Aggressive Lending and Real Estate Markets

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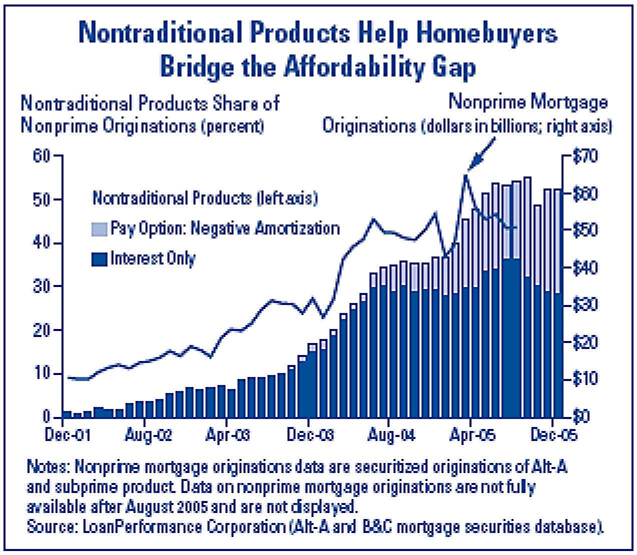
This paper establishes a theoretical and empirical link between the use of aggressive mortgage lending instruments and the underlying house price volatility. Within the context of a general equilibrium model with borrowing constraints, we demonstrate that the supply of aggressive lending instruments, such as non-amortizing low-equity mortgages, increases the asset prices in the underlying market because borrowers use these instruments to further leverage their current income. Thus, the aggressive lending instruments effectively relax the borrowing constraint faced by prospective homeowners. Furthermore, in our model lenders rationally re-price all mortgage instruments following a negative demand shock. We show that the relative use of aggressive lending instruments declines following a negative demand shock whether this re-pricing is anticipated or not. These two results provide for the important policy implication that the availability of aggressive mortgage lending instruments magnifies the real estate cycle and the effects of large negative demand shocks. Using both local and national price index data we empirically confirm the predictions of the model. In particular, we find that neighborhoods and cities that experienced a high concentration of aggressive lending instruments at their respective real estate market peaks suffered more severe price declines and a lower supply of aggressive instruments following a negative demand shock. Overall, we find that the fluctuation of supply of aggressive lending instruments increases the volatility of the underlying asset prices over the course of the market cycle.

Introduction

This paper establishes a link between the availability of aggressive mortgage lending instruments and underlying asset market prices**.** Industry sources suggest that aggressive lending instruments, such as interest only loans, negative amortization loans, low or zero equity loans, and teaser-rate ARMs, accounted for nearly two-thirds of all U.S. loan originations since 2003.[1]



[2]

The wide-spread popularity of these instruments has not escaped the attention of the policy makers in these countries. As early as 2004, the U.S. Federal Reserve Chairman at the time, Alan Greenspan, expressed a concern that many homeowners took out interest-only mortgages or option-adjustable rate mortgages to buy property they otherwise could not afford. "In the event of widespread cooling in house prices, these borrowers, and the institutions that service them, could be exposed to significant losses," Greenspan said.

More recently, Lingling Wei wrote in the Wall Street Journal (December 5, 2006) that lenders have a hard time selling their sub-prime mortgage lending units because of concerns over the subprime sellers' costly obligation of having to buy back the loans already sold in the secondary market due to borrowers' defaults. In the same issue, Ruth Simon and James Hagerty report that delinquency rates on subprime mortgages originated in the past year have soared to the highest levels in a decade. While these delinquencies are still at too low levels to affect the general economy, they have

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[1] FDIC Outlook: Breaking New Ground in U.S. Mortgage Lending. December 18th, 2006 <http://www.fdic.gov/bank/analytical/regional/ro20062q/na/2006_summer04.html>

[2] Nonprime mortgage originations rose at an even pace from 2001 through 2003 to reach between $25 billion and $30 billion in January 2004. Originations accelerated in 2004 before peaking in March 2005 in a range between $60 billion to $70 billion and declined since then to reach approximately $50 billion in August 2005. Recent data on subsequent months are not fully available and are subject to revision. < http://www.fdic.gov/bank/analytical/regional/ro20062q/na/2006_summer04_chart03.html> Refer also to appendix tables A1 through A4.

prompted credit-rating agencies to instruct issuers of mortgage-backed bonds to set aside additional funding to cover losses. Even if delinquencies remain modest, this increased capital requirement will ultimately force lenders to re-price their loans.

In this paper we provide both theoretical and empirical support for these policy concerns and industry reactions. Within the context of a general equilibrium model we demonstrate that the existence of aggressive lending instruments, such as interest-only mortgages, increases asset prices in the underlying market because borrowers are able to further leverage their current income or wealth. The inability to borrow against human capital imposes a constraint on many young US households, especially if both the personal and the economy-wide productivity are expected to grow overtime. The ability to increase the leverage of current wealth and income relaxes this constraint, which, in turn, increases the housing expenditures of these households. This additional source of demand is then translated into higher market prices, especially in markets of fixed or inelastic supply. We obtain this result with all lending instruments, aggressive or conservative, being fairly priced.

This effect can in theory cause a one-time price increase which reflects the relaxed borrowing constraint for many households with no further consequences. However, a more general model that allows market participants to revise the probability of a negative demand shock from their historical experience suggests that mortgage instruments get re-priced following such shocks. In this case, the price premium of aggressive instruments is correlated with past realizations. This correlation increases the overall volatility of real estate markets and magnifies negative demand shocks. We obtain this result even if all lending instruments are fairly priced, and the re-pricing of aggressive instruments following a negative demand shock is fully anticipated.

We use local-level transaction-based price indices and concentration of aggressive instruments in Los Angeles County to empirically investigate the hypothesized link. We also use the OFHEO metropolitan areas indices and concentration of aggressive instruments across cities to investigate this link on a national level. The empirical results from these two data sets provide are consistent with our theoretical conclusions described above.

First, we find that neighborhoods or cities that benefited from a high concentration of affordable aggressive instruments at the top of their market cycle experienced deeper price declines following their respective negative demand shock. Furthermore, the neighborhoods or the cities that experienced the largest price declines had the smallest concentration of aggressive instruments at the *bottom* of the market. These two findings are consistent with the prevalence of aggressive instruments that enables recent realizations of the market and magnifies the effects of negative demand shocks. This magnifying effect on the downside is present even in the absence of sizeable default rates. In other words, it is the fluctuation of the use of aggressive instruments that exacerbates market downturns, not the fact that such instruments generate relatively higher default rates.

