread not only of new private-issue instrument designs and ABS products, but also of weaker underwriting standards to flow in great volumes into the void. These events may be deemed complicit, if not dominant in precipitating the subsequent series of adverse trends which later beset the housing and mortgage markets.

[29] This can be seen easily by looking at the coefficients for the contemporaneous effect of all loan densities in Table 6 for all HPI tiers and in the aggregate. All are positive, and although the subprime coefficient is insignificant, several loan-types, particularly the Alt-A and non-owner occupied loan products, display considerable significance.

References

Avery, Robert, Kenneth Brevoort, and Glenn Canner. 2007. The 2006 HMDA Data. *Federal Reserve Bulletin*, Summer.

Bailey, Martin J.; Richard F. Muth; Hugh O. Nourse. 1963. A Regression Method for Real Estate Price Index Construction. *Journal of the American Statistical Association*, 58, (304): 933-942.

Brueckner, Jan K. 1994. The Demand for Mortgage Debt: Some Basic Results. *Journal of Housing Economics* 3: 251-262.

Brueckner, Jan K. and James Follain. 1988. The Rise and Fall of the Arm: An Econometric Analysis of Mortgage Choice *The Review of Economics and Statistics* 70 (1): 93-102.

Calhoun, Charles. 1996. OFHEO House Price Indexes: HPI Technical Description. Office of Federal Housing Enterprise Oversight.

Calhoun, Charles A. 2005, The Hidden Risks of Piggyback Lending. PMI.

Capozza, Dennis, Patric Hendershott, and C. Mack. 2004. An Anotomy of Price Dynamics in Illiquid Markets: Analysis and Evidence from Local Housing Markets. *Real Estate Economics* 32 (1): 1-21.

Case, Karl E. and Robert J. Shiller. 1987. Prices of Single-Family Homes Since 1970: New Indexes for Four Cities, *New England Economic Review*, September- October: 46-56.

Case, Karl E. and Robert J. Shiller. 1989. The Efficiency of the Market for Single Family Homes, *American Economic Review* 79: 125–37.

Case, Karl E. and Robert J. Shiller. 2003. Is There a Bubble in the Housing Market? Brookings Papers on Economic Activity, No. 2, 2003

FFIEC. 2006. Interagency Guidance on Nontraditional Mortgage Product Risks . September 25, 2006, available at www.ffiec.gov.

FFIEC. 2007. Interagency Statement on Subprime Mortgage Lending. June 28, 2007, available at www.ffiec.gov.

Foote, Chris, Kristopher Gerardi, Lorenz Goette, and Paul Willen, "What (We Think) We Know about the subprime Crisis and What We Don't," Federal Resserve Bank of Boston Public Policy discussion Paper 08-02, 2008.

Gabriel, Stuart, "Comments on 'The Consequences of Mortgage Credit Expansion: Evidence from the 2007 Mortgage Default Crisis,' NBER Conference on The Mortgage Crisis, April 24, 2008.

Glaeser, Edward, Joseph Gyrouko, and Raven Saks. 2005. Why Have Housing Prices Gone Up? *American Economic Review* 2: 329-333.

Gramlich, Edward. 2007. Subprime Mortgages: America's Latest Boom and Bust. Washington, D.C.: The Urban Institute Press.

Gyourko, Joseph, Albert Saiz, and Anita A. Summers. 2007. A New Measure of the Local Regulatory Environment for Housing Markets: The Wharton Residential Land Use Regulatory Index. *Urban Studies*, forthcoming.
Hamilton, James, "Did Fannie and Freddie Cause the Mortgage Crisis?" *Seeking Alpha*, http://seekingalpha.com/article/85146, posted July 16, 2008.

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

Inside Mortgage Finance. 2007. Non-Prime Market Share Plummets in 2007 as Alt A Mortgage Sector Overtakes Subprime. November 30, 2007, page 3.

Jaffee, Dwight M., and John M. Quigley, "Housing Subsidies and Homeowners: What Role for Government-Sponsored Enterprises?" Working Paper No. W06-006, Program on Housing and Urban Policy, Haas School of Business, University of California-Berkeley, January 2007.

Jones, Lawrence D. 1993. The Demand for Home Mortgage Debt. *Journal of Urban Economics* 33(1): 10-28.

LaCour-Little, Michael and Jing Yang. 2007. Alternative Mortgage Products and Housing Consumption. Working paper, California State University, Fullerton.

Leonnig, Carol D. "How HUD Mortgage Policy Fed the Crisis," *Washington* Post, June 10, 2008, p. A01.

Leamer, Edward. 2007. Housing and the Business Cycle. Paper presented at Symposium sponsored by the Federal Reserve Bank of Kansas City, Jackson Hole, Wyoming, Aug 30 - Sept 1, 2007.

Luhby,Tami, "Cracking Down on Mortgage Scammers," *CNNMoney.com*, July 30, 2008.

Malpezzi, Stephen. 1999. Housing Prices, Externalities, and Regulation in U.S. Metropolitan Areas. *Journal of Housing Research* 7(2): 209-241.

Malpezzi, Stephen. 1999. A Simple Error Correction Model of House Prices. *Journal of Housing Economics* 8(1): 27-62.

Malpezzi, Stephen and Duncan Maclennan. 2001. The Long-Run Price Elasticity of Supply of New Residential Construction in the United States and the United Kingdom. *Journal of Housing Economics* 10(3): 278-306.

McCarthy, Jonathan and Richard W. Peach. 2004. Are Home Prices the Next 'Bubble'? *FRBNY Economic Policy Review* 10 (3): 1-17.

McLean, Bethany, “The Fall of Fannie Mae,” *Fortune*, January 24, 2005.

Mian, Atif and Amir Sufi. 2008. The Consequences of Mortgage Credit Expansion: Evidence from the 2007 Mortgage Default Crisis. Working Paper, University of Chicago Graduate School of Business.

