

The Effect of Subprime Lending on Residential Housing Investment: Evidence from the 2006 HMDA Loan Access Register

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Abstract

This paper empirically examined the effects of economic variables on the residential housing transaction with more emphasis on the subprime issues. The results support the easiness of lending will lead to more housing transaction.

Introduction and Background

As we are left to pick up the pieces of the mortgage crisis, we can only but ask 'how did we get here?' What role did exotic subprime mortgages play in the housing boom and bust? This most recent cycle upturn has been marked by a set of concomitant trends whose association in economic theory gives support to a causal relationship. Rising prices tracked expanding credit, especially to parts of the population previously without access to mortgages. We look for empirical evidence of the opening of this credit market, and find support in the literature that such an expansion contributes to bubble-like behavior in housing markets.

Former Federal Reserve Governor Edward Gramlich explains the boom in subprime lending as the result of more sophisticated appraisal, pricing, and allocation of risk in his book Subprime Mortgages: America's Latest Boom and Bust. Credit scoring algorithms can now be run in a matter of minutes; these rely on actuarial models that predict an individual's probability of repayment based on credit score, income stream, expected interest rates and macroeconomic conditions, etc. One benefit of such mechanistic risk assessment is that overt discrimination in lending is no longer necessary (where ethnicity can act as a screen to ration credit by). Automation however, may have caused some lenders to act carelessly, or not verify the information provided by the applicant. Algorithms may obscure the risk assessment to the broker making the loan. Second, the rollback of usury laws has allowed loans with greater degrees of risk to be priced accordingly higher and hence enabling these markets to better clear (the rationing described above is now done by *price*) One such important regulatory shift was the Depository Institutions Deregulation and Monetary Control Act of 1980, which eliminated rate ceilings on all first liens and set the pace for further liberalizations at the state level. Expansion of the value of possible loan transactions should naturally increase demand for its complementary good, housing. Furthermore, the pool of capital available to finance home purchases has deepened significantly for the subprime market. The secondary mortgage market was created and for years dominated by the Federal National Mortgage Administration, or Fannie Mae, founded as a government agency in 1938. In 1968 Fannie Mae was officially (if not implicitly) privatized and given competition in the similarly-chartered Federal Home Loan Mortgage Corporation, or Freddie Mac in 1970. The Government Sponsored Enterprises (Fannie, Freddie and Ginnie Mae, which underwrites FHA and VA guaranteed loans) would not purchase nor securitize mortgages failing to meet certain standards indicative of the loan's repayment likelihood (i.e. subprime loans) Mortgage securitization has since become a profitable opportunity for the private sector, and subprime loan securitizations have become good business for hedge funds and investment banks. Securitization of mortgage assets improves liquidity,

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since risk can now be broken down into smaller parts and traded to a diffuse set of investors. Credit scoring and generally favorable ratings by the likes of Standard and Poor's, Moody's, etc. made subprime mortgage paper look like a good investment; and indeed hedge funds and investment banks were soon supplying much of the capital for the residential housing market. Indeed, the GSEs' share of total home financing seems to have dropped off sometime in 2003⁴ as they were outpaced by private financing, typically with more lax underwriting standards. What did not change about the nature of real estate investment however, is that the underlying asset (a house) is illiquid and has a long maturity horizon. Hence a leveraged investment operation can quickly find itself insolvent when the value of its mortgage-backed holdings declines because of foreclosures.

We observe an expansion of the available supply of capital as well as a greater degree of market clearing for higher risk loans. These factors should alone contribute to rising house prices, but there may be some positive feedback at work in real estate cycles. Since a house embodies a large fraction of a family's wealth, the possibility of quick capital gains may have been pulling families into mortgages that would otherwise be unaffordable. One, this essentially lowers the opportunity cost for non-performance of a loan, since the house can be re-sold to exit the loan without significant financial loss. This situation may not apply to families taking out subprime mortgages, which often carry large prepayment penalties (and given high loan-to-value ratios, interest-only payments, etc., these families will have accumulated next to no equity in their houses). The corresponding incentives faced by the lender however, make this issue mostly distributional. If the borrower decides to walk away and the lender is forced to foreclose on the mortgage, an appreciated home value can ameliorate the lender's losses (or indeed she may come out ahead) and thus encourage more risky lending to begin with. For example, Abreu and Brunnermeier (2003) model how investors will 'ride' a bubble hoping to divest while the market is still pricing assets above fundamentals.