The market share of aggressive instruments in our model is endogenously determined through the interaction of borrower segmentation and the re-pricing of all mortgages. Therefore, the fluctuation in the use of aggressive instruments throughout the market cycle is not entirely controlled by lenders. However, if lender reaction adds to the pricing fluctuation of aggressive instruments the result may be added price volatility and accompanying destabilization of markets. While the empirical evidence is not yet available to confirm this potential impact, the conceptual framework makes evident a secondary policy implication. In particular, the lending industry regulators should be careful not to take steps that alter markets after the fact, rather the goal should be to maintain availability of mortgage lending instruments in both rising and falling markets.

Ours is not the first study to investigate the link between lending and asset markets. Allen and Gale (1998 and 1999), Herring and Wachter (1999), and Pavlov and Wachter (2002, 2005) show that underpricing of the default risk in bank lending leads to inflated asset prices in markets of fixed supply. Furthermore, Pavlov and Wachter (2002, 2005, 2006) show that underpricing of the default risk exacerbates asset market crashes.

One unifying feature of this prior literature on the link between lending and asset markets is that the asset-backed loans are mispriced, either rationally or not. Our point of departure in this paper is that all loans are assumed fairly priced. Lenders react to current information on risks which may change over the cycle. Perceived risks change as market conditions change, hence, the fluctuations in the risk pricing of aggressive instruments, if any, are correctly anticipated. In the first instance, what drives market price inflation above its fundamental value in this model is the evolving constraint faced by borrowers. It is the time variation of this constraint, together with the dynamic re-pricing of the lending instruments, that generates our finding that aggressive lending magnifies the effect of negative demand shocks.

A handful of empirical investigations directly study the impact of aggressive lending on real estate, whether these instruments are priced correctly or not. Hung and Tu (2006) find that the increase of the use of adjustable rate mortgages in California is associated with an increase in median home prices. They make no comment on whether this increase is temporary and will reverse with the business cycle or whether it is a one-time permanent positive shock. Similarly, the September 2004 IMF report on the World Economic Issues suggests that countries with higher use of adjustable-rate mortgages have more volatile housing markets (Chapter II, page 81). The mechanism they conjecture to explain this finding is that higher use of ARM-like instruments makes real estate markets more sensitive to interest rate changes. This report does not consider the fluctuation in availability of ARMs and other aggressive instruments throughout the real estate market cycle. Even though the empirical findings of both studies do not provide a direct test of our model, they are indeed consistent with its implications.

We proceed as follows. Section 2 develops the link between lending and asset markets in a theoretical model. Section 3 presents the data and results using Los Angeles and national data. Section 4 concludes with a brief summary and suggestions for future research.

2 Model

This section presents a model of borrower demand and lending behavior in the presence of both traditional mortgages and aggressive lending instruments in the context of a competitive real estate market with fixed supply.[3] At each point in time, borrowers decide on their housing expenditure, lenders offer fairly priced aggressive and conservative mortgage loans, and the price for real estate is set to clear the market.

2.1 Borrower demand

We presume there are two distinct types of borrowers on the market – conservative and aggressive. We call the first type "conservative," as they would choose the traditional mortgages all the time as long as both instruments are priced fairly. The budget constraint for real estate of the conservative and aggressive borrowers is given respectively by:

$$\begin{aligned} (r_t^c + \gamma) P_t Q_t^c &= H_t^c \\ r^a P_t Q_t^a &= H_t^a \end{aligned} \tag{1}$$

where γ represents the required amortization payment on the conservative mortgage (not required for the aggressive mortgage, $r_t^{c,a}$ denotes the interest payment on each mortgage, presumed to be paid at the beginning of each period, $Q_t^{a,c}$ denotes the quantity of real estate purchased by each borrower group, and H_t^a and H_t^c denote the budget allocated to real estate by each group.[4] Define

$$H_t = H_t^a + H_t^c, \quad \alpha = H_t^a \big/ H_t \tag{2}$$

We introduce uncertainty over time in the budget allocated to real estate by both groups:

$$dH = \mu dt - \tilde{g} d\tilde{q} \tag{3}$$

[3] Numerical solutions of a model with supply response suggests that our results hold as long as the elasticity of supply is not infinite.

[4] These budget constraints are the result of the lenders restriction that payment to income ratio cannot exceed a certain pre-determined level. Thus, borrowers are off of their demand curve and are constraint by this requirement. However, these allocations to real estate can in theory also be obtained by optimizing a separable utility function of consumption and housing, with instantaneous budget constraint of the following form: $C + rPQ = I$, where *C* denotes consumption of other goods, and *rP* denotes the mortgage payment. With logarithmic utility function, the allocations in Equation (1) are exact. With iso-elastic utility, the functional form of the allocations is more complicated, but their behavior with respect to interest rates, prices, and quantities is the same. In this case, the price of real estate cannot be solved for explicitly, but our comparative statics results hold.

where μdt is expected growth in budget over dt, $\tilde{g}d\tilde{q}$ is a compound Poisson process, with,

$$d\tilde{q} = \begin{cases} 0 & \textit{with probability}\,(1-\delta)dt \\ 1 & \textit{with probability}\ \delta dt \end{cases} \tag{4}$$

$\tilde{g}$ is the random amount with mean $\lambda \geq 0$ and variance β by which demand falls in the case of a negative demand shock.

Summing the demand of the aggressive and conservative borrowers and equating it to the total fixed supply of real estate, Q, we obtain:

$$Q = Q_t^A + Q_t^C = \frac{(1-\alpha)H_t}{(r_t^c + \gamma)P_t} + \frac{\alpha H_t}{r_t^a P_t} \tag{5}$$

Solve for P_t:

$$P_t = \frac{H_t}{Q}\left(\frac{1-\alpha}{r_t^c + \gamma} + \frac{\alpha}{r_t^a}\right) \tag{6}$$

Assuming the prices of loans is unchanged through time (an assumption we relax below), the expected change in price in case of a negative jump is:

$$E\left(\frac{H_t}{Q}\left(\frac{1-\alpha}{r_t^c+\gamma}+\frac{\alpha}{r_t^a}\right)-\frac{(1-\tilde{g})H_t}{Q}\left(\frac{1-\alpha}{r_t^c+\gamma}+\frac{\alpha}{r_t^a}\right)\right) = E\left(\tilde{g}P_t\right) = \lambda P_t \tag{7}$$

This result suggests that losses are proportional to the asset price as long the supply of aggressive instruments does not change following a negative demand shock.