Mortgage Banking Magazine, various issues 2002-2008.

Muolo, Paul, and Matthew Padilla, *Chain of Blame*, Wiley, 2008.

Office of Federal Housing Enterprise Oversight, “OFHEO, SEC Reach Settlement with Fannie Mae; Penalty Imposed,” Press Release, May 23, 2006.

Pavlov, Andrey and Susan Wachter. 2006a. Aggressive Lending and Real Estate Markets. Working Paper, The Wharton School, University of Pennsylvania.

Pavlov, Andrey and Susan Wachter. 2006b. Underpriced Lending and Real Estate Markets. Working Paper, The Wharton School, University of Pennsylvania.

Pavlov, Andrey and Susan Wachter. 2004. Robbing the Bank: Short-term Players and Asset Prices. Journal of Real Estate Finance and Economics. 28:2/3, 147-160.

Shiller, Robert J. 2007. Understanding Recent Trends in House Prices and Home Ownership. Paper presented at Symposium sponsored by the Federal Reserve Bank of Kansas City, Jackson Hole, Wyoming, Aug 30 - Sept 1, 2007.

Stevenson, Richard W., “Defending Home Turf from Attack; Fannie Mae is Facing Assault by House Panel and Business Rivals,” *The New York Times*, April 22, 2000.

Syron, Richard F., Letter to James B. Lockhart, Director OFHEO, July 31, 2006.

Tierney, John, “Privileged Life in Peril for 2 Mortgage Giants,” *The New York Times*, June 17, 2003.

Thomas, Jason. 2003. Problems and Freddie Mac and Fannie Mae: Too Big to Fail? *Republican Policy Committee, United States Senate*. September 9.

United States Government Accountability Office. 2006. Alternative Mortgage Products . Report to the Chairman, Subcommittee on Housing and Transportation, Committee on Banking, Housing, and Urban Affairs, U.S. Senate. GAO-06-1021.

Wall Street Journal (2007a). Battle Lines Form Over Mortgage Plan. December 7, 2007: A1.

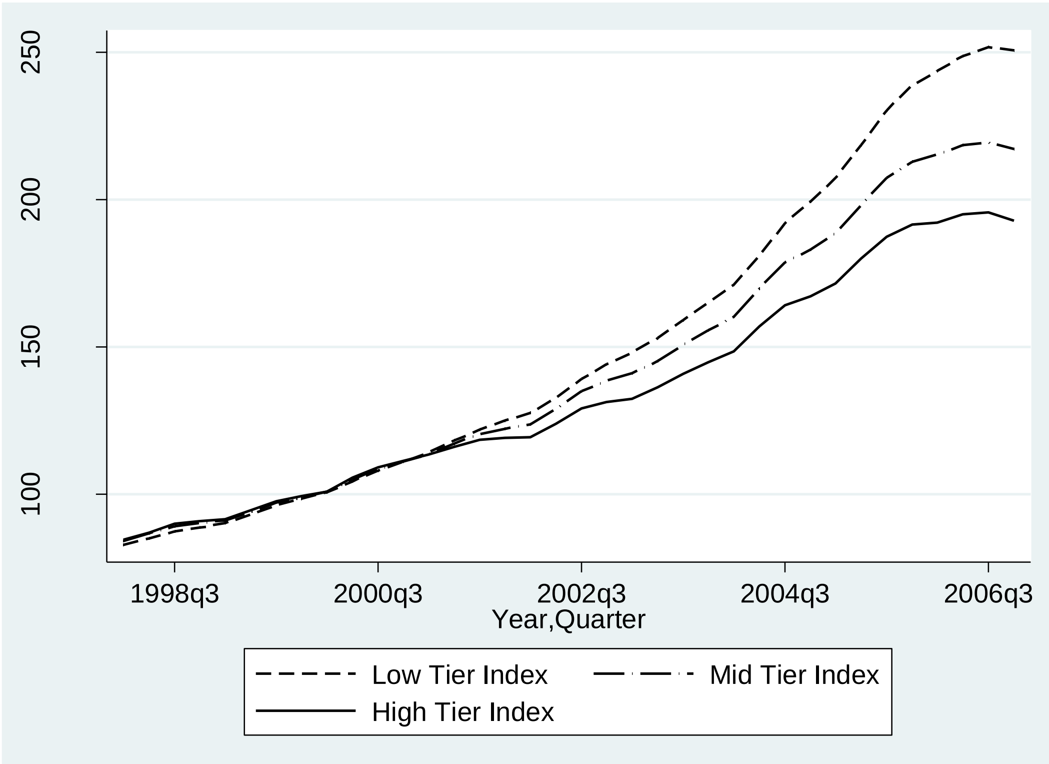
Wall Street Journal (2007b). U.S. Mortgage Crisis Rivals S&L Meltdown. December 10, 2007: A1.

Westley, Steve. 2007. Overview of the Subprime Mortgage Crisis. U.S. Government Accountability Office. Presentation at the Hudson Institute.

Wheaton, William C. and Gleb Nechayev. 2007. The 1998-2005 Housing "Bubble" and the Current "Correction": What's Different This Time? *Journal of Real Estate Research*, forthcoming.