Model Design

The most detailed source of freely available housing market data is through the Home Mortgage Disclosure Act. The Act, passed in 1974, requires lenders to report specified details about every mortgage they make. It was passed with the intent of documenting discrimination in the lending market. Hence, this study contains detailed information about the race, ethnicity, sex and income of the borrowers, but unfortunately omits several important factors pertaining to the fundamentals of each loan. These include credit score, loan-to-value-ratio, and any cut-and-dry definition regarding whether a loan is considered subprime. We are somewhat limited by the availability of good subprime mortgage data, but there are precedents in the housing literature that will allow us to cope. Since our model will want to capture the cyclical impact of subprime credit on housing demand; but is constrained by the greater availability of cross-sectional HMDA data (only 2006 is freely distributed), we can model the *number* (relative to population) of home-purchase loan transactions based on income by state or Metropolitan Statistical Area to capture the relative "hotness" of real estate markets. While housing investment accelerated across the board during 2001-2006, there were a select few "hot" markets that saw the greatest appreciation and the most activity. These areas were often characterized by coastal locations, booming local economies, and most critically, affluence. Stein (1995) first documents a tendency

⁴ <http://economistsview.typepad.com/economistsview/2008/07/did-fannie-and.html>

of not only prices, but also number of housing transactions to rise in a booming housing market. Ortalo-Magné and Rady explore this relationship in greater depth and develop a theoretical framework in a series of papers from 1998 – 2004. Transactions rise with prices and incomes because the liquidity of the housing market is constrained by down payment requirements. Stein rationalizes the down payment requirement as a response to adverse selection in the housing market; without a down payment requirement there will always be incentive for a borrower to default at any given rate of interest. Down payments offset this incentive since borrowers stand to lose substantial equity in a foreclosure. Indeed, high loan-to-value ratios may have provided the moral hazard necessary to turn the first subprime mortgages bad and “pop” the housing bubble.

The primary focus of the down payment literature, however, is on how this requirement creates feedback loops that turn exogenous shocks into booms and busts. If say, first time homebuyers gain access to subprime credit and can buy “starter homes” previously unavailable to them, the prices of starter homes will appreciate. Existing homeowners experience a wealth shock because the equity in their homes is now worth more, and this in turn allows these homeowners to meet a previously unattainable down payment on a “trade-up” home. Ortalo-Magné and Rady summarize:

Caplin, Chan, Freeman and Tracy (1997, p. 31) argue “it is almost impossible for a household to buy a home without available liquid assets of at least 10% of the home’s value”. It is this effective wealth requirement that we want to capture with the credit constraint in our model. (p.463)

Income effects and credit constraints dictate that most transactions will occur in a booming market. We can thus identify booming markets using the proxy variable of high transaction volume.

Likewise, incomes can play a role in housing bubbles since higher-income buyers are less likely to be credit-constrained.

... if the effect of capital gains or losses on the housing demand of constrained repeat buyers is strong enough to generate price overreaction, the level of prices, the cross-sectional variance of prices, and the number of transactions move with income. (Ortalo-Magné & Rady p.460)

Subprime borrowers are distinguished by low incomes, high debt-to-income ratios, low credit scores, and a need to borrow a high proportion of a home’s value. These subprime borrowers must of course pay higher interest rates for access to the housing market, but low income will no longer present as daunting a barrier to home purchase. In the aggregate then, we expect higher-cost subprime loans to weaken the linkage between high incomes and price bubbles (via housing transactions). Our focus will be whether the coefficient of income’s effect on transaction velocity significantly different for high cost vs. low cost loans. If yes, then we can support the claim that the subprime lending contributed to the housing bubble by boosting the purchasing power of a modest income.

