Subprime Lending and the Housing Bubble:

Tail Wags Dog?

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ABSTRACT

Significant policy attention and concern has been focused recently upon the extent, degree, and duration of the "housing bubble" associated with the sharp rise and then drop in home prices over the period 1998-2008. The widespread availability of subprime and other alternative mortgage products during this period, while arguably increasing homeownership rates (at least temporarily), has been broadly blamed for these market outcomes. In this paper we empirically investigate the validity of this proposition against several other alternative explanations. After a general discussion of past research framing alternative mechanisms possible for generating observed house price patterns, we specify a model of house price dynamics. A cross-sectional time-series data base across 20 metropolitan areas over the period 1998-2006 is used for estimation. The dependent variable is quarterly house price returns. Beyond traditional economic explanatory variables, we consider measures of the density of subprime and other alternative mortgage originations, investor home purchase mortgage activity, and a measure of supply side constraints. Results suggest that prior to late 2003, 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, although there is strong evidence of a price-boosting effect by investor loans. Alt-A and Jumbo origination activity tend to have cyclical effects on subsequent house price returns over a year duration, but in different directions, so the overall picture is unclear. Evidence also supports the importance of land use regulatory restrictiveness on the supply side in driving up house price returns, though the economic significance is low. Most significantly, we find evidence that the changing credit regime that took place in late 2003, as the GSE's pulled back from the market for political, regulatory, and market-based reasons, is suggested to be a primary factor reducing the dominance of market fundamentals in affecting house price returns and creating the price-momentum conditions characteristic of a "bubble". 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 economic, political, and regulatory environment characteristic of the early- to mid-2000's (the "dog").

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Introduction

Recent turmoil in the mortgage market -- in particular the contraction in liquidity occurring during 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] -- have attracted considerable attention from the media, policymakers, and analysts. It is now widely recognized that prices in the housing market, after a number of years of very rapid growth, have declined since sometime in early 2006. As of November 2007, based on the Case-Shiller repeat sales index (CS Index)[2], real home prices had fallen 3.4% since the first quarter of 2006 (Shiller [2007]). More recent CS Index data as of January 2008 showed a 12.5% decline in aggregate house prices over the last year with larger percentage declines in some metropolitan areas, including Detroit (18.6%), Miami (19.0%), Las Vegas (20.4%), Los Angeles (17.9%), and Phoenix (20.8%). In contrast, in some metropolitan areas, including Portland, Seattle, and Charlotte, the index indicates continued house price appreciation. Figures 1 and 2 depict the CS Index in levels and as quarterly returns over the period 1998-2007 in the aggregate and by price level tiers (lowest, middle, and highest third of prices). Note that the lowest tier displayed the highest returns over this period, while the highest tier displayed the lowest returns.

The widespread availability of subprime and other alternative mortgage products during this period, while arguably increasing consumption levels and homeownership rates, has been broadly blamed for these outcomes. The combined share of subprime and alternative mortgage products peaked at 34.8% of all mortgages originated during the first quarter of 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 four alternative explanations for the current dynamic that have been, or could be, offered: (1) economic fundamentals (e.g., employment, income, population

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

[2] This index, including the composite depicted and individual indices for 20 major metropolitan areas, is based on the work on repeat sales of Case and Shiller (1987, 1989). A futures product based on the index began trading on the Chicago Mercantile Exchange in May 2006.

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; and (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 other mortgage products.[3]

Policymaker concern regarding current housing market conditions stems, in part, from the fact that the majority of U.S. recessions since 1950 have been preceded by problems in the housing sector (Leamer [2007]). In addition, to some extent as the result of house price declines, default and foreclosure rates have also been increasing significantly. According to the Mortgage Banker's Association, the delinquency rate for mortgage loans on one-to-four unit residential properties was 5.82% during the fourth quarter of 2007 on a seasonally adjusted basis, up from 4.95% one year earlier. Likewise, the percentage of loans entering the foreclosure process was 2.05% of all loans outstanding at the end of the third quarter of 2007, up from 1.19% one year earlier.[4] Many of these problems are related to the subprime mortgage sector, where default and foreclosure rates are even higher. According to Loan Performance[5] as of September 2007, the overall serious delinquency rate on subprime loans was 13.2%.; more recent estimates are even higher. For example, Federal Reserve Governor Randall Krasner cited a 17% serious delinquency rate for subprime adjustable-rate mortgages and a quarterly rate of 320,000 foreclosures nationwide, up 50% from levels experienced during 2005-2006 [Federal Reserve (2007)]. In addition, media sources have recently reported a substantial increase in delinquencies among prime ARM borrowers (Wall Street Journal [2007a]). Recent policy initiatives to mitigate foreclosure have focused on the payment shock likely to be encountered by households with subprime ARMs, a large number of which will re-set to higher interest rates in the near term, primarily through the expiration of "teaser rates" (see Figure 3).

Losses to mortgage investors continue to mount, with current estimates of total losses ranging from $150-400 billion (Wall Street Journal [2007b]). In late July 2007, Bear Stearns announced the bankruptcy and liquidation of two large hedge funds that used leverage to invest in Collateralized Debt

[3] 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.

[4] Mortgage Bankers Association National Delinquency Survey March 6, 2008.

[5] LoanPerformance.com: *The Market Pulse*.

Obligations backed by subprime mortgage loans[6]. In March 2008, Bear Stearns itself agreed to be acquired by JP Morgan Chase & Co. in a move to stave off bankruptcy. A number of other large mortgage market participants have entered bankruptcy protection, including New Century, formerly one of the largest subprime specialists, and American Home Mortgage, an Alt-A specialist, and mainstream lenders have retreated from indirect, wholesale origination channels[7]. During the first week of August 2007, credit spreads widened dramatically throughout the nonconforming mortgage market, affecting even prime jumbo mortgage rates, as well as Alt-A and subprime market segments. During the third quarter of 2007, a number of major financial institutions reported write-downs in the billions of dollars, with several high level executive departures resulting, including CEOs at Citigroup and Merrill Lynch. As a result, the share of new loans that were subprime plunged during the 3rd Quarter, while Alt-A volume stayed relatively constant, with the two categories together accounting for 14.4% of new loan origination volume, down from a peak level in early 2006 of almost 35% (Inside Mortgage Finance [2007]).