Figure 1

Case-Shiller Housing Price Indices by Price Tier

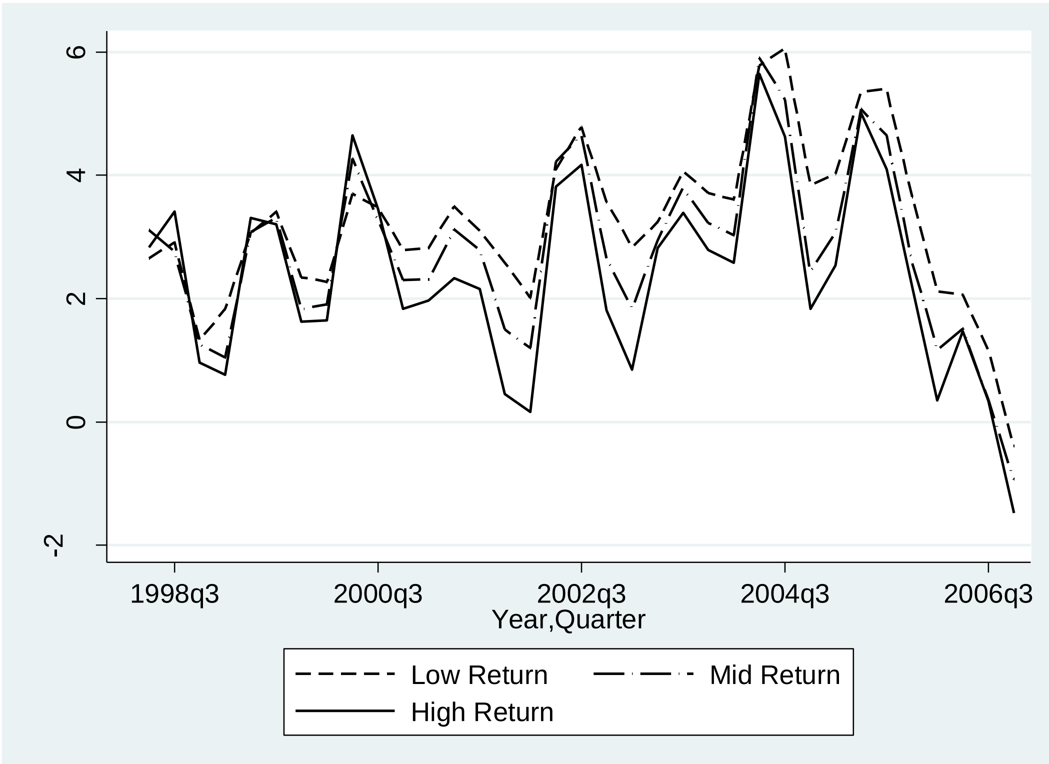


Single-family home purchase transactions are classified into terciles by price of the home. All three tiers are standardized to 100 at the start of 2000. SPCS20R is for all 20 Case-Shiller metro areas and has data back to 2000. CSXR is for the 10 largest areas and has data back to 1987.

Source: S&P Case-Shiller Home Price Index

Figure 2

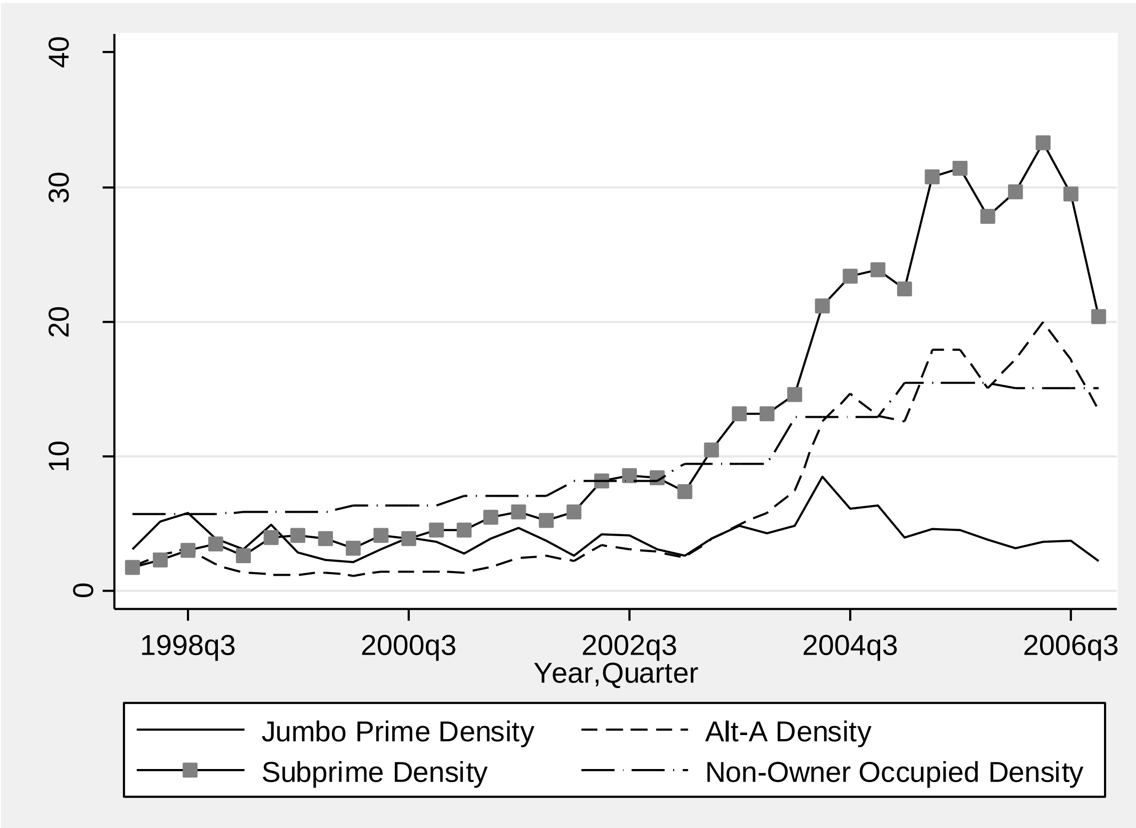
Quarterly Returns in the Case-Shiller Housing Price Indices by Price Tier



Single-family home purchase transactions are classified into terciles by price of the home.
Source: S&P Case-Shiller Home Price Index