Despite the existence of many theoretical models of housing liquidity and transaction volume, little empirical work has been done on the subject. Genovese and Mayer (1997) take a sample of condominiums in the Boston area and find a positive relationship between loan-to-value ratios, asking prices, and time on the market. Credit-constrained *sellers* are more susceptible to an insufficient sale price failing to meet the debt obligations outstanding on their property. Homeowners who already have sufficient equity in their houses (they test this for equity shares >20%) can better afford to pay off the debt on their house with a lower price either because they have less interest to service or losses are merely personal capital losses rather than defaults. We may reasonably infer that the high prepayment penalties faced by many subprime borrowers would amplify these sale-side liquidity constraints.

Methodology

We take the raw Home Mortgage Disclosure Act Loan Application Register⁵ and aggregate along 56 of the nation's Metropolitan Statistical Areas. Only conventional (non FHA or VA guaranteed) loans intended for home purchase and originated in the year 2006 are examined. For each metropolitan area, two regressand observations are calculated, one total for all loans issued with rate spreads of less than 3% with comparable treasury securities, and one for all 'subprime' loans with rate spreads at or exceeding 3%. This cutoff seems rather arbitrary, but it is the cutoff below which the HMDA does not require reporting of the rate spread of a loan. Furthermore, the Federal Reserve has recently proposed to bring all such loans under the provisions of the Home Ownership and Equity Protection Act⁶. Each regressand observation is then divided by the population of the corresponding metro area as estimated for 2006 by the Census Bureau and then multiplied by 1000 to aid computability. The regressors are as follows: respective Consumer Price Indices (base 1982 = 100) for Urban Consumers as published by the Labor Department⁷; the metropolitan housing price index as published by the Office of Federal Housing Enterprises Oversight⁸; an indicator for whether the aggregated loan total was of prime or subprime loans (high spread loans were assigned a '1'); the median income of the borrowers of each aggregated population; a squared income term to capture the relative dearth of very affluent areas⁹; the interaction between income and subprime status; and a metropolitan area rent variable constructed from Housing and Urban Development data¹⁰. For subprime borrowers, the rent for the second lowest quintile was taken, while for conventional homebuyers, the rent for the second *highest* quintile was used for comparison. Rent was included partly as a curiosity; to investigate whether rental and owner-occupied housing are gross substitutes or whether their prices for a given area reflect a common underlying scarcity of housing. Either scenario would suggest a rent variable improves model specification regardless. All variables are relevant to the year 2006 and were averaged where available only in quarterly increments. In equation form, the model can be written:

$$\# \text{Transactions} / \text{Population} = \beta_0 + \beta_1 \text{ CPI for MSA} + \beta_2 \text{ housing price index for MSA} + \beta_3 \text{ Rate spread high or low} + \beta_4 \text{ med. income} + \beta_5 \text{ income}^2 + \beta_6 \text{ income} \times \text{rate spread} + \beta_7 \text{ Rent}$$

5 <http://www.ffiec.gov/hmdafeedback/hmdaproducts.aspx>

6 <http://www.federalreserve.gov/newsevents/press/bcreg/20071218a.htm>

7 <http://www.bls.gov/CPI/>

8 http://www.ofheo.gov/media/hpi/1q08hpi_cbsa.csv

9 Just as fewer subprime loans are made than prime loans, there are far more 'middle income' markets and these more prosaic markets tend to be larger. Note that income was divided by 1000 before squaring to aid model computability.

10 http://www.huduser.org/datasets/50thper/FY2006_Area_50th.xls

Results

The coefficients of the equation were estimated using ordinary least squares, but the results of this regression indicated non-constant error variance. Selected statistics from that estimation are listed here:

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 104 DF	P-VALUE	PARTIAL CORR.
CPI	-0.53966E-01	0.1437E-01	-3.755	0.000	-0.346
HPI	0.26979E-01	0.9980E-02	2.703	0.008	0.256
SUB	-7.7910	2.510	-3.104	0.002	-0.291
INC	0.25866E-03	0.1055E-03	2.453	0.016	0.234
INC2	-0.10436E-02	0.3618E-03	-2.885	0.005	-0.272
INCSUB	-0.37649E-04	0.2948E-04	-1.277	0.204	-0.124
RENT	-0.71965E-02	0.2605E-02	-2.763	0.007	-0.261
CONSTANT	14.749	5.003	2.948	0.004	0.278
R-SQUARE = 0.6819					
R-SQUARE ADJUSTED = 0.6605					