Literature Review

The literature on house price dynamics is voluminous, so our review here is necessarily limited. Focusing on the measurement of house price movements, Case and Shiller (1987, 1989) develop the repeat sales methodology, now widely viewed as the best available method for assessing house price movement over time.[8] Case and Shiller find considerable momentum in house price changes; however, transaction costs make profitable trading strategies difficult. Since 2006, a futures product based upon the Case-Shiller Index has been traded on the Chicago Mercantile Exchange[9]. Similar, though not identical, indices for all metropolitan statistical areas are publicly available from the Office of Federal Housing Enterprise Oversight (OFHEO), with technical details about development of the index available in Calhoun (1996). One issue with the OFHEO index is that some of the data points used for

[6] The Bear Stearns High-Grade Structured Credit Strategies Master Fund Ltd. and the Bear Stearns High-Grade Structured Credit Strategies Enhanced Leverage Master Fund Ltd. filed for protection under Chapter 15 of the bankruptcy code, according to court documents.

[7] Indirect or wholesale channels include loans sourced through brokers or correspondent lending relationships and are generally viewed as riskier than retail loan originations.

[8] Case and Shiller acknowledge that their index built upon earlier work by Bailey, Muth, and Nourse (1963).

[9] See http://www.cme.com/trading/prd/re/housing.html

index estimation are based on mortgage loan refinancing transactions in which an appraisal, rather than an arm's length sale, establishes the property's value at a point in time, although recently OFHEO has made available a sale-only index. Another issue has to do with the fact that the OFHEO index is made up only of Fannie Mae or Freddie Mac loans, hence is a biased sample of the market.

Capozza, Hendershott, and Mack (2004) summarize the literature on house price forecasting models. They contend that there is wide consensus that employment and population growth cause rents and prices to increase. They also argue that there is further consensus that prices should increase with income and move inversely with the level of interest rates or, more broadly, the cost of capital.

Turning to the recent literature on the housing bubble, Case and Shiller (2003) begin by noting that the term "bubble" is widely used but rarely precisely defined. They argue that the term 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 argue 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 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.

More recently, Mian and Sufi (2008) make use of micro-level data at the Zip Code level to examine the dynamic of freeing latent demand through the offering of aggressive lending vehicles, which they found was intimately bound up with the immediate sale of such loans into securities. They attribute increases in house prices followed by sharp subsequent rises in default and rapid house price declines in high latent-demand neighborhoods to the moral hazard facing originators selling into such conduits.

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.

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 caused by regulation, could be primarily responsible for house price growth patterns.[10] 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 since the late 1990s as a classic speculative bubble, driven mainly by extravagant expectations for future price increases, and argues that survey research measuring the extent to which consumer expectations of house price expectations are inflated confirms this description.

Most recently, in a paper most closely related to our work, Wheaton and Nechayev (2007) (henceforth W-N) investigate whether the growth in housing prices between 1998 and 2005 can

[10] 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.

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.

The literature on mortgage lending is likewise extensive, so we merely note briefly important earlier and more recent research addressing related topics. Early literature addressed the demand for mortgage debt (Jones [1993], Brueckner [1994]) and the demand for alternative mortgage products, such as those allowing variable interest rates (Brueckner and Follain [1988]). More recent patterns in the mortgage market as revealed by Home Mortgage Disclosure Act (HMDA) data , in particular the rapid growth of non-prime lending, the increased volume of lending on properties that are not owner-occupied, and the increasing use of simultaneous-close second liens (also called "piggybacks"), have been described by Avery, Brevoort, and Canner (2007). 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 (FFIEC [2006, 2007]).[11] LaCour-Little and Yang (2007) trace the history of recent mortgage contract innovations and set out a formal model of the choice of alternative mortgage products, 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) provides a

[11] 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/).

detailed discussion of the rise of subprime lending, its role in increasing home ownership rates among traditionally under-served households, and the risks associated with this development.

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

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.[12]

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.[13] 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.[14] Finally, "flipping" of properties within a year by investors/ redevelopment contractors could increase the supply of homes on the market, thus driving down returns.[15]

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

[12] 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.

[13] 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 purchses.

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

[15] 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.

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.[16]

Figure 4 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 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% for first liens, thus suggesting that the notion of higher LTV's after 2003 due to increases in alternative mortgage densities was not consistent with the empirical evidence.

Because of the lack of MSA-specific LTV information in the MIRS data, we made use of LTV information from Loan Performance, 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 density 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 5).

[16] 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.

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. This anomaly is possibly explained by the increased use of "piggy-back" second liens and "80-10-10" financing to substitute for PMI or simply draw equity out during over the observation period.[17] Unfortunately, a consistent data base that includes all sources of borrowing and total LTV at origination by source does not exist for individual MSA's and all originations over the observation period. Thus, we must merely note that the effect of our Percent of Mortgage Originations over 90% LTV variable may not be an adequate proxy for high-ratio lending.

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 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. Note that although W-N use the OFHEO index, with its problems as noted above, this nonetheless enables them to enlarge their sample size to 59 metropolitan markets. We attempt to replicate our estimation results using the OFHEO index, but found the noise from OFHEO's appraisal-based valuations, as discussed above, 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.

[17] See Charels 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.

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], macro controls [Outstanding mortgage balances in the U.S., GDP, S&P500 index, slope of yield curve (10 yr./2 yr.), MSA population, MSA

unemployment rate, MSA income, effective mortgage rate], 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.[18] 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.[19] To examine the possibility that the impact of subprime density 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 Jumbo Prime density 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 -0.18% (-.0018) quarterly return in the aggregate HPI after six months, but a +0.25% 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 (+0.13%), 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, though significantly greater in magnitude, to the alt-A market. The percent of loans that were non-owner occupied had a significant positive relationship with home prices over 0-6 months (peaking at +0.32% (+.0032) after 3 months in the aggregate model). But over 9-12 months this relationship reversed and there was a

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

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

significant negative effect of a similar magnitude (-0.27% 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 +0.06%) and barely significant positive contemporaneous effect that persists across price tiers. 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 percent of mortgages of at least 90% LTV at origination did not seem to be significantly associated with house price changes across any of the price tiers, although as noted above, this result could be confounded by the possible expansion of mezzanine "piggyback" loans, which would reduce LTV for the first lien position, but may increase it overall.