Figure 3

Loan Type Origination Density

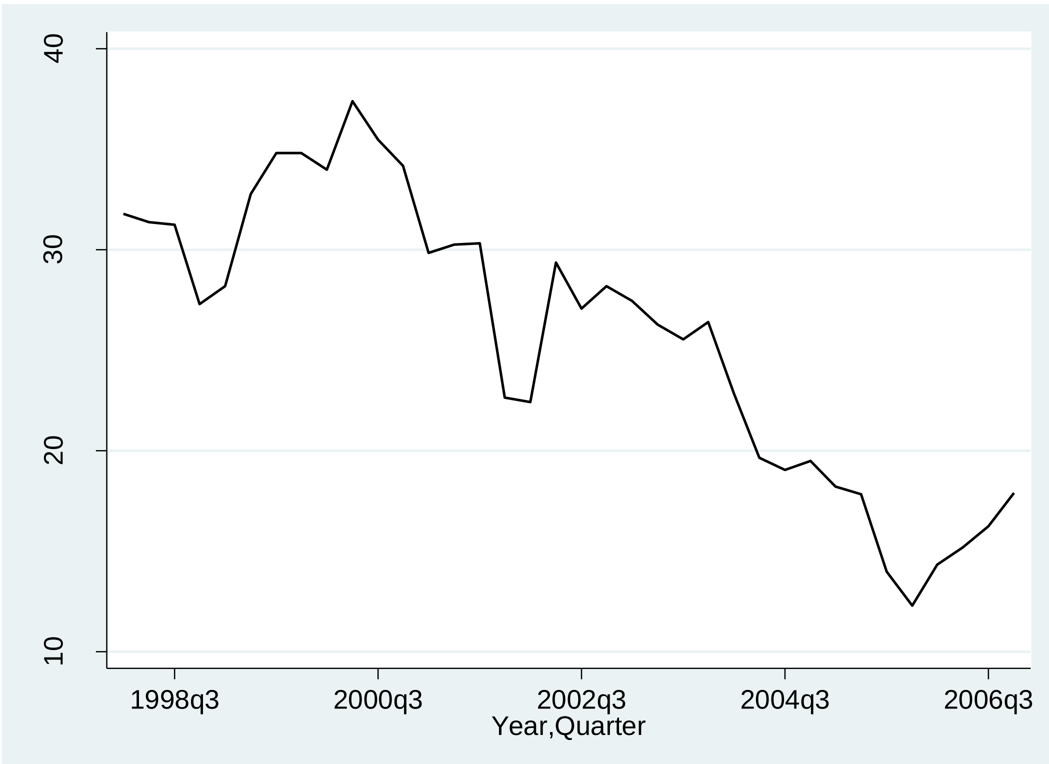


Counts of each loan type are divided by total count of HMDA loans resulting in the percent of total loans accounted for by each loan type. Percent prime can be approximated as 1-(Percent_MBS+Percent_AltA+Percent_BC). Subprime lending intensity peaks mid-year 2006.

Source: Loan Performance and HMDA

Figure 4

Percent of first Mortgage Loans with Loan-to-Value Ratios over 90%

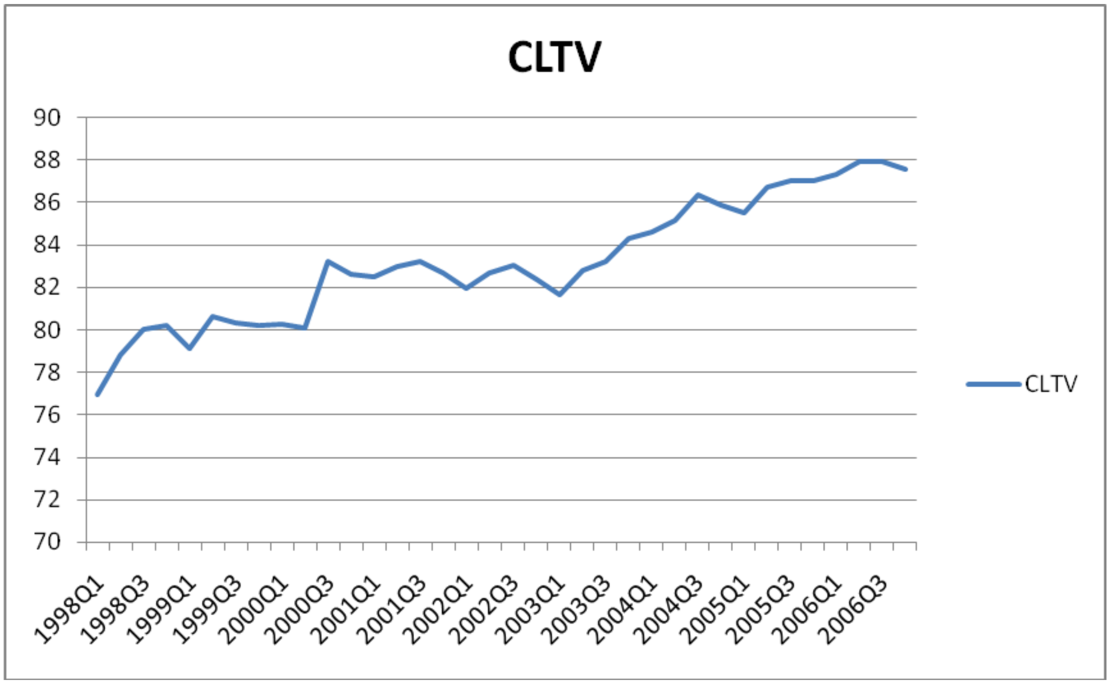


Includes Loan Performance loan origination counts for the 20 MSA's used to calculate the Case-Shiller 20 Index.