ANALYSIS OF VARIANCE - FROM MEAN

	SS	DF	MS	F
REGRESSION	2599.9	7.	371.41	31.855
ERROR	1212.6	104.	11.659	P-VALUE
TOTAL	3812.4	111.	34.346	0.000

Graphs shown in Figure 1 and Figure 2 showing the spread of the residuals falling with income, which are supported by the Chow statistic (=4.024) and Goldfield-Quandt statistic (=2.23) obtained by partitioning the data evenly. Some way of correcting for proportional heteroskedasticity in our model is needed then. Despite the variance problems discussed, the model is free of other problems such as autocorrelation and misspecification. The Durbin-Watson statistic (=1.9459) for the unrestricted OLS falls well within d_U and $4 - d_U$. Due to the cross-sectional nature of this study, no autocorrelation was expected. Furthermore, the Ramsey regression specification error tests do not support significant evidence of model misspecification.

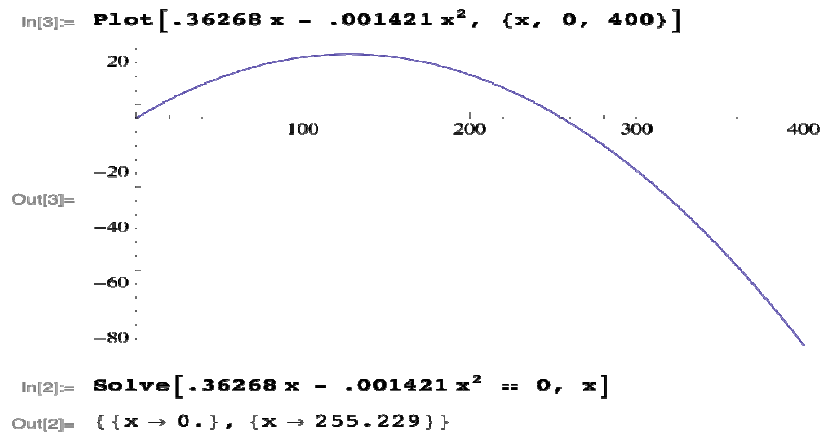
To correct proportional heteroskedastic error terms, a generalized least squares model was estimated using the assumption that the error variance was proportional to income. The results of that estimation are given in the following table:

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 104 DF	P-VALUE	PARTIAL CORR.
CPI	-0.51715E-01	0.1485E-01	-3.483	0.001	-0.323
HPI	0.25054E-01	0.1019E-01	2.458	0.016	0.234
SUB	-5.5102	2.690	-2.048	0.043	-0.197
INC	0.36268E-03	0.1107E-03	3.278	0.001	0.306
INC2	-0.14210E-02	0.4006E-03	-3.547	0.001	-0.329
INCSUB	-0.63536E-04	0.3345E-04	-1.900	0.060	-0.183
RENT	-0.78860E-02	0.2742E-02	-2.876	0.005	-0.271
CONSTANT	9.4178	5.318	1.771	0.079	0.171
R-SQUARE = 0.6905					
R-SQUARE ADJUSTED = 0.6696					

ANALYSIS OF VARIANCE - FROM MEAN

	SS	DF	MS	F
REGRESSION	0.31248E-01	7.	0.44641E-02	33.142
ERROR	0.14008E-01	104.	0.13469E-03	P-VALUE
TOTAL	0.45256E-01	111.	0.40772E-03	0.000