With respect to our macro- and MSA-specific economic variables, we found a negative and significant coefficient (with the exception of the highest price tier) on the S&P 500. This could be an indication that over our sample period real estate was used as a safety vehicle by investors, especially during the major decline in equities that started in 2000 when investors sought to take their wealth out of stocks and put it in real assets, namely real estate (although one would have expected this effect to be greatest at the high end of the market). A sizeable proportion of this flow of funds was likely done through non-owner occupancy purchasing. This suggests the possibility that in an equity upturn these same investors would be willing and able (assuming real estate illiquidity did not hinder them) to quickly reverse their flow of funds back to the stock market and out of real estate.[20]

Model 1a indicates that population growth and the unemployment rate were the main macroeconomic variables driving home prices. Surprisingly, interest rates were not found to have a significant relationship with home prices. Over our sample period the Fed raised, lowed and raised

[20] This finding suggests a more detailed look at the relationship between the S&P 500 vs. the percent of non-owner occupied mortgages over time is in order.

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 unless one believes increased credit could represent an "oversupply" of credit, shifting the housing supply curve outward and downward and reducing prices.

Finally, we observe that the supply constraint index (WRLURI) is correctly positively signed and significant at the 10 percent level (other specifications showed higher significance). The significance is greater and the magnitude of the coefficient higher at the high end of the market, as expected. Perhaps if we had better data – a time series version that permitted individual MSA variations over time – it is possible that supply constraints would have been shown to have had a more significant positive impact on prices, although the likelihood that land use regulatory restrictiveness is persistent over time within individual MSA's is high.

Model 2: GSE-to-private ABS regime shift

As shown in Table 7 and Figure 6, Freddie Mac and Fannie Mae exhibited two different regimes of behavior during our observation period. Until 2003Q3, they were active issuers and purchasers of conventional conforming MBS securities (regime I). However, after this time, they stepped back considerably (regime II).

This retrenchment can be hypothesized to be a result of several factors. 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. Ongoing assertions of lack of safety and soundness caused by lack of proper hedging mechanisms and being "too big," resulted, in their weakened political state, in pledges to reduce the growth of their portfolios. Their retained loan portfolio was capped. Since 2006 until very recently, their maximum lending limit for single-family loans remained at $417,000 in the face of continuing increases in house prices nationwide, resulting in their being able to purchase increasingly fewer loans (although this was not a binding constraint for most of our observation period). 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]

[21] 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

However, the explanation for GSE withdrawal from a dominant mortgage origination position in late 2003 is more complex than simply political and regulatory pressures. The GSE's actually loosened their underwriting standards to a degree during this period and attempted to compete aggressively with the private ABS issuers, but were unsuccessful.[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 (see Greenspan [2008]) starting in 2005. Indirectly, our data suggests this started as early as late 2003-early 2004.

The significant withdrawal of the GSEs from the conventional conforming market is shown in Table 7 and Figure 4 to have led to a significant substitution effect, in which the private ABS and RMBS market supplanted that of the conventional conforming RMBS market for new originations during this period.[23] 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 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.[24] 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.[25] A natural question of concern is the extent to which such a regime change had on the housing market, and specifically house prices.

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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.

[22] 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.

[23] In fact, the effect was even stronger than a "substitution" effect. The total volume of mortgage lending peaked at $3.725 trillion in 2003, up from $2.085 trillion in 2001, dropping back to $2.550 trillion by 2006 and as low as $1.210 trillion in the first two quarters of 2007 (Table 7).

[24] 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.

[25] 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 liquidated).

Our results for the two regime periods – 1998Q1 to 2003Q3 and 2003Q4 to 2006Q4 – 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 fundaments, 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, i.e. demonstrating the least autocorrelation, possibly an indication of a market that was not raising demand based on past increases in prices (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.

During regime I, the Jumbo MBS, Alt-A, and Non-owner occupied loan percentages have basically the same pattern of results as in model 1a, though generally at somewhat lower significance levels. However, for the first time, we see sub-prime BC loans as being statistically significant in quarters 2 and 3, though with a sudden shift in sign from a decrease in the HPI return of -0.19% for every percentage point increase in the density of Subprime loan originations six months in the future, followed by an increase of +0.17% 9 months in the future. The contemporaneous effect on prices is also positive and marginally significant at +0.18%. Although this saw-tooth pattern is unexplained, it suggests some modest direct impact of subprime during regime I when the GSE's were still active.

The impact of the lending 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 density seems to show significant impact on returns is a contemporaneous positive effect (+0.23%) by Alt-A mortgages. We note that the modest prior indication of significance of the 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 were still active. The steepness of the yield curve (ratio of 10-year to 2-year Treasury yields to maturity) displays a coefficient of -3.75, 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 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 underpricing 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.

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 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 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 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. A negative and sometimes significant coefficient with the S&P500 Index provided some evidence of the influence of capital flows from sectors considered "weaker" to those considered "stronger" over the cycle. Surprisingly mortgage interest rates were not found to have a significant relationship with house prices when other factors were taken into account. As expected, the construction cost index for housing, proxied in this study by the CPI index, was found to positively influence house prices, as was the other supply variable, the Wharton Land Use Regulatory Index (WRLURI). We were not, however, successful in finding an effect of higher LTV's, used as a proxy for "looser" lending standards (comparable to W-N's LTI variable), on house prices, as they were able to do using the LTI variable.[26]

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. Significantly, 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 contemporaneous or later house price index returns. These results are seemingly in contrast to Pavlov and Wachter (2004, 2006a, 2006b) if we confine our

[26] This is probably due to the fact that our LTV variable represented first liens only and did not consider the growth of piggyback loans and 80-10-10 structures, intended to substitute for PMI, over the observation period. Total LTV's likely increased considerably.

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.[27]

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 late 2003, with the considerable pullback of the GSE's from the market, both for political, regulatory, and economic reasons. 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 permitted not only new instrument designs, but also weaker underwriting standards, to flow in great volumes into the void – may be deemed complicit, if not dominant in precipitating the subsequent series of adverse events.