Source: Loan Performance

Figure 5

Combined Loan-to-Value Ratio (CLTV) over time for Case-Shiller 20 MSAs*



*Does not include Boston MSA

Source: Loan Performance

Table 1

Summary Statistics for the 20 Case-Shiller MSA Sample, 1998Q1-2006Q4

Variable	Mean	Std. Dev.	Min	Max
Case-Shiller Home Price Index	134.76	44.48	76.73	280.03
Case-Shiller quarterly return	2.03	2.23	-4.25	16.11
Case-Shiller Low Price Tier quarterly return	2.61	2.46	-4.53	15.06
Case-Shiller Mid Price Tier quarterly return	2.26	2.41	-3.20	18.13
Case-Shiller High Price Tier quarterly return	2.06	2.30	-4.16	15.87
Loan Variables				
Loan counts				
Jumbo Prime loan count	651	650	5	4,414
Alt-A loan count	1,247	1,732	38	10,281
Subprime loan count	2,295	2,890	5	15,928
Non-owner occupied loan count	1,730	1,538	260	11,566
Loan densities				
Jumbo Prime loan density	5.1%	7.9%	0.2%	69.3%
Alt-A loan density	8.7%	12.0%	0.4%	79.3%
Subprime loan density	13.2%	12.7%	1.0%	81.8%
Non-owner occupied loan density	9.6%	5.5%	2.2%	30.0%
Mortgages>90%LTV	25.7%	14.2%	0.2%	56.3%
Combined LTV*	83.2	4.5	71.8	92.9
ARM density, nationally	21.7%	8.4%	9.7%	37.7%
Supply side restrictions				
WRLURI	0.3128	0.5464	-0.6191	1.3566
Metropolitan specific economic fundamentals				
Unemployment rate	4.7%	1.3%	1.8%	8.7%
Population	4,907,559	4,076,896	1,233,759	18,800,000
Income	$36,174	$5,784	$25,243	$57,430
National macroeconomic variables				
CPI Urban (1984=100)	182.2	13.1	161.9	208.9
Outstanding Home Mortgages ($Mill)	$6,677,724	$1,990,834	$4,044,035	$10,700,000
Real GDP ($Bill, 2000)	$10,220	$723	$8,936	$11,631
Aggregate personal savings ($Bill)	148.311	78.95198	-48.8	291.7
S&P 500 Index	$1,182.32	$156.70	$860.76	$1,475.98
Cost of capital				
Effective Mortgage Rate, nationally	6.66%	0.75%	5.60%	8.10%
US govt 10yr/2yr YTM	1.3765	0.5074	0.9410	2.5469

*Does not include Boston MSA

Table 2

Case-Shiller metro areas*:
Percent changes in metropolitan area data from 1998Q1-2006Q4

	Percent Change				
Metropolitan Area	Subprime intensity	Non-owner intensity	Per-capita Income	Population	HPI
Washington	2038%	261%	48%	15%	171%
San Diego	1778%	104%	57%	8%	205%
Detroit - MI	1468%	434%	27%	1%	41%
Chicago	1409%	177%	35%	7%	87%
Denver	1349%	164%	43%	19%	71%
Phoenix - AZ	1333%	146%	37%	35%	156%
Los Angeles	1318%	66%	42%	8%	235%
Cleveland - OH	1301%	151%	31%	-2%	33%
New York	1249%	85%	41%	5%	155%
Minneapolis - MN	1198%	302%	36%	11%	105%
Boston	1120%	70%	49%	3%	117%
Las Vegas	1065%	226%	34%	47%	149%
Seattle - WA	1016%	130%	40%	11%	117%
Charlotte - NC	987%	214%	35%	28%	39%
Miami	851%	90%	44%	14%	208%
Portland - OR	802%	131%	33%	16%	93%
Tampa - FL	673%	238%	39%	17%	156%
San Francisco	670%	40%	50%	4%	179%
Atlanta - GA	643%	280%	24%	31%	53%
Dallas - TX*	470%	255%	21%	18%	24%

Mortgage type intensities are calculated as the number of loans originated of a given type divided by the total number of HMDA loans originated. *Dallas: Case-Shiller HPI data began in 2000Q1, thus all changes for Dallas are over the period 2000Q1-2006Q4.

Sources: Loan Performance, HMDA, Bureau of Economic Analysis, S&P Case-Shiller Home Price Index

Table 3

Case-Shiller metro areas:
Subprime loan intensity vs. income and population

	As of 2006 4th Quarter		
Metropolitan Area	Subprime intensity	Per-capita Income	Population
Los Angeles	33%	$40,144	12,958,274
Detroit - MI	31%	$38,504	4,463,822
Miami	31%	$40,689	5,483,437
Las Vegas	26%	$36,977	1,811,627
San Diego	25%	$43,911	2,943,877
Phoenix - AZ	25%	$34,660	4,119,511
Dallas - TX	23%	$40,176	6,094,429
Washington	21%	$52,462	5,309,786
Denver	19%	$45,264	2,432,236
Tampa - FL	18%	$35,814	2,723,327
Portland - OR	18%	$38,003	2,158,062
Cleveland - OH	18%	$37,894	2,108,664
Atlanta - GA	18%	$36,357	5,221,225
Chicago	17%	$42,266	9,535,340
New York	16%	$49,962	18,820,944
Minneapolis - MN	15%	$44,499	3,192,037
Boston	15%	$51,544	4,458,383
Seattle - WA	15%	$45,538	3,291,300
Charlotte - NC	13%	$38,954	1,613,787
San Francisco	13%	$57,430	4,191,035

Subprime intensity is calculated as the number of subprime loans originated divided by the total number of HMDA loans originated.