The results appear consistent with the theoretical literature. A negative coefficient -.0517 for consumer prices indicates a downward sloping indifference curve between housing and non-housing goods. Specifically, a 1-point rise in the urban consumers CPI will generate an average of .0517 fewer housing transactions per 1000 people in a metro area. Housing prices and housing transactions are indeed correlated, although whether this is demand's effect on prices or prices' effect on demand is still murky. A one point HPI increase is correlated with .0251 more housing transactions per 1000 people on average. Income is positively correlated for low to moderate levels of income, but negatively for very large median incomes. This appears puzzling but perhaps there is a threshold above which households earn enough to be unfazed by down payments. Consider the following graph that shows only the income components of the estimated equation (both terms have here been scaled to thousands of dollars):



The overall effect of median income on housing transactions is positive up to roughly

\$255 thousand. As this is a rather high median income, it is safe to conclude that there exists a positive correlation between median incomes and housing transactions at reasonable median incomes. The interaction term $inc*sub$ estimates the difference in marginal effect of income depending on the status of sub (0 or 1). The significance of this estimated coefficient supports that high rates of interest do indeed weaken the effect of income on housing purchases. Since income has a coefficient of .00036268 for prime loans ($sub=0$) and a coefficient of $.00036268 - 0.000063536 = .0000299144$ for subprime loans ($sub=1$); we can say that subprime loans cut off about 17% of the marginal effect that income has on housing loan transactions. This would not itself indicate a stunning deluge of new credit, but explains at least a part of the wider bubble. The negative coefficient on rent is the only puzzling result of the estimated equation. Rent and housing demand should generally track each other from city to city to the extent that they reflect a scarcity of dwellings, given demand. The finding is however consistent with historically low rent-to-home price ratios. The desertion of rental for owner-occupied housing is an oft-touted statistic of the bubble discussion¹¹. This might explain its counter-intuitively negative coefficient.

Concluding

Overall, the model performs very well and supports anecdotal and theoretical explanations for housing market behavior. Given the level of aggregation at work in our data set, the equation explains a large and significant share of the variation among geographic and socioeconomic housing markets. Possible directions for future research in this vein are numerous and intriguing. For example, access to other years' HMDA loan application registers would allow a time series regression to examine how the relationship between income, interest rates, and home values changed over the pivotal 1990s. More years would also reveal how individual markets heated up over time. The individualized and disaggregated nature of the HMDA data also lends itself to logistic estimation of a much more fine-grained probabilistic equation. As more housing market data from post-bubble years becomes available, it will be possible to examine whether credit really has become expanded to lower-income borrowers in the long term.

¹¹ <http://www.cbo.gov/ftpdocs/88xx/doc8876/12-05-HBCMacroTestimony.pdf>, see figure 4