[27] 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.

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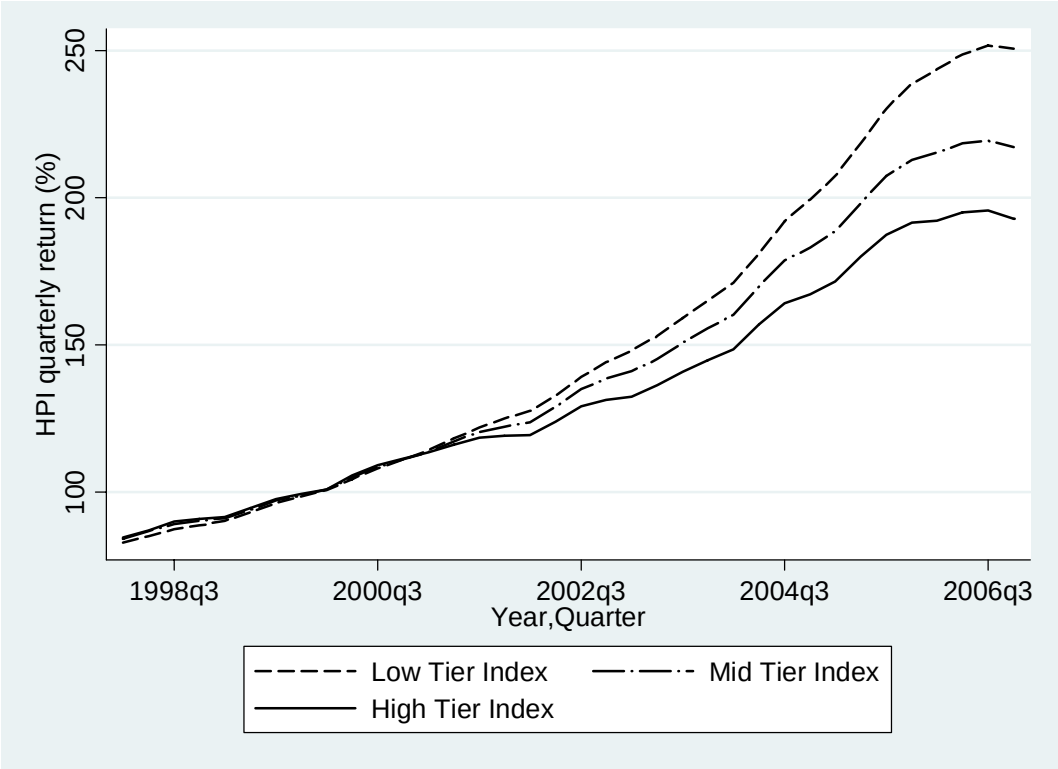
Figure 1

Case-Shiller Housing Price Indices by Price Tier

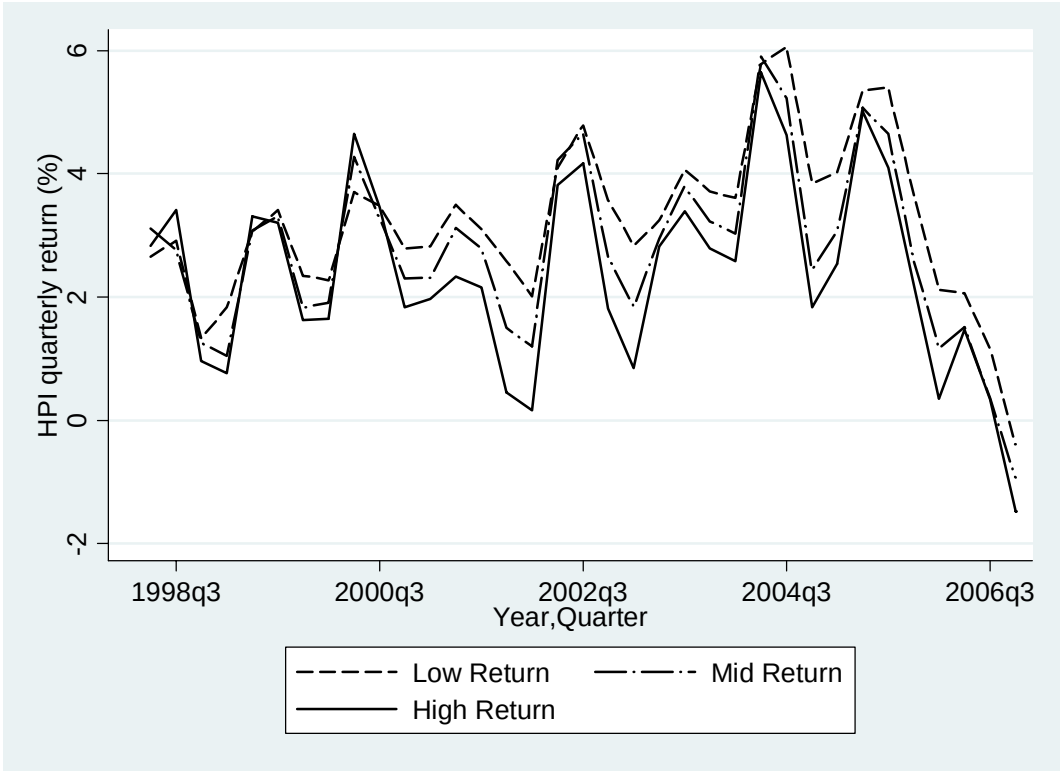


Single-family home purchase transactions are classified into terciles by price of the home. All three tiers are standardized to 100 at the start of 2000. SPCS20R is for all 20 Case-Shiller metro areas and has data back to 2000. CSXR is for the 10 largest areas and has data back to 1987.