2.2 Lender Behavior

We assume a competitive risk-neutral lender who offers both the conservative and the aggressive mortgages and sets the rates so that the expected return for each instrument is the risk-free rate, assumed zero. The lender is assumed to experience losses only if a negative jump in demand occurs. The expected return for the aggressive and the conservative instruments is:

$$\begin{aligned} E(R_t^c) &= r_t^c - \delta(\lambda - \gamma) = r_t^a + \delta\gamma \\ E(R_t^a) &= r_t^a - \delta\lambda \end{aligned} \tag{8}$$

Setting these expected returns to zero, we find the interest rates on the two instruments:

$$\begin{aligned} r_t^c &= \delta(\lambda - \gamma) \\ r_t^a &= \delta\lambda \end{aligned} \tag{9}$$

Substitute (9) into (6) to obtain the price in period *t*:

$$P_t = \frac{H_t}{Q}\left(\frac{1-\alpha}{r_t^c + \gamma} + \frac{\alpha}{r_t^a}\right) = \frac{H_t}{Q}\left(\frac{\delta\lambda + (1-\delta)\gamma\alpha}{\delta\lambda(\delta\lambda + (1-\delta)\gamma)}\right) \tag{10}$$

Clearly, $\frac{\partial P_t}{\partial \alpha} \geq 0$, which demonstrates the price inflation effect of aggressive loans.

2.3 Dynamic share of aggressive lending and myopic lenders

With uncertainty agents are not likely to know the probability of a negative demand shock. Thus in this section, we assume that agents estimate the probability of a negative demand shock from existing historical data and update these probabilities with experience. Any reasonable econometric method would produce a higher estimate for the probability of a negative demand shock, $\hat{\delta}$, immediately following an observed shock. For instance, the simplest estimate of the probability of a shock is the number of past shocks divided by the time length of the data sample, $\hat{\delta} = \#shocks / T$. Clearly this estimate will increase immediately following a negative demand shock, since the numerator will increase by 1, while the denominator will not change. Since the lender is assumed risk-neutral, we can replace the probability of a negative demand shock, δ, with its estimate and the resulting parameter uncertainty will not alter the interest rates and asset price derived in Equations (9) and (10). For now we further assume that lenders are myopic in the sense that they do not anticipate the upward revision of the shock probability following a negative demand shock. In other words, lenders think that the probability of a negative demand shock will not be revised even though in the aftermath of an actual event it will indeed be revised upward. We relax this assumption in the next section.

An upward revision of the shock probability, δ, following a negative demand shock has two consequences that exacerbate the shock. First, the asset price falls more then proportionally to the decline in demand. Equation (9) shows that both interest rates increase with an increase in the shock probability. Equation (10) then shows that the price is a declining function of the shock probability, $\frac{\partial P}{\partial \delta} < 0$. Thus, following a negative demand shock, the asset price needs to adjust not only to account for the new lower total demand, H_t, but also to incorporate the higher probability of future negative shocks.

The second consequence of an upward revision of the shock probability, δ, is that the composition of the aggressive and conservative loans changes. Modify Equation (10) to show that:

$$r^a P_t = \frac{H_t}{Q}\left(\frac{(1-\alpha)r^a}{r^c+\gamma}+\alpha\right) \tag{11}$$

Differentiate with respect to δ:

$$\frac{\partial r^a P_t}{\partial \delta} = \frac{H_t(1-\alpha)}{Q}\frac{\lambda(\delta(\lambda-\gamma)+\gamma)-\delta\lambda(\lambda-\gamma)}{\left(r^c+\gamma\right)^2} = \frac{H_t(1-\alpha)}{Q}\frac{\lambda\gamma}{\left(r^c+\gamma\right)^2} > 0 \tag{12}$$

Then, using Equation (1), it is immediate that $\frac{\partial Q^a}{\partial \delta} < 0$. Similarly, it can be verified that $\frac{\partial Q^c}{\partial \delta} > 0$. In other words, the share of aggressive mortgages declines following a negative demand shock.

Furthermore, the price effect, $\frac{\partial P}{\partial \delta} < 0$ is magnified for markets with higher presence of aggressive lending. The cross-derivative $\frac{\partial^2 P}{\partial \alpha \partial \delta}$ is:

$$\begin{aligned} \frac{\partial^2 P}{\partial \alpha \partial \delta} &= \frac{\partial}{\partial \delta}\left(\frac{H}{Q}\left(\frac{-1}{\delta\lambda-\delta\gamma+\gamma}+\frac{1}{\delta\lambda}\right)\right) = \\ &= \frac{H}{Q}\left(\frac{\lambda-\gamma}{\left(\delta\lambda-\delta\gamma+\gamma\right)^2}-\frac{\lambda}{\left(\delta\lambda\right)^2}\right) \le 0 \end{aligned} \tag{13}$$

which is negative since the positive term has a smaller numerator and a larger denominator. Therefore, for markets with a higher presence of aggressive lending, measured by higher α, the asset price is more sensitive to changes in the probability of a negative demand shock, δ. In other words, markets with high concentrations of aggressive lending instruments experience larger than proportional (to the shock) price declines following a negative demand shock.

2.4 Dynamic share of aggressive lending and strategic lenders

In this section we assume lenders correctly anticipate an increase in the jump probability estimate following a negative demand shock**.** We find that the asset price still declines more than proportionally to the decline in demand and this result remains stronger for larger concentration of aggressive instruments. Let subscripts *B* and *A* denote the time immediately before and after the crash, respectively. The interest rate on the aggressive instrument before the crash is given by:

$$P_B r_B^a = \delta_B (P_B - P_A) \tag{14}$$

or,

$$(\delta_B - r_B^a) P_B = \delta_B P_A \tag{15}$$

or,

$$(\delta_B - r_B^a) P_B = (\delta_B - \delta_B \lambda) \frac{P_A}{(1-\lambda)} \tag{16}$$

The additional risk from the re-pricing of all instruments following a negative demand shock raises the interest rate before the shock, $r_B^a > \delta_B \lambda$. Therefore,

$$(1-\lambda) P_B \geq P_A \tag{17}$$

In other words, *the decline in price is more then proportional to the decline in demand following a negative demand shock.* Thus, even if lenders correctly anticipate the re-pricing of all instruments following a negative demand shock, aggressive instruments magnify the asset price impact of negative demand shocks.