Sources: Loan Performance, HMDA, Bureau of Economic Analysis

Table 4
Pairwise Correlations of Area Specific Data

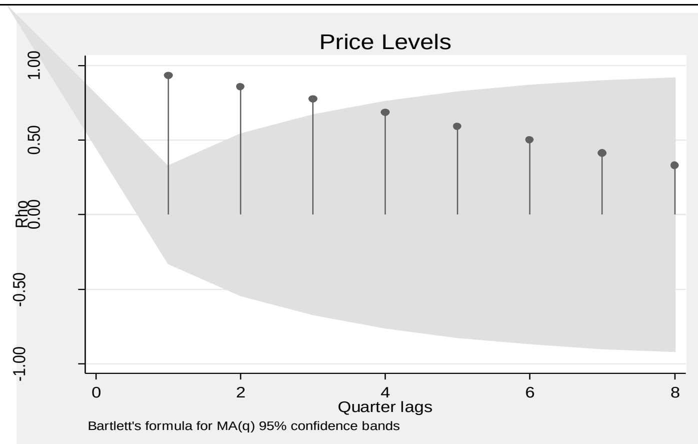
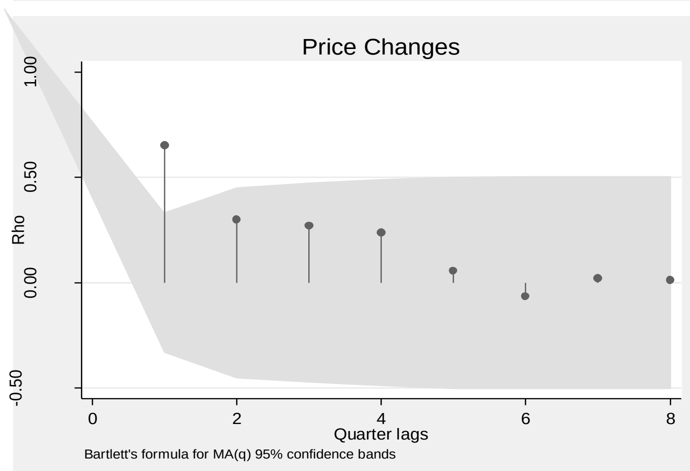
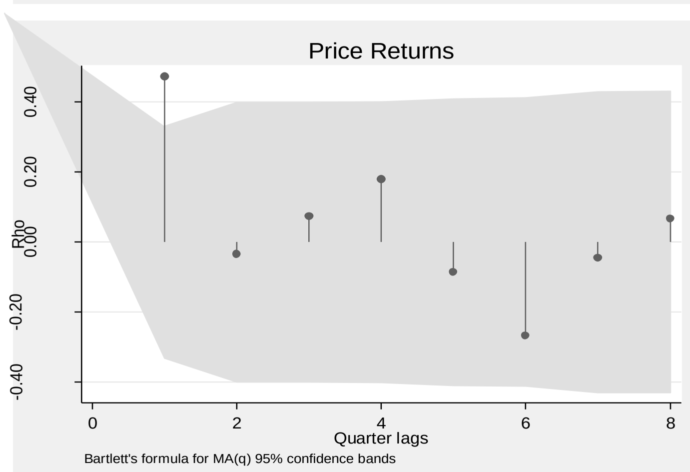
	Quarterly HPI Returns	Subprime Origination Density	Alt-A Origination Density	Non-owner Occupied Origination Density	Jumbo Prime Origination Density	Unemployment Rate	Per-capita Income	Population	WRLURI	Yield curve slope (10/2)	Private ABS Share of new mortgages
Quarterly HPI Returns	1										
Subprime Origination Density	-0.0229	1									
Alt-A Origination Density	-0.0995	0.4133	1								
Non-owner Occupied Origination Density	0.2176	0.2823	0.4027	1							
Jumbo Prime Origination Density	0.0159	0.0979	0.511	0.0796	1						
Unemployment Rate	-0.0901	0.2168	-0.0406	0.1458	-0.0667	1					
Per-capita Income	0.0337	0.3133	0.3995	0.1434	0.4855	0.0277	1				
Population	0.123	0.1468	0.1554	-0.1128	0.2795	0.1961	0.3526	1			
WRLURI	0.1566	0.022	0.1039	-0.0004	0.2361	-0.0112	0.363	0.1131	1		
Yield curve slope (10/2)	0.1129	-0.1115	-0.1587	0.0774	-0.0745	0.5996	0.0561	0.0033	0	1	
Private ABS Share of new mortgages	0.0246	0.6334	0.5809	0.3927	0.0657	0.1134	0.3562	0.0096	0	-0.1491	1

Pairwise correlations are calculated across all 20 Case-Shiller metropolitan areas and across all quarters, 1998Q1-2006Q4. Subprime origination intensity is calculated as the number of subprime loans originated divided by the total number of HMDA loans originated. Non-owner occupied origination intensity is calculated similarly. WRLURI is a cross-sectional variable that is static through time.

Gyourko, Saiz, and Summers (2007) find that higher land use regulation is associated with a higher income area. This is confirmed in our Case-Shiller Metropolitan area sample.

Source: Loan Performance; HMDA; Bureau of Economic Analysis; S&P Case-Shiller Home Price Index; Gyourko, Saiz, and Summers (2007); Bureau of Labor Statistics

Table 5
Momentum in Housing Price Levels, Changes, and Returns

Price measure	Correlograms	Rho estimate	Durbin-Watson
Levels		1.06	.16
Changes		.63	.76
Returns		.80	.66

Correlograms show autocorrelations over a two year period. Only price changes show significant autocorrelation beyond one year. Rho estimates are calculated with Prais-Winsten iterative algorithm. Durbin-Watson statistics are calculated with residuals from OLS on our main reduced-form model.