Figure 1

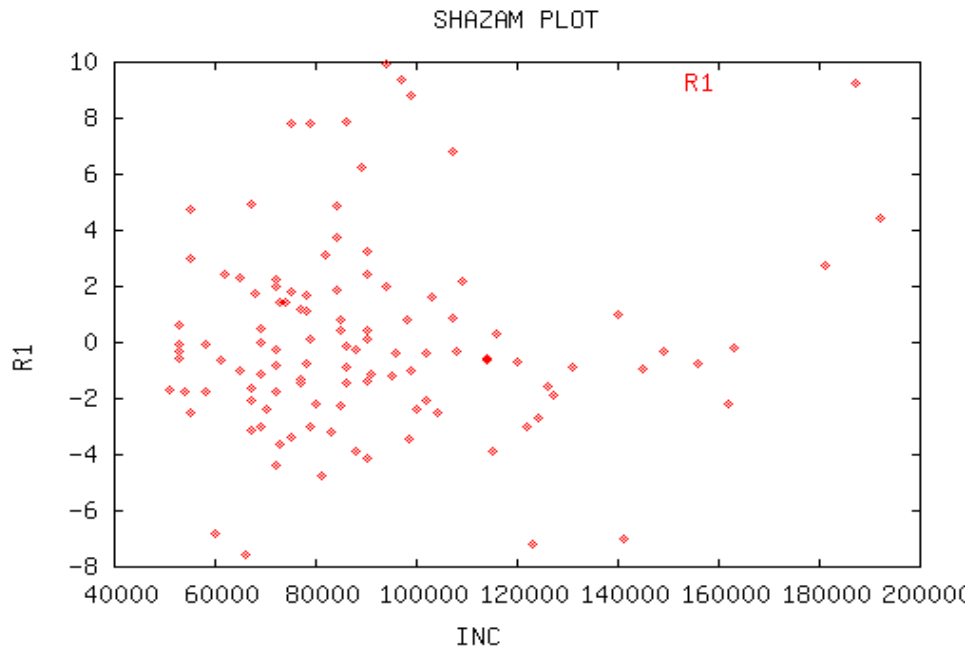
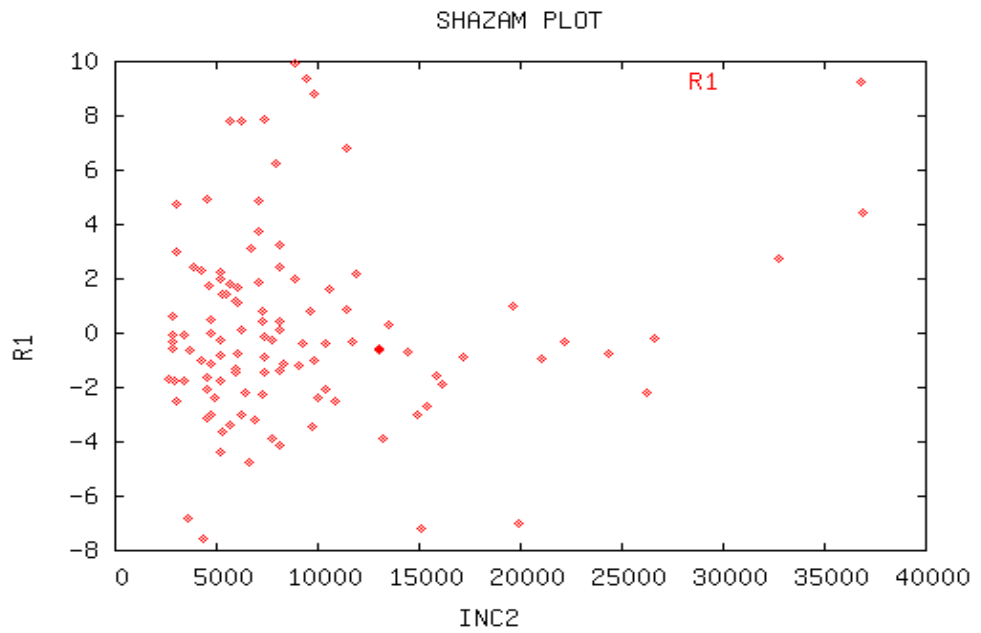