Furthermore, this effect is still larger for markets with high concentration of aggressive instruments, although part of the difference is reduced by the strategic behavior of the lenders. It is easily verified that $r^c = r^a - \delta\gamma$. Substitute this into Equation (10) and suppress the time subscripts,

$$P = \frac{H}{Q} \left(\frac{1-\alpha}{r^a + (1-\delta)\gamma} + \frac{\alpha}{r^a} \right) \tag{18}$$

Note that r^a is no longer given by Equation (9), but is still an increasing function of the shock probability, δ. Differentiate (18) with respect to α and δ:

$$
\frac{\partial^2 P}{\partial \alpha \partial \delta} = \frac{\partial}{\partial \delta}\left(\frac{H}{Q}\left(\frac{-1}{r^a + (1-\delta)\gamma} + \frac{1}{r^a} \right)\right) =
$$

$$
= \frac{H}{Q}\left(\frac{\frac{\partial r^a}{\partial \delta} - \gamma}{\left(r^a + (1-\delta)\gamma\right)^2} - \frac{\frac{\partial r^a}{\partial \delta}}{\left(r^a\right)^2} \right) \le 0 \tag{19}
$$

The cross-derivative in Equation (19) is negative because the positive term has a smaller numerator and a larger denominator. Therefore, the sensitivity of the asset price to changes in the shock probability is larger for markets with higher demand for the aggressive instrument. In other words, markets with high concentration of aggressive lending instruments experience larger price declines following negative demand shocks of a constant magnitude. Note that Expression (19) reduces to Equation (13) if $r_t^a = \delta\lambda$. However, as discussed above, r_t^a is higher due to the lender's anticipation of a re-pricing after a negative shock.

The second consequence of an upward revision of the shock probability, δ, is that the composition of the aggressive and conservative loans changes. Modify Equation (10) to show that:

$$
r^a P_t = \frac{H_t}{Q}\left(\frac{(1-\alpha) r^a}{r^c + \gamma} + \alpha \right) \tag{20}
$$

Differentiate with respect to δ:

$$
\frac{\partial r^a P_t}{\partial \delta} = \frac{H_t (1-\alpha)}{Q} \frac{\frac{\partial r^a}{\partial \delta}(r^a + (1-\delta)\gamma) - r^a (\frac{\partial r^a}{\partial \delta} - \gamma)}{\left(r^a + (1-\delta)\gamma\right)^2} = \frac{H_t (1-\alpha)}{Q} \frac{\frac{\partial r^a}{\partial \delta}(1-\delta)\gamma + r^a \gamma}{\left(r^a + (1-\delta)\gamma\right)^2} > 0 \tag{21}
$$

Then, using Equation (1), it is evident that $\frac{\partial Q^a}{\partial \delta} < 0$. Similarly, it can be verified that $\frac{\partial Q^c}{\partial \delta} > 0$. In other words, the share of the aggressive mortgages declines following a negative demand shock.

In summary, the above model suggests the following empirical implications:

1. The asset price is an increasing function of the demand for aggressive lending instruments.
2. If lenders do not observe the true probability of a negative demand shock but estimate it from historical data, following a negative demand shock
   a. the estimated probability of a negative demand shock increases

b. the asset price declines more then proportionally to the decline in demand
c. the decline in asset price is larger for markets with high concentration of aggressive lending instruments
d. the use of aggressive instruments declines

3. These implications hold even if lenders correctly anticipate the change in shock probability, or its estimate, following a negative demand shock, although their magnitude may be partially reduced by the strategic behavior of lenders.

3.0 Empirical evidence

In this section we test the empirical implications of our conceptual framework using two distinct data sets, described below. In particular we show that asset prices decline more in markets with high concentration of aggressive instruments and that the use of aggressive instruments declines the most for markets that experience the largest price declines.

3.1 Los Angeles Empirical Evidence

Using data from the 1990 – 1995 real estate market downturn in Southern California we consider whether the historical evidence is consistent with our hypothesis. We utilize transaction data from *DataQuick*, a company specializing in collecting real estate transaction data. The underlying data comes from the County Recorder. Following Pavlov (2001) and Deng, Pavlov, and Yang (2005) we divide Los Angeles County into 22 areas that capture to a great extend the heterogeneity of the Los Angeles real estate market. Then, we compute the total percent decline for each of the regions between May, 1990 and October, 1995, which represent the top and the bottom of the Los Angeles real estate market cycle, respectively. We use all transactions which occurred within 3 months of the top and the bottom of the market to estimate a hedonic regression of the following form:

$$\ln(V_i) = \sum_{z=1}^{22} \alpha_z \zeta_{zi} + \sum_{z=1}^{22} \beta_z \zeta_{zi} t_i + X_i \gamma + \varepsilon_i \ , \qquad (22)$$

where V_i denotes the value of transaction i, ζ_{zi} is an indicator variable which takes the value of 1 if the property is located in zone z and zero otherwise, t_i is an indicator variable which takes the value of 1 if the transaction occurred between August, 1995 and January, 1996, and zero otherwise, X_i denotes a horizontal vector of physical characteristics of the property, α, β, and γ are parameters of the model and ε_i is the estimation error. The physical characteristics we include are number of bedrooms and bathrooms, size of the lot and of the building, year built, and whether the property has a pool or not. Given the above equation, the estimated parameters β_z are estimates of the percent decline in property values from 1990 to 1995 for each of the 22 neighborhoods. Table 1 provides summary statistics for the Los Angeles price data. The median percent decline during that period was just over 21% for the entire metropolitan area, ranging from 7% to 35% for each of the 22 neighborhoods.