Table 6

Base Model 1a: Independent Variable – Quarterly Returns in the HPI, by Price Tier 1998Q1 – 2006Q4

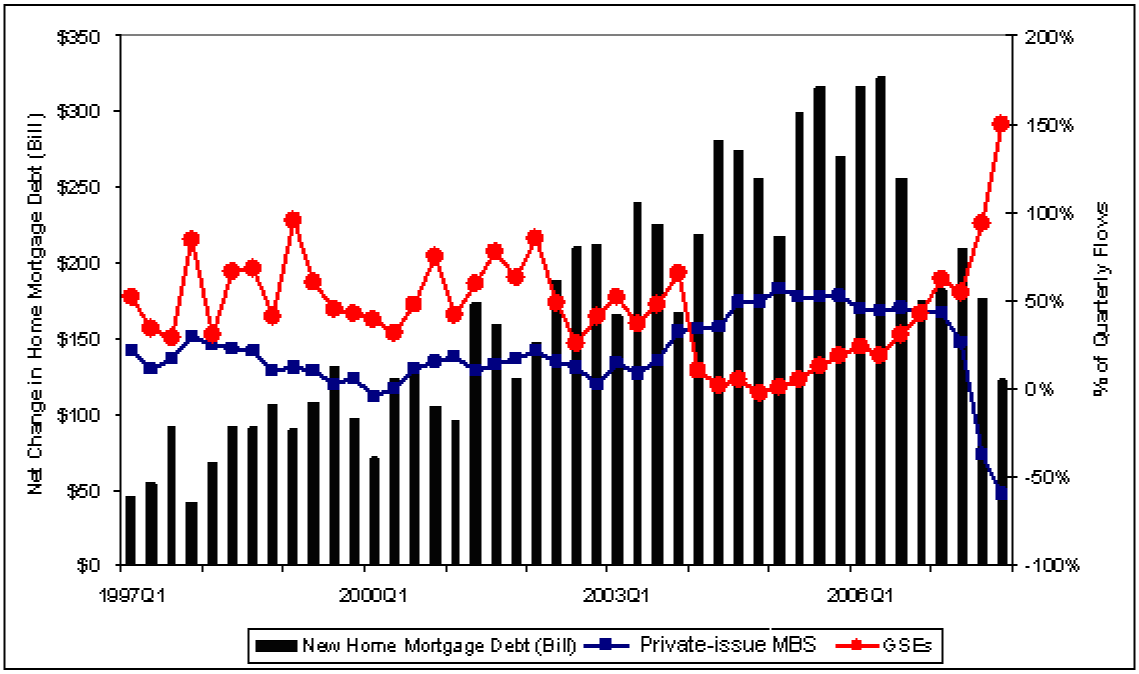
N	584	496	496	496
R^2	0.534	0.4608	0.5471	0.5607
Adjusted R^2	0.5060	0.4223	0.5148	0.5293
Case-Shiller HPI returns	**All Tiers**	**Low Tier**	**Mid Tier**	**High Tier**
Jumbo Prime				
no lag	0.03768 (0.73)	0.04354 (1.07)	0.05825 (1.1)	0.06884 (0.99)
3 month lag	-0.11661 (-3.49)	-0.0097 (-0.26)	-0.12191 (-3.39)	-0.17426 (-4.66)
6 month lag	-0.16692 (-2.85)	-0.13395 (-2.85)	-0.18952 (-3.71)	-0.21256 (-2.79)
9 month lag	0.07352 (2.92)	0.02911 (1.07)	0.08133 (2.44)	0.07247 (3.09)
12 month lag	0.239 (9.94)	0.12163 (4.39)	0.2391 (8.65)	0.28233 (10.26)
Alt-A density				
no lag	0.12052 (2.03)	0.08869 (2.17)	0.13748 (2.28)	0.11517 (3.08)
3 month lag	0.02582 (0.7)	0.01531 (0.58)	-0.00564 (-0.12)	-0.03501 (-0.7)
6 month lag	-0.03972 (-1.37)	-0.07493 (-2.83)	-0.04689 (-1.21)	-0.00936 (-0.21)
9 month lag	-0.02779 (-0.52)	-0.01794 (-0.35)	-0.04439 (-0.94)	-0.06066 (-0.98)
12 month lag	-0.08139 (-2.18)	-0.06512 (-1.57)	-0.10067 (-2.33)	-0.0333 (-0.82)
Subprime density				
no lag	0.03257 (1.16)	0.07877 (2.41)	0.0424 (1.94)	0.05003 (2.18)
3 month lag	-0.02595 (-1.35)	0.01102 (0.54)	-0.00912 (-0.42)	-0.0087 (-0.33)
6 month lag	-0.02414 (-0.94)	-0.03075 (-1.05)	-0.03156 (-1)	-0.06154 (-1.91)
9 month lag	-0.00848 (-0.41)	-0.00398 (-0.13)	-0.00328 (-0.15)	0.02928 (1.01)
12 month lag	0.02492 (0.85)	0.02836 (0.81)	0.05037 (1.6)	0.04368 (1.25)
Non-owner occ. density				
no lag	0.22412 (7.29)	0.27425 (10.17)	0.27147 (8.03)	0.265 (8.78)
3 month lag	0.32986 (3.86)	0.30902 (4.99)	0.32563 (3.39)	0.33522 (3.28)
6 month lag	0.08758 (1.93)	0.09312 (4.35)	0.09395 (1.2)	0.09323 (1.7)
9 month lag	-0.21922 (-2.16)	-0.22218 (-2.13)	-0.25375 (-2.15)	-0.24727 (-2.17)
12 month lag	-0.26499 (-4.67)	-0.27441 (-5.78)	-0.25606 (-4.01)	-0.30764 (-5.22)
Combined LTV (CLTV)	-0.00225 (-0.04)	-0.16021 (-2.8)	0.00061 (0.01)	0.00048 (0.01)
Aggregate Home Mtgs ($trill)	-1.98233 (-2.81)	-0.79054 (-1.04)	-1.89208 (-2.09)	-2.5936 (-3.64)
Real GDP ($bill)	0.00232 (1.67)	-0.00058 (-0.28)	0.00268 (1.22)	0.00377 (2.23)
Aggregate personal savings ($bill)	0.00008 (0.13)	-0.0005 (-0.46)	0.00002 (0.02)	0.00071 (0.89)
S&P 500 Index	-0.00156 (-1.83)	-0.00113 (-0.83)	-0.00224 (-1.79)	-0.00122 (-1.05)
US govt 10yr/2yr YTM	-0.28235 (-0.77)	-0.42171 (-1.03)	-0.46114 (-0.88)	-0.14534 (-0.29)
Population (in 100,000's)	0.01335 (3.24)	0.00613 (1.52)	0.013 (2.89)	0.0095 (2.79)
Unemployment Rate (%)	-0.40178 (-3.05)	-0.2794 (-1.97)	-0.27189 (-1.77)	-0.37617 (-2.61)
Income ($1000)	0.01795 (0.3)	0.06506 (0.97)	0.05755 (0.97)	0.04103 (0.9)
Average Mortgage Rate (%)	-0.085 (-0.25)	-0.16391 (-0.44)	-0.09089 (-0.2)	-0.22272 (-0.47)
Urban CPI (1984=100)	0.11381 (1.2)	0.03884 (0.46)	0.0499 (0.52)	0.10899 (1.02)
WRLURI	0.57372 (2.2)	0.19881 (0.51)	0.3834 (1.3)	0.47531 (2.19)
Intercept	-27.99091 (-1.59)	18.95099 (0.97)	-22.02453 (-0.95)	-38.94446 (-2.3)
Rho	0.6695297	0.6159624	0.6696074	0.5596928
Durbin-Watson	1.667907	1.814806	1.598976	1.740831