Source: S&P Case-Shiller Home Price Index

Figure 2

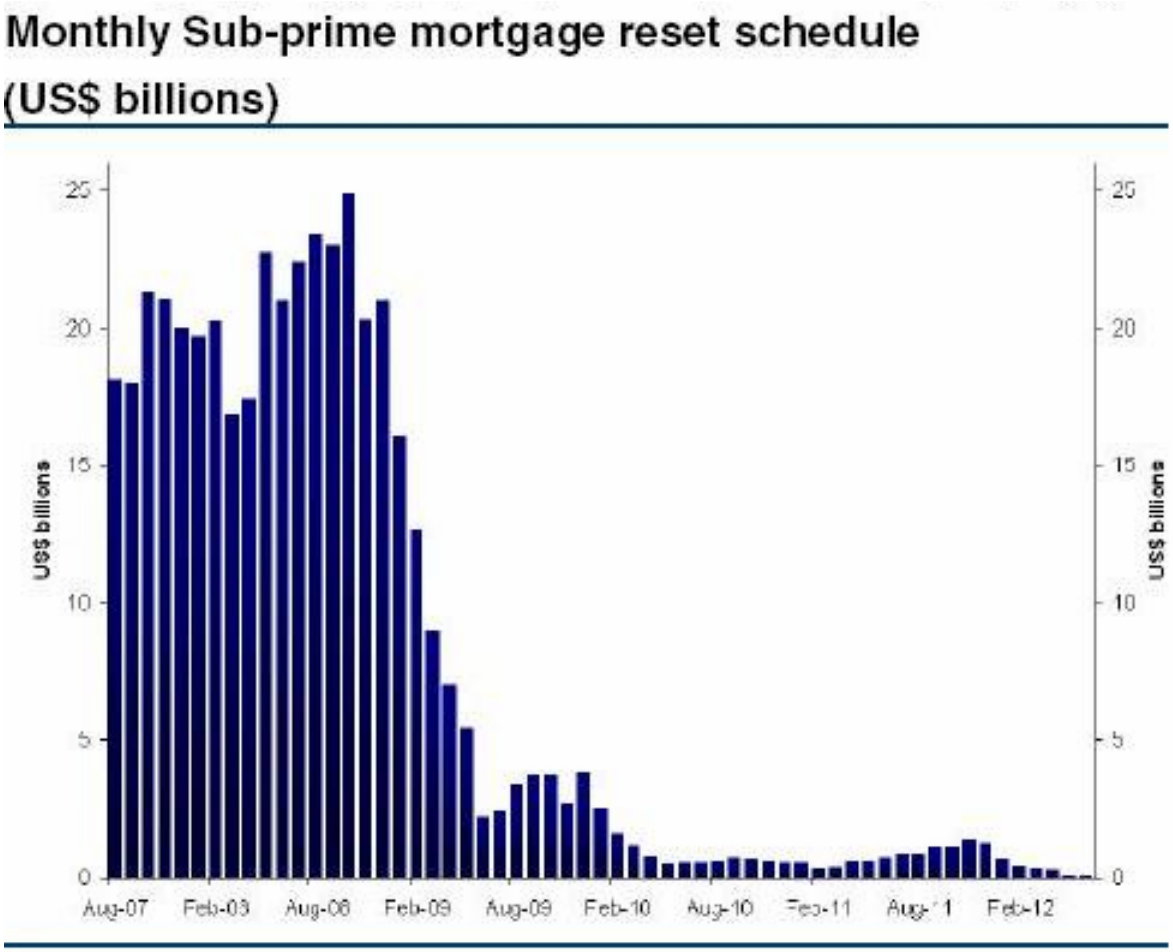
Quarterly Returns in the Case-Shiller Housing Price Indices by Price Tier