We further use loan origination data from *Wells Fargo Mortgage* that contains private-label securitized mortgage loan originations, spanning a period from 1988 to 2001. The data is of high quality and is consistent through time. This data accounts for over 20% of all loan originations in Los Angeles County and contains the postal zip code of the underlying property. This allows us to spatially assign the originations to each of the 22 neighborhoods. While no interest only or extended amortization mortgages were available at the time, the late 1980's was the period when adjustable-rate mortgages became popular in the U.S. While ARMs are not particularly aggressive instruments, they do have all the characteristics of these instruments when compared to the traditional fully amortizing fixed-rate mortgages. For example, ARMs allow borrowers to spend more on a real estate purchase, holding their housing expenditure constant. This benefit came at the cost of increased risk for some borrowers. ARMs were new at the time, so their pricing and future availability was unclear. Finally, ARMs became increasingly popular during the late 1980s run-up. Summary statistics of the loan data is also reported in Table 1.

Table 2 reports a single variable regression of the top to bottom price decline, measured in absolute terms, in a neighborhood as a function of the ARM share in that neighborhood at the top of the market. We first report the results for loans used for purchasing homes. The proportion of ARMs at the top of the market is associated with a large and significant impact on the subsequent price decline. *For each one percent higher share of ARMs in 1990, the price decline increases by 1.3 percent for that neighborhood.* This finding is consistent with our theoretical implication that the presence of ARMs at the top of the market magnifies the subsequent negative demand shock.

Furthermore, as expected, our results are weak and insignificant for loans used for refinancing. Our model suggests that aggressive lending instruments allow borrowers to purchase homes they otherwise cannot afford. Clearly, this effect is not operational for refinancing loans, due to the fact that the borrower is already an owner. The insignificant but in the right sign coefficients we find may be due to the refinancing activity shadowing the origination loans. In other words, borrowers who used an ARM for purchase may be more likely to use an ARM for refinancing or equity out purposes because they have a higher comfort level with these instruments.

Table 3 reports the results of a single variable regression of the change in proportion of ARM originations during the 1990 to 1995 period on the percent decline in each neighborhood. The model implies that areas that suffer the largest price declines during a crash are those in which ARM originations decline the most. The results reported in Table 3 are consistent with this, as the decline in ARM originations is associated with the percent decline in prices from top to bottom. This finding is significant for all loans and loans used for purchase, although as expected not significant for loans used for refinancing. Aggressive instruments appear to be "hot money." Their prevalence puts the market at greater risk as their originations tend to decline on a relative basis faster than the traditional more conservative instruments in the face of a negative demand shock in the underlying market.

3.2 National-level Empirical Evidence

We further test our theoretical implications using a national dataset of house price changes and the prevalence of aggressive instruments. We obtain metropolitan area price indices from OFHEO. We select all metropolitan areas in the US which have experienced a total continuous nominal price decline of at least 5% at any time in the past. This includes the following ten cities: Boston, Dallas, Denver, Honolulu, Los Angeles, New York, Phoenix, Salt Lake City, San Diego, and San Francisco. Table 4 provides summary statistics for this data.

We obtain loan origination data from the Federal Housing Finance Board.[5] This data is from FHFB's Monthly Survey of Rates and Terms on Conventional Single-Family Non-farm Mortgage Loans. The reported information is based on fully amortized mortgage loans used to purchase single-family non-farm homes and excludes non-amortized loans, balloon loans, and loans used to refinance houses. The survey reports only conventional mortgages, and thus excludes mortgage loans insured by the Federal Housing Administration (FHA) or guaranteed by the Veterans Administration (VA).

The FHFB data set contains all originations as well as the proportion of ARM originations through time. Since each market reached its top and bottom at different times, we use the difference between the proportion of ARM originations in each city and the proportion of ARM originations across the nation. This is the "excess" ARM originations above the national average for each city which adjusts the data for the secular trend of increased use of ARMs. We also report the change in the excess ARM originations in Table 4.

Even just the descriptive statistics reported in Table 4, provide support for our theoretical predictions. The proportion of ARM originations in most markets that experienced a large negative demand shock was above the national average at the respective peaks of these markets. Furthermore, the proportion of ARM originations fell below the national average following the negative demand shock in each city.

Table 5 reports a single variable regression of the top to bottom decline, measured in absolute terms, in a metropolitan area a function of the ARM originations share in that area in excess of the national average originations share at the top of the market. The proportion of ARMs on the top of the market has a large and significant impact on the subsequent price decline. This finding is consistent with our theoretical implication that the presence of ARMS at the top of the market magnifies the subsequent negative demand shock.

The effect using national data reported in Table 5, is smaller in magnitude than the effect for the Los Angeles neighborhoods reported in Table 2. This is not surprising, as metropolitan areas experience a reduction in the variation of price declines as a result of large aggregation.

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[5] Federal Housing Finance Board December 18th, 2006 <http://www.fhfb.gov/Default.aspx?Page=53> (Table 12)

Table 6 reports the regression results of the top to bottom change in the proportion of ARM originations in excess of the national average change in proportion as a function of the percent decline in each metropolitan area that experienced a decline. While this result is marginally significant (at the 10% level), it is of substantial magnitude and in the expected sign. This evidence is consistent with our theoretical implication that the share of ARM originations experience larger declines in markets that experience larger price declines.

We further investigate the impact of ARMs across the nation both in raising (RISING) and falling markets. To this end, we first regress the OFHEO price change for each year between 1986 and 2002 on the proportion of ARM originations the previous year for all metropolitan areas in the OFHEO dataset. We then regress the slope estimates from each of the 22 regressions on the average national appreciation rate for that year. The positive and significant coefficient reported in Table 7 indicates that high share of ARM organizations have a positive impact on subsequent price changes during up markets and a negative impact during down markets. In other words, markets with a relatively high concentration of aggressive instruments experience larger price fluctuations over the market cycle, which is consistent with the theoretical findings of our model.

3.3 Alternative Explanations

Both the national and the Los Angeles empirical evidence is strongly consistent with our theoretical predictions. However, two alternative mechanisms can potentially generate similar empirical findings. First, affordability constrained markets are supply inelastic, and, therefore experience larger price increases and declines with the market cycle (see Linneman and Wachter (1989)). In this case, high concentration of ARMs on the market top is a response to the affordability constraint, and the decline in ARM share is a demand led response to the reduced affordability constraint at the market bottom. While perfectly plausible, this explanation does not in any way contradict our hypothesis that aggressive lending instruments magnify the market cycles. As long as ARMs help alleviate the affordability constraint in the inelastic markets at the top, their presence pushes transaction prices even higher on the top of the market. Absent aggressive instruments, the highly binding affordability constraint at the top of the market would have curtailed the price run-ups and, therefore, reduced the magnitude of the market cycle. This is exactly as predicted by the theoretical model. Nonetheless, the magnitude of the impact of aggressive lending instruments we estimate from the data would be lessened with this alternative mechanism, if it is at work.