Figure 2



Metropolitan Statistical Areas Examined

Akron, OH	<i>Philadelphia-Camden-Wilmington, PA-NJ-DE-MD</i>
Anchorage, AK	Camden, NJ
Ann Arbor, MI	Philadelphia, PA
Atlanta-Sandy Springs-Marietta, GA	Wilmington, DE-MD-NJ
Atlantic City, NJ	Phoenix-Mesa-Scottsdale, AZ
Baltimore-Towson, MD	Pittsburgh, PA
<i>Boston-Cambridge-Quincy, MA-NH</i>	Portland-Vancouver-Beaverton, OR-WA
Boston-Quincy, MA	Racine, WI
Cambridge-Newton-Framingham, MA	Riverside-San Bernardino-Ontario, CA
Rockingham County-Strafford County, NH	St. Louis, MO-IL
Boulder, CO	Salem, OR
Bremerton-Silverdale, WA	San Diego-Carlsbad-San Marcos, CA
<i>Chicago-Naperville-Joliet, IL-IN-WI</i>	<i>San Francisco-Oakland-Fremont, CA</i>
Chicago-Naperville-Joliet, IL	Oakland-Fremont-Hayward, CA
Gary, IN	San Francisco-San Mateo-Redwood City, CA
Lake County-Kenosha County, IL-WI	San Jose-Sunnyvale-Santa Clara, CA
Cincinnati-Middletown, OH-KY-IN	<i>Seattle-Tacoma-Bellevue, WA</i>
Cleveland-Elyria-Mentor, OH	Seattle-Bellevue-Everett, WA
<i>Dallas-Fort Worth-Arlington, TX</i>	Tacoma, WA
Dallas-Plano-Irving, TX	Tampa-St. Petersburg-Clearwater, FL
Fort Worth-Arlington, TX	<i>Washington-Arlington-Alexandria, DC-VA-MD-WV</i>
Denver-Aurora, CO	Bethesda-Gaithersburg-Frederick, MD
<i>Detroit-Warren-Livonia, MI</i>	Washington-Arlington-Alexandria, DC-VA-MD-WV
Detroit-Livonia-Dearborn, MI	
Warren-Troy-Farmington Hills, MI	
Flint, MI	
Greeley, CO	
Honolulu, HI	
Houston-Sugar Land-Baytown, TX	
Kansas City, MO-KS	
<i>Los Angeles-Long Beach-Santa Ana, CA</i>	
Los Angeles-Long Beach-Glendale, CA	
Santa Ana-Anaheim-Irvine, CA	
<i>Miami-Fort Lauderdale-Miami Beach, FL</i>	
Fort Lauderdale-Pompano Beach-Deerfield Beach, FL	
Miami-Miami Beach-Kendall, FL	
West Palm Beach-Boca Raton-Boynton Beach, FL	
Milwaukee-Waukesha-West Allis, WI	
Minneapolis-St. Paul-Bloomington, MN-WI	
<i>New York-Northern New Jersey-Long Island, NY-NJ-PA</i>	
Edison, NJ	
Nassau-Suffolk, NY	
Newark-Union, NJ-PA	
New York-White Plains-Wayne, NY-NJ	

References

- About Fannie Mae*. Washington, DC: Federal National Mortgage Association. On-line. Available from Internet, <http://www.fanniemae.com/aboutfm/index.jhtml>, accessed 24 July 2008.
- Abreu, Dilip and Markus Brunnermeier. 2003. *Bubbles and Crashes*. *Econometrica* 71 (January): 173–204.
- Congressional Budget Office, *The Current Economic Situation* Washington, DC: U.S. Government Printing Office, 2007. On-line. Available from Internet, <http://www.cbo.gov/ftpdocs/88xx/doc8876/12-05-HBCMmacroTestimony.pdf>, accessed 24 July 2008.
- FRB: Press Release--Request for comment on changes to Regulation Z to protect consumers from unfair or deceptive home mortgage lending and advertising practices--December 18, 2007*. Washington, DC: Board of Governors of the Federal Reserve System. On-line. Available from Internet, <http://www.federalreserve.gov/newsevents/press/bcreg/20071218a.htm>, accessed 24 July 2008.
- Genesove, David and Christopher J. Mayer. 1997. *Equity and Time to Sale in the Real Estate Market*. *American Economic Review* 87 (June): 255–269.
- Gramlich, Edward M. 2007. *Subprime Mortgages: America's Latest Boom and Bust*. Washington: The Urban Institute Press.
- Ortalo-Magné, François and Sven Rady. *Boom In, Bust Out: Young Households and the Housing Price Cycle* (September 1998).
- Ortalo-Magné, François and Sven Rady. 2004. *Housing Transactions and Macroeconomic Fluctuations: A Case Study of England and Wales*. *Journal of Housing Economics* 13 (December): 287–303.
- Ortalo-Magné, François and Sven Rady. 2006. *Housing Market Dynamics: On the Contribution of Income Shocks and Credit Constraints*. *Review of Economic Studies* 73 (April): 459–485.
- Stein, Jeremy C. 1995. *Prices and Trading Volume in the Housing Market: A Model with Downpayment Effects*. *Quarterly Journal of Economics* 110 (May): 379–406.
- Thoma, Mark. 2008. *Economist's View: "Did Fannie and Freddie Cause the Mortgage Crisis?"*. Eugene, OR: University of Oregon. On-line. Available from Internet, <http://economistsview.typepad.com/economistsview/2008/07/did-fannie-and.html>, accessed 24 July 2008.