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

Figure 3

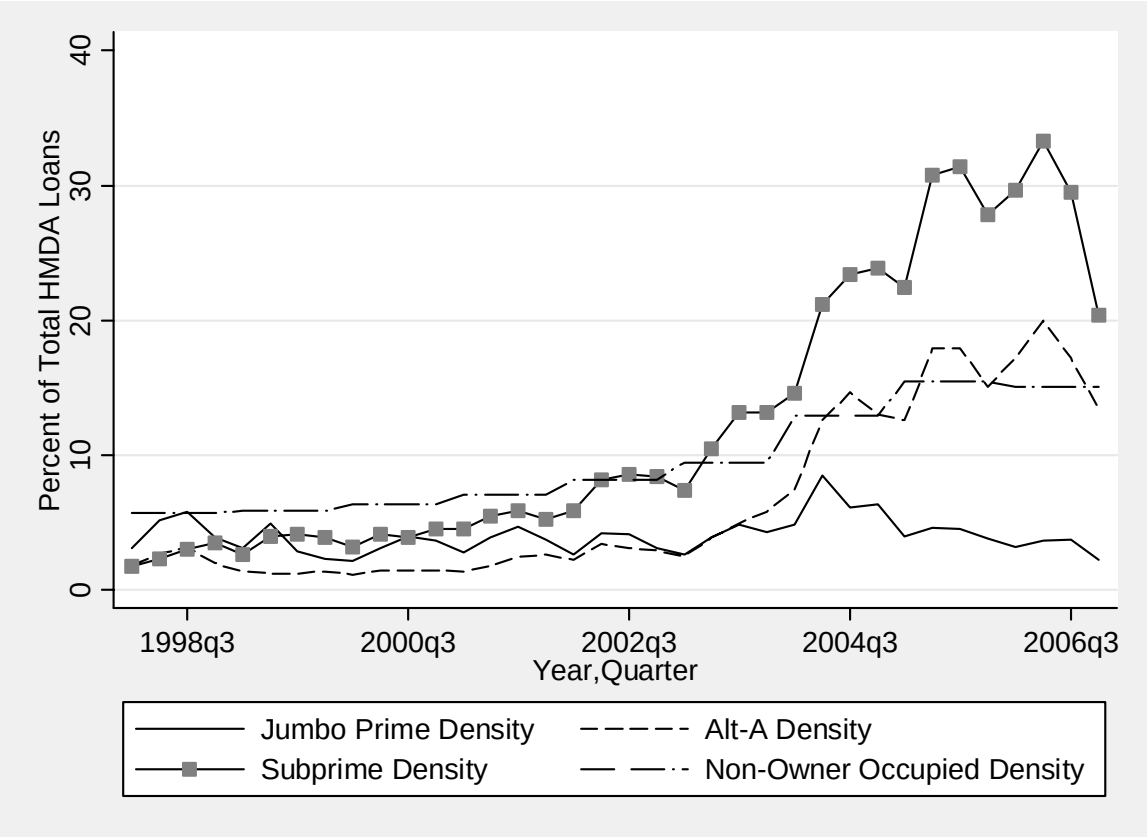
Timing of ARM Rate Re-sets



Source: Credit Suisse Mortgage strategy research

Figure 4

Loan Type Origination Density

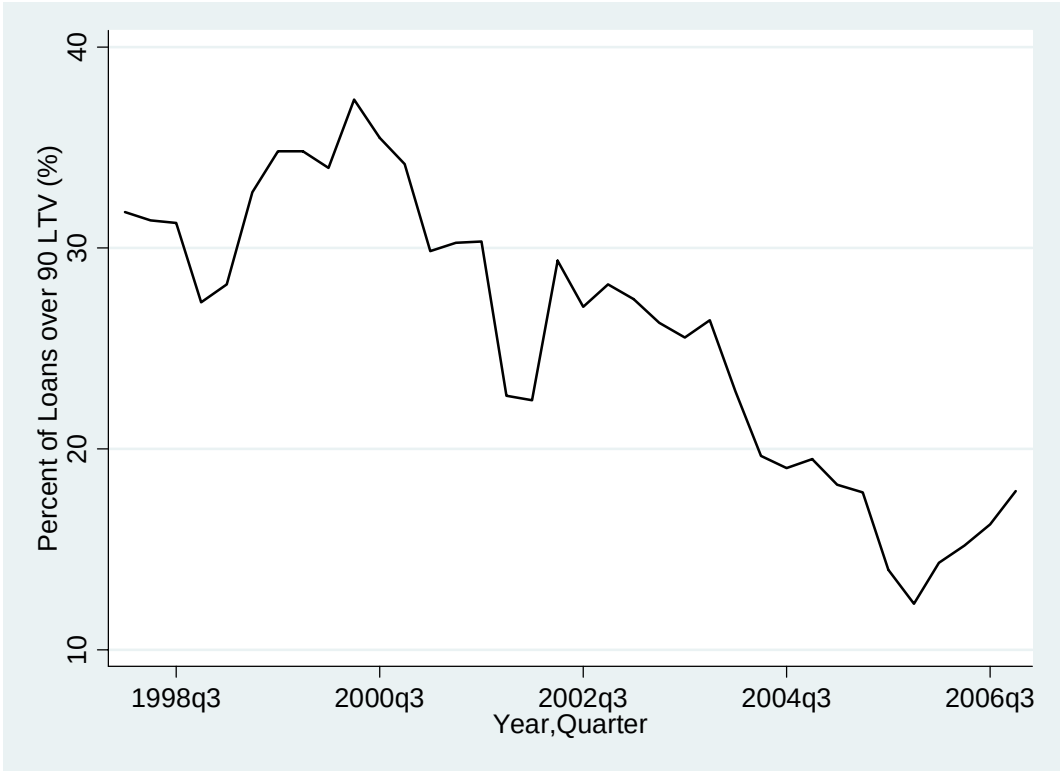


Counts of each loan type are divided by total count of HMDA loans resulting in the percent of total loans accounted for by each loan type. Percent prime can be approximated as 1-(Percent_MBS+Percent_AltA+Percent_BC). Subprime lending intensity peaks mid-year 2006.

Source: Loan Performance and HMDA

Figure 5

Percent of Loans with Loan-to-Value Ratio over 90%



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

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%
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

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

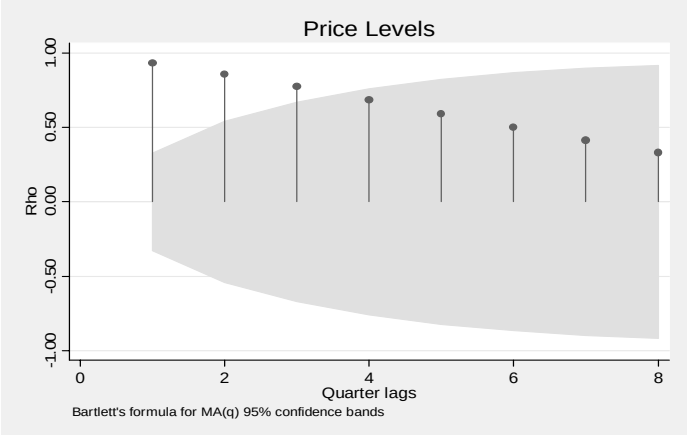
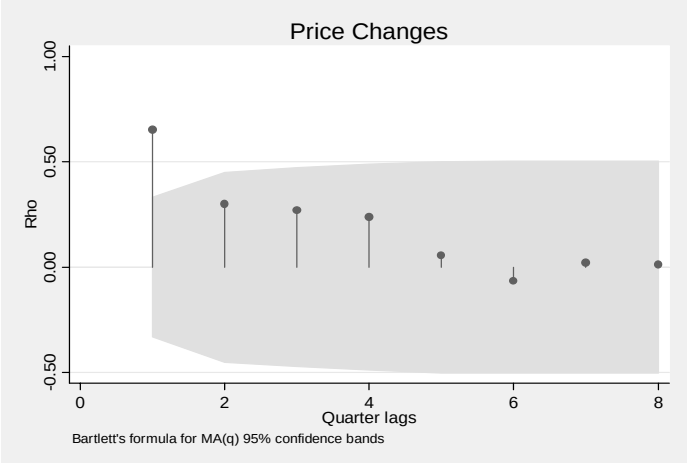
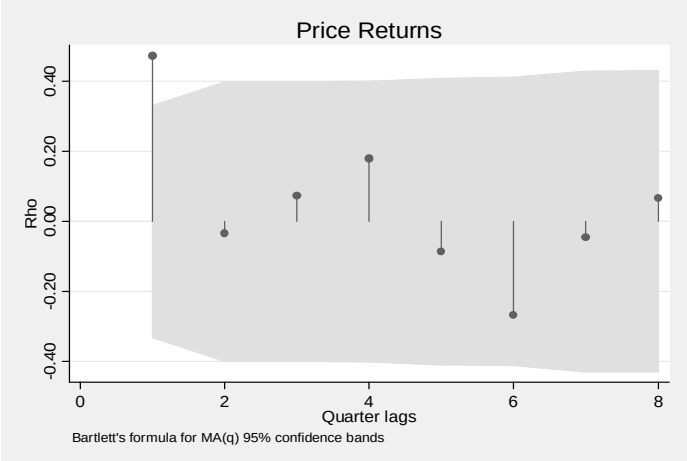
	Quarterly HPI Returns	Subprime Origination Density	Alt-A Origination Density	Non-owner Occupied Origination Density	Jumbo Prime Origination Density	Unemployment Rate	Per-capita Income	Population	WRLURI	Yield curve slope (10/2)	Private ABS Share of new mortgages
Quarterly HPI Returns	1										
Subprime 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