Second, it is possible that exuberant borrowers at the top borrow using aggressive mortgage instruments and also bid up prices. In this case, even if aggressive lending instruments did not exist, those same overly-optimistic borrowers would have bid up prices to the same extent. While this explanation may potentially generate the first effect we find, i.e., that prices fall more in ARM-rich neighborhoods or cities, it is unlikely to generate the second, that ARM share declines more for harder hit neighborhoods. We find this result for loans used for purchase only, as well as in the entire dataset. It is hard to imagine that somebody purchasing a home is not optimistic about the future of the market or their personal future even following a negative demand shock. That is, they are avoiding ARMs at the bottom of the market while nonetheless purchasing homes because they are fearful of the future and they are more fearful in areas where prices declined more. In any case if this were the total explanation we would not find a nonsignificant response for refi borrowers. Buyers are usually optimistic, a negative demand shock is just associated with a fewer number of optimists in the market.

Nonetheless, we plan to directly test these two alternative implications in future work. In particular, we plan to include a measure of market elasticity as an explanatory variable for the price decline in addition to the share of ARMs. Furthermore, we plan to investigate rejection rates across markets and through the market cycle to test if home buyer's sentiment towards aggressive lending changes.

4.0 Conclusion

In this paper we show, both theoretically and empirically, that the presence of aggressive lending instruments magnifies real estate market cycles. Markets with high concentration of aggressive lending instruments are at a risk of relatively larger price declines following a negative demand shock. At the same time, markets that decline the most following a negative demand shock, tend to suffer greater withdrawal of aggressive lending.

The five markets that currently have highest concentration of aggressive lending instruments are Florida, Arizona, District of Columbia, Nevada, and California for prime loans, and Illinois, Utah, California, Arizona, and Nevada for sub-prime (Appendix table 1). Our findings predict that these markets are likely to experience relatively the largest market declines should a negative demand shock occur.

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Table 1: Descriptive Statistic of the Los Angeles Price and Loan Data

Variable	Mean	Median	Minimum	Maximum	St. Dev.
1990 – 1995 Price decline by region	21.4%	21.1%	6.8%	34%	7.7%
1990 proportion of ARMs All loans	7%	6.5%	1.2%	12.4%	2.9%
1995 proportion of ARMs All loans	10%	9%	2.1%	20%	3.8%
Change in proportion of ARMs, 1990 – 1995	3%	3%	-2.1%	14%	3.7%

Table 1 provides summary statistics for the Los Angeles price and loan data. The price decline is computed using the following equation:

$$\ln(V_i) = \sum_{z=1}^{22} \alpha_z \zeta_{zi} + \sum_{z=1}^{22} \beta_z \zeta_{zi} t_i + X_i \gamma + \varepsilon_i \ , \tag{23}$$

where V_i denotes the value of transaction i, ζ_{zi} is an indicator variable which takes the value of 1 if the property is located in zone z, t_i is an indicator variable which takes the value of 1 if the transaction occurred between August, 1995 and January, 1996, X_i denotes a horizontal vector of physical characteristics of the property, α, β, and γ are parameters of the model and ε_i is the estimation error. The physical characteristics we include are number of bedrooms and bathrooms, size of the lot and of the building, year built, and whether the property has a pool or not. Given the above equation, the estimated parameters β_z are estimates of the percent decline in property values from 1990 to 1995 for each of the 22 neighborhoods. The median percent decline during that period was just over 21% for the entire metropolitan area, ranging from 7% to 35% for each of the 22 neighborhoods.

Loan origination data from *Wells Fargo Mortgage* contains private-label securitized mortgage loan originations, spanning a period from 1988 to 2001. The summary statistics provided in Table 1 are for all originations in 1990 and 1995, and the change between 1990 and 1995. While the ARM share increased on average across the nation during the 1990 – 1995 period, there was a great dispersion in the growth rates in different LA neighborhoods. In fact, about a quarter of our neighborhoods saw no increase or decrease in the share of ARMs during the 1990 – 1995 period despite the positive secular trend.

Table 2: Los Angeles Price Decline and Aggressive Lending in 1990

		Origination Loans		
Dependent variable in absolute value	Type of loans	Constant	% ARM, 1990	R^2
Percent price decline May 1990 – Oct 1995	All loan originations	12 (3.19)	1.3 (2.56)	.25
Percent price decline May 1990 – Oct 1995	Loans for purchase only	15 (4.9)	1.5 (2.34)	.22
Percent price decline May 1990 – Oct 1995	Loans for refinancing and Equity only	15 (3.67)	.73 (1.8)	.14

Table 2 reports a single variable regression of the top to bottom decline in a neighborhood as a function of the ARM share in that neighborhood at the top of the market. The total decline is measured in absolute terms. We report the results for all loans as well as loans used for purchase and refinancing separately. The proportion of arms on the top of the market has a large and significant impact on the subsequent price decline. For each one percent increase in share of ARMs in 1990, the price decline increased by 1.3 percent for that neighborhood. This finding is consistent with our theoretical implication that the presence of ARMs at the top of the market magnifies the effect of the subsequent negative demand shock.

Furthermore, as expected, our results are weakest for loans used for refinancing. Our model suggests that aggressive lending instruments allow borrowers to purchase homes they otherwise cannot afford. Clearly, this effect is weakened for refinancing loans, since the borrower is already an owner. Nonetheless, aggressive loans have a positive impact on refinancing because the borrower may be more willing to postpone a sale of their home if they can withdraw a large portion of the equity they have.