Table 7
Testing for Endogeneity between Subprime Origination Intensity and Housing Returns

N	562
Adjusted R^2	0.5873
Subprime Intensity	**1998Q1-2006Q4**
Housing returns	
no lag	0.1599 (2.61)
3 month lag	0.02415 (0.25)
6 month lag	0.22269 (3.04)
9 month lag	0.28475 (3.61)
12 month lag	0.34383 (3.68)
CLTV	0.61817 (6.69)
Aggregate Home Mortgages (Trill)	16.53315 (13.67)
Real GDP ($bill)	0.01802 (10.1)
Aggregate personal savings ($bill)	0.00309 (3.74)
S&P 500 Index	-0.00944 (-10.26)
US govt 10yr/2yr YTM	-3.08939 (-11.11)
Population (in 100,000's)	0.00025 (0)
Unemployment Rate (%)	0.40545 (1.58)
Income ($1000)	-1.38444 (-3.43)
Average Mortgage Rate (%)	-1.56867 (-4.64)
Urban CPI (1984=100)	1.09384 (11.7)
WRLURI	0.61689 (0.14)
Intercept	-294.0851 (-13.34)
Rho	1.027845
Durbin-Watson	1.673599

Figure 6

Total and GSE vs. Private-Issue MBS Share of Net Home Mortgage Flows
1997Q1 – 2007Q4



Source: Federal Reserve Board, *Flow of Funds Accounts*. Percent of Quarterly Flow can be negative or greater than 100% because institutions may sell or buy home mortgages from each other in addition to buying newly originated home mortgages

Table 8

Housing Price Return Model Before and After GSEs' Decline in Share of Originations

	Model 2a Regime I	Model 2b Regime II
N	337	228
Adjusted Rsqr	0.5333	0.6178
Case-Shiller HPI returns	**1998Q1-2003Q3**	**2003Q4-2006Q4**
Jumbo Prime		
no lag	-0.04773 (-0.92)	0.00851 (0.24)
3 month lag	-0.3041 (-9.77)	0.02819 (0.62)
6 month lag	-0.11742 (-2.27)	-0.05424 (-0.55)
9 month lag	0.00833 (0.27)	0.04439 (0.68)
12 month lag	0.32714 (10.74)	-0.08766 (-1.27)
Alt-A density		
no lag	-0.03894 (-0.29)	0.23538 (4.26)
3 month lag	0.32 (2.58)	-0.02826 (-0.51)
6 month lag	-0.26848 (-0.87)	-0.08275 (-2.05)
9 month lag	0.23187 (1.51)	-0.02114 (-0.4)
12 month lag	0.2209 (2.1)	-0.0639 (-1.47)
Subprime density		
no lag	0.17434 (2.01)	-0.01391 (-0.47)
3 month lag	-0.05126 (-0.58)	-0.0587 (-1.47)
6 month lag	-0.17546 (-1.84)	0.00315 (0.1)
9 month lag	0.13687 (1.83)	0.00381 (0.11)
12 month lag	-0.01264 (-0.16)	0.03545 (1.08)
Non-owner occ. density		
no lag	-0.0015 (-0.02)	0.35189 (5.84)
3 month lag	0.3117 (3.06)	0.15998 (1.21)
6 month lag	0.0272 (0.33)	0.15443 (2.06)
9 month lag	0.06846 (0.42)	-0.26134 (-1.48)
12 month lag	-0.30898 (-2.22)	-0.29717 (-3.32)
Combined LTV (CLTV)	-0.03886 (-1.06)	-0.19618 (-2.02)
Aggregate Home Mortgages (Trill)	0.31955 (0.2)	2.55352 (1.68)
Real GDP ($bill)	-0.00107 (-0.88)	-0.01742 (-2.47)
Aggregate personal savings ($bill)	-0.00137 (-0.88)	-0.00166 (-0.57)
S&P 500 Index	-0.00124 (-0.85)	-0.00209 (-0.2)
US govt 10yr/2yr YTM	-2.19021 (-1.45)	-3.98686 (-5.6)
Population (in 100,000's)	0.00624 (1.28)	0.00415 (0.69)
Unemployment Rate (%)	-0.44089 (-3.08)	-0.23415 (-1.12)
Income ($1000)	0.13645 (2.43)	-0.02624 (-0.31)
Average Mortgage Rate (%)	0.34659 (1.47)	-0.28825 (-0.11)
Urban CPI (1984=100)	0.18763 (1.93)	0.22497 (0.75)
WRLURI	0.14084 (0.67)	0.71278 (1.42)
Intercept	-21.38322 (-1.59)	153.4307 (1.74)
rho	0.5312735	0.7264739
Durbin-Watson	1.765077	1.603208