N	615	527	527	527
Adjusted R^2	0.5155	0.4163	0.5262	0.5441
Case-Shiller HPI returns	**All Tiers**	**Low Tier**	**Mid Tier**	**High Tier**
Jumbo Prime				
no lag	0.05032 (0.93)	0.05351 (1.12)	0.07053 (1.27)	0.08534 (1.17)
3 month lag	-0.1142 (-3.95)	-0.0177 (-0.54)	-0.12156 (-3.85)	-0.17135 (-5.08)
6 month lag	-0.17602 (-3.07)	-0.12654 (-2.97)	-0.20719 (-3.83)	-0.22448 (-2.79)
9 month lag	0.07288 (3.19)	0.03909 (1.28)	0.07814 (2.64)	0.0722 (3.49)
12 month lag	0.24643 (10.13)	0.13153 (4.86)	0.25515 (8.05)	0.29768 (10.28)
Alt-A density				
no lag	0.12915 (2.2)	0.08175 (2.01)	0.13794 (2.38)	0.11968 (3.09)
3 month lag	0.0128 (0.33)	0.02898 (1.09)	-0.00564 (-0.12)	-0.03665 (-0.76)
6 month lag	-0.01751 (-0.49)	-0.05581 (-2.11)	-0.02898 (-0.71)	0.01202 (0.25)
9 month lag	-0.0467 (-0.81)	-0.03335 (-0.65)	-0.05049 (-1.05)	-0.06814 (-1.08)
12 month lag	-0.07527 (-1.65)	-0.05583 (-1.27)	-0.10199 (-2.25)	-0.03742 (-0.85)
Subprime density				
no lag	0.02877 (1.03)	0.06254 (1.97)	0.04097 (1.91)	0.04772 (2.14)
3 month lag	-0.02611 (-1.41)	0.00294 (0.13)	-0.01054 (-0.49)	-0.01359 (-0.52)
6 month lag	-0.03078 (-1.16)	-0.03939 (-1.4)	-0.04016 (-1.24)	-0.07072 (-2.09)
9 month lag	0.00318 (0.13)	0.01878 (0.66)	0.00469 (0.2)	0.03798 (1.27)
12 month lag	0.02654 (0.88)	0.03033 (0.87)	0.05009 (1.51)	0.04834 (1.34)
Non-owner occ. density				
no lag	0.22883 (7.71)	0.2569 (9.99)	0.26914 (8)	0.26738 (8.54)
3 month lag	0.32152 (3.89)	0.3215 (5.9)	0.32235 (3.59)	0.32055 (3.2)
6 month lag	0.09517 (2.1)	0.07336 (3)	0.09885 (1.29)	0.10341 (1.92)
9 month lag	-0.21895 (-2.18)	-0.2083 (-2)	-0.25662 (-2.16)	-0.2432 (-2.15)
12 month lag	-0.27075 (-4.94)	-0.24487 (-4.98)	-0.26135 (-4.15)	-0.30818 (-5.08)
Mortgages>90%LTV	0.31149 (0.26)	-1.68739 (-1.51)	-0.37104 (-0.27)	1.18787 (0.83)
Aggregate Home Mtgs ($trill)	-2.01472 (-3.17)	-1.29 (-1.88)	-1.95 (-2.5)	-2.81 (-4.17)
Real GDP ($bill)	0.00237 (2.11)	0.00092 (0.49)	0.0026 (1.46)	0.00417 (2.82)
Aggregate personal savings ($bill)	0.0002 (0.34)	-0.00035 (-0.35)	0.00009 (0.14)	0.00067 (0.9)
S&P 500 Index	-0.00179 (-2.55)	-0.00255 (-2.24)	-0.00217 (-2.23)	-0.00154 (-1.37)
US govt 10yr/2yr YTM	-0.2383 (-0.72)	-0.1207 (-0.31)	-0.3083 (-0.65)	-0.16145 (-0.36)
Population (in 100,000's)	0.01418 (4.18)	0.0128 (3.81)	0.01325 (3.75)	0.01089 (4.14)
Unemployment Rate (%)	-0.45152 (-3.14)	-0.38288 (-2.49)	-0.32206 (-2.07)	-0.36302 (-2.46)
Income ($1000)	0.00626 (0.11)	0.06257 (1.07)	0.03731 (0.66)	0.03026 (0.72)
Average Mortgage Rate (%)	-0.07773 (-0.25)	0.0774 (0.23)	-0.0417 (-0.1)	-0.18193 (-0.42)
Urban CPI (1984=100)	0.11505 (1.34)	-0.00009 (0)	0.06434 (0.71)	0.12662 (1.3)
WRLURI	0.52249 (1.97)	0.18582 (0.51)	0.29347 (1.09)	0.39642 (1.67)
Intercept	-28.10455 (-1.84)	0.67148 (0.04)	-23.02684 (-1.27)	-44.79748 (-2.92)
Rho	0.6602539	0.6205199	0.85613	0.5731218
Durbin-Watson	1.702206	1.812539	1.608433	1.753732