Table 3: Change in Aggressive Lending and Los Angeles Price Declines

Dependent Variable	Constant	Percent price decline, May 1990 – Oct 1995 (absolute value)	R^2
Change in proportion of ARM originations 1990 – 1995, All loans	.09 (4.93)	-.29 (-3.48)	.38
Change in proportion of ARM originations 1990 – 1995, Purchase only	.11 (3.4)	-.48 (-3.43)	.37
Change in proportion of ARM originations 1990 – 1995, Refinance or equity out only	.1 (3.86)	-.16 (-1.43)	.09

Table 3 reports the results of a single variable regression of the change in proportion of ARM originations during the 1990 to 1995 period on the percent price decline in each neighborhood. Our model predicts that ARM originations decline the most in areas that suffered the largest price declines during a crash. The results reported in Table 3 are consistent with this implication, as the percent decline from top to bottom had a negative impact on the change in ARM originations. This finding has large implications and is significant for all loans as well as loans used for purchase. As expected, the effect is weaker but still present for refinancing and equity out loans. Aggressive instruments appear to be "hot money." Their prevalence puts the market at risk as their originations tend to decline on a relative basis faster than the traditional more conservative instruments in the face of a negative demand shock in the underlying market.

Table 4: Descriptive Statistic of the National Price and Loan Data

Variable	Mean	Median	Minimum	Maximum	St. Dev.
Price decline, top to bottom by city	11.8%	11.37%	6.69%	21.55	1.47
Proportion of ARMs – National average proportion Top of the market	13.8%	13.5%	-10%	35%	4.15
Proportion of ARMs – National average proportion Change from top to bottom of the market	-13.2%	-16.5%	-35%	11%	4.13

Table 4 provides summary statistics for the national price and loan data. We use the OFHEO price index to measure price declines. We select all metropolitan areas in the US which have experienced total continuous nominal price decline of at least 5% at any time in the past. This includes the following ten cities: Boston, Dallas, Denver, Honolulu, Los Angeles, New York, Phoenix, Salt Lake City, San Diego, and San Francisco.

We obtain loan origination data from the Banker's Association. Their data set contains all originations and the proportion of ARM originations through time. Since each market reached its top and bottom at different times, we use the difference between the proportion of ARM originations in each city and the proportion of ARM originations across the nation. This is the "excess" ARM originations above the national average for each city. This adjusts the data for the secular trend of increased use of ARMs. We also report the change in the excess ARM originations in Table 4.

Even just the descriptive statistics reported in Table 4 provide some support for our theoretical predictions. The proportion of ARM originations in most markets that experienced a large negative demand shock was above the national average at the respective peaks of these markets. Furthermore, the proportion of ARM originations fell below the national average following the negative demand shock in each city.

Table 5: National Price Decline and Aggressive Lending

Dependent variable in absolute value	Constant	% ARM top minus % ARM national average	R^2
Percent price decline	9	.2	.27
Top to bottom	(4.8)	(2.07)	

Table 5 reports a single variable regression of the top to bottom decline in a metropolitan area aS function of the ARM originations share in that area in excess of the national average originations share at the top of the market. The total decline is measured in absolute terms. The proportion of ARMs on the top of the market has a large and significant impact on the subsequent price decline. This finding is consistent with our theoretical implication that the presence of ARMs at the top of the market magnifies the subsequent negative demand shock.

The effect using national data is smaller in magnitude than the effect for the Los Angeles neighborhoods reported in Table 2. This is not surprising, as metropolitan areas experience a reduction in the variation of price declines as a result of large aggregation.

Table 6: Change in Aggressive Lending and National Price Declines

Dependent Variable	Constant	Percent price decline, Top to bottom (absolute value)	R^2
Change in proportion of ARMs minus National proportion of ARMs	3.3	-1.4	.15
	(.3)	(-1.65)	

Table 6 reports the regression results of the top to bottom change in the proportion of ARM originations over the national average change in proportion as a function of the percent decline in each metropolitan area that experienced a decline. While this result is marginally significant (at the 10% level), it's of substantial magnitude and in the right sign. This evidence is consistent with our theoretical implication that the share of ARM originations falls more in markets that experience larger price declines.

Table 7: The effect of aggressive lending during up and down markets

Dependent Variable	Constant	Average Appreciation Rate	R^2
Slope of price change on ARM originations share	0	.04	.67
	(0)	(5.76)	

For each year between 1986 and 2002 we first regress the OFHEO price change during that year on the proportion of ARM originations the previous year for all metropolitan areas in the OFHEO dataset. We then regress the slope estimates from each of the 22 regressions on the average national appreciation rate for that year. The positive and significant coefficient reported in Table 7 indicates that a high share of ARM originations have a positive impact on subsequent price changes during up markets and negative impact during down markets. In other words, markets with relatively high concentrations of aggressive instruments experience larger price fluctuations over the market cycle, which is consistent with the theoretical findings of our model.

Appendix Tables

Table A1: First Liens, count-weighted, 2006 originations only
source: calculations of Federal Reserve economists, Andreas Lehnert et al.

Prime Loans

Bottom 5		Top 5	
State	**ARM %**	**State**	**ARM%**
Oklahoma	0.052505	Florida	0.345101
Arkansas	0.064802	Arizona	0.347988
Louisiana	0.066273	District of Columbia	0.391303
North Dakota	0.070094	Nevada	0.472748
Mississippi	0.071004	California	0.597999

Subprime Loans

Bottom 5		Top 5	
State	**ARM %**	**State**	**ARM%**
Oklahoma	0.507833	Illinois	0.780561
West Virginia	0.515663	Utah	0.788109
Tennessee	0.524461	California	0.788690
Mississippi	0.535778	Arizona	0.792880
Ohio	0.547293	Nevada	0.809030

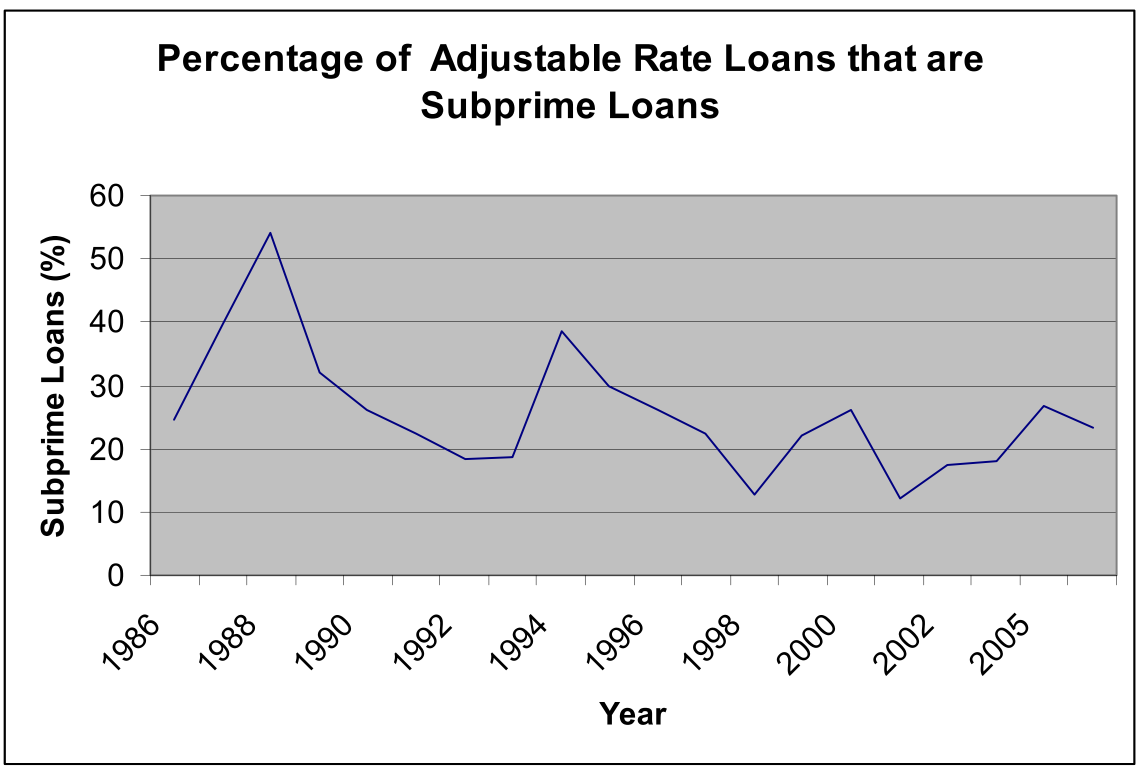


Table A2

Recent Collateral Trends in Lending for Interest-Only and Pay-Option Adjustable Rate Mortgages: Combining Higher-Risk Loan Features Results in "Risk Layering" and Heightens the Overall Level of Credit Risk					
Year	**Low or No Documentation**[a]	**Loan to Value**[b]	**Credit Score**[b]	**Investor Share**[c]	**Prepayment Penalty**[a]
2003	53.90%	76	701	11.60%	50.50%
2004	58.00%	77.1	692	12.60%	51.90%
2005	65.70%	76.4	696	14.10%	59.20%

[a] Calculated as a percentage of total interest-only or pay-option adjustable-rate mortgage originations.

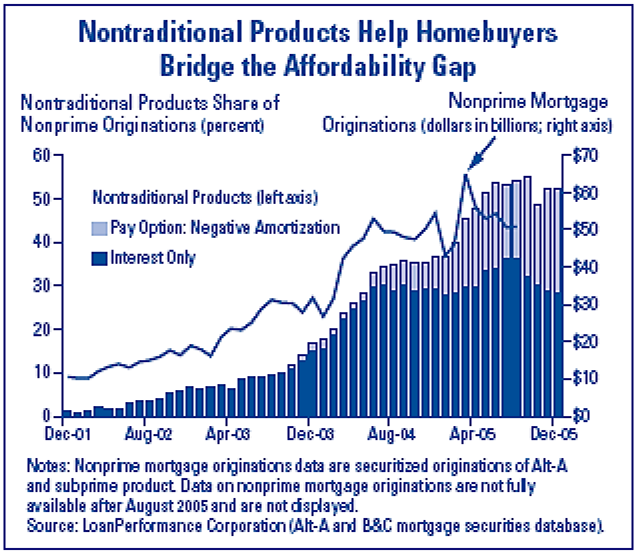
[b] Original combined loans to value and credit scores are weighted averages.

[c] Calculated as nonowner and second home originations.

Source: LoanPerformance Corporation (Alt-A and B&C mortgage securities database).

http://www.fdic.gov/bank/analytical/regional/ro20062q/na/2006_summer04.html#11

Appendix
Table A3, underlying data follow



Nonprime mortgage originations data are securitized originations of Alt-A and subprime product. Data on nonprime mortgage originations are not fully available after August 2005 and are not displayed.

Source: LoanPerformance Corporation (Alt-A and B&C mortgage securities database).
http://www.fdic.gov/bank/analytical/regional/ro20062q/na/2006_summer04.html#11

Appendix
TableA3 (underlying data)

Nontraditional Products Help Homebuyers Bridge the Affordability Gap		
Month and Year	Interest-Only Share of Nonprime Originations (percent)	Pay Option: Negative Amortization Share of Nonprime Originations (percent)
1-Dec	1.06%	1.11%
2-Jan	0.75%	0.79%
2-Feb	1.36%	1.39%
2-Mar	2.21%	2.29%
2-Apr	1.71%	1.82%
2-May	1.72%	1.80%
2-Jun	2.86%	3.02%
2-Jul	3.33%	3.48%
2-Aug	3.65%	3.77%
2-Sep	4.15%	4.25%
2-Oct	5.01%	5.18%
2-Nov	5.84%	6.00%
2-Dec	6.31%	6.53%
3-Jan	6.16%	6.44%
3-Feb	6.60%	6.79%
3-Mar	7.07%	7.26%
3-Apr	6.25%	6.46%
3-May	8.28%	8.59%
3-Jun	8.65%	9.03%
3-Jul	8.74%	9.06%
3-Aug	9.23%	9.60%
3-Sep	9.42%	10.19%
3-Oct	10.92%	11.95%
3-Nov	12.66%	14.06%
3-Dec	15.01%	16.76%
4-Jan	15.66%	17.66%
4-Feb	18.80%	20.17%
4-Mar	22.30%	23.91%
4-Apr	24.45%	25.95%
4-May	26.58%	28.51%
4-Jun	29.54%	32.87%
4-Jul	29.96%	34.61%
4-Aug	28.62%	34.68%
4-Sep	29.99%	35.78%
4-Oct	28.83%	35.14%
4-Nov	29.33%	35.23%
4-Dec	29.44%	36.84%
5-Jan	27.83%	36.69%

5-Feb	28.34%	40.08%
5-Mar	29.88%	45.36%
5-Apr	29.80%	47.68%
5-May	33.42%	51.62%
5-Jun	33.77%	53.60%
5-Jul	36.33%	53.34%
5-Aug	35.97%	53.97%
5-Sep	32.26%	55.07%
5-Oct	30.09%	48.82%
5-Nov	29.04%	52.35%