Table 7

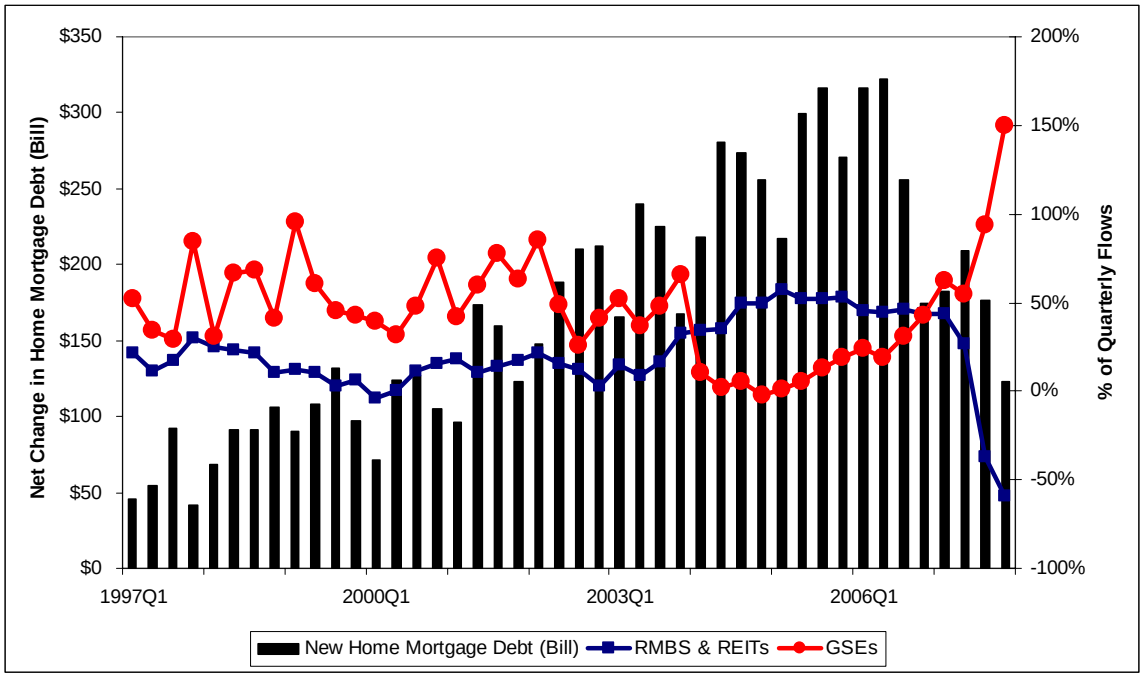
Mortgage Originations by Loan Type 2001 – 2007Q2
(billions of dollars)

	2001	2002	2003	2004	2005	2006	2007Q1	2007Q2
Conventional Conforming	1280	1711	2460	1210	1090	990	260	310
percent	61.4	63.0	66.0	47.2	39.6	38.8	44.4	49.6
FHA/VA	175	176	220	130	90	80	18	24
percent	8.4	6.5	5.9	5.1	3.3	3.1	3.1	3.8
Jumbo	450	576	650	510	570	480	107	135
percent	21.6	21.2	17.4	19.9	20.7	18.8	18.3	21.6
Alt A	60	67	85	185	380	400	105	100
percent	2.9	2.5	2.3	7.2	13.8	15.7	17.9	16.0
Subprime	120	185	310	530	625	600	95	56
percent	5.8	6.8	8.3	20.7	22.7	23.5	16.2	9.0
Total	2085	2715	3725	2565	2755	2550	585	625

Source: Inside Mortgage Finance

Figure 6

Agency vs. Private SIVs and REITs in Share of Home Mortgage Flows



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' Pullback

	Model 2a Regime I	Model 2b Regime II
N	355	240
Adjusted R^2	0.5466	0.6254
Case-Shiller HPI returns	**1998Q1-2003Q3**	**2003Q4-2006Q4**
Jumbo Prime		
no lag	-0.02058 (-0.37)	0.02115 (0.5)
3 month lag	-0.2883 (-10.7)	0.02392 (0.5)
6 month lag	-0.13175 (-2.12)	-0.04373 (-0.5)
9 month lag	0.00654 (0.17)	0.10055 (1.58)
12 month lag	0.32761 (9.09)	-0.06435 (-0.91)
Alt-A density		
no lag	-0.03201 (-0.25)	0.22609 (4.02)
3 month lag	0.21342 (1.79)	-0.03039 (-0.6)
6 month lag	-0.2136 (-0.72)	-0.0676 (-1.45)
9 month lag	0.20451 (1.35)	-0.05698 (-1.13)
12 month lag	0.16557 (1.86)	-0.05324 (-1.21)
Subprime density		
no lag	0.17807 (1.92)	-0.0273 (-0.87)
3 month lag	-0.05362 (-0.6)	-0.0634 (-1.77)
6 month lag	-0.19217 (-2.03)	-0.00591 (-0.18)
9 month lag	0.17459 (2.28)	0.02431 (0.69)
12 month lag	0.00586 (0.07)	0.045 (1.34)
Non-owner occ. density		
no lag	-0.00198 (-0.02)	0.33179 (5.64)
3 month lag	0.31128 (2.99)	0.16074 (1.22)
6 month lag	0.03546 (0.37)	0.15851 (2.39)
9 month lag	0.01697 (0.1)	-0.25896 (-1.52)
12 month lag	-0.28558 (-1.97)	-0.24997 (-3.02)
Mortgages>90%LTV	-1.84625 (-2.06)	-5.60135 (-1.3)
Aggregate Home Mtgs ($trill))	0.84925 (0.53)	2.2745 (1.58)
Real GDP ($bill)	-0.00112 (-1.1)	-0.01656 (-2.62)
Aggregate personal savings ($bill)	-0.00134 (-0.87)	0.00032 (0.1)
S&P 500 Index	-0.0023 (-1.8)	-0.00235 (-0.25)
US govt 10yr/2yr YTM	-2.22942 (-1.6)	-3.7506 (-5.31)
Population (in 100,000's)	0.00756 (1.76)	0.0115 (1.69)
Unemployment Rate (%)	-0.53872 (-4.05)	-0.28067 (-1.3)
Income ($1000)	0.1076 (2.64)	-0.06408 (-0.8)
wAverage Mortgage Rate (%)	0.50288 (1.87)	-0.60964 (-0.24)
Urban CPI (1984=100)	0.10501 (1.26)	0.26106 (0.84)
WRLURI	0.05353 (0.29)	0.34861 (0.61)
Intercept	-10.18574 (-0.83)	125.8717 (1.56)
rho	0.4445347	0.7053489
Durbin-Watson	1.747267	1.611298