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Securitization and Asset Price Cycle: Causality and Post-Crisis Policy Reform

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Abstract

This study aims to explain causal relationships between the two dramatic cycles observed in the U.S. during the recent financial crisis – the mortgage credit cycle and the home price cycle. In the viewpoint of mortgage lending, the main demand-side driver for the observed credit concentration from the early 2000s was the extremely low, even negative, user cost of capital (UCC) for owning between 2002-2006. UCC was, in turn, influenced by three key factors - the record low mortgage interest rate, the practical removal of capital gains taxes for home sales, and high expected home price appreciation on the part of home owners. Easing borrowing constraints, gradually from the early 1980s and abruptly from the early 2000s, is also shown as a significant shift factor in the demand side. In the supply-side, the main drivers for the boom-bust of mortgage credit between early to mid 2000s are identified to be: the favorable interest rate environment, the low rates as well as the sizable yield spreads, which rapidly changed from 2005; the generous bond ratings at initial security issuance, followed by abrupt and deep post-issuance downgrading from 2007; and, the sudden rise of the private-label (PL) RMBS issuers from 2004, resulting in gradual deterioration of the mortgage underwriting criteria. Preliminary econometric analyses show that: the share of PL RMBS in the total issuance Granger-caused the home price growth, but not the other way around; and, the home price boom-bust in the 2000s was significantly influenced by UCC and the share of PL RMBS, but not by the total issuance volume of RMBS. Policy implications of the findings are discussed, in particular, regarding micro- and macro-prudence regulations governing the mortgage·MBS sector.

Key words: mortgage securitization, housing price cycle, and prudence regulation
JEL codes: E44, G21, G28

I. Introduction

Since mid-1980s, asset securitization, a funding method that transforms illiquid financial assets to liquid securities, has spread to various consumer and business lending sectors in the U.S., Europe, and emerging market countries. Social good of this relatively recent innovation was, among others, to extend financial service to borrowing-constrained households or business entities, such as low-income and/or less-creditworthy home buyers or high-yield corporate borrowers. However, the 2007-2009 global financial crisis revealed its social cost in various forms, e.g., the rapid credit concentration to the mortgage lending sector (in the U.S.), the ensuing home price bubble, the large scale credit losses and the resulting credit crunch, the liquidity spiral following the Lehman's failure, and the deterioration in real economic activities in the U.S. and other countries.[1] In short, the recent crisis demonstrated the scale of systemic instability that securitization can inflict both domestically and internationally.

As a sector-specific outcome, the boom-bust of the mortgage securitization in the U.S. was dramatic. In particular, the new issuance of the non-agency residential mortgage backed securities (RMBS) in the U.S., which reached the $917 billion mark in 2006, dropped to the meager $21 billion in 2009 (YTD by October).[2] Furthermore, several structured securities in this market, e.g., ABS backed by subprime and Alt-A mortgages, and its re-securitized products - ABS CDO (Collateralized Debt Obligation), and ABS CDO-squared, all experienced a precipitous decline in value, serving as the epicenter of the turmoil in the global financial system and real economy. Coincidentally, the home price cycle in the U.S. also had its dramatic turn: after building up the unprecedented cumulative growth since 1998, it reached its peak in the mid-2006, and has been declining by more than 30% since then. In consequence, about $8 trillion worth home equity has evaporated since the turn of the market.

This paper aims to identify, and, to the extent possible, quantify, causal relationships between the two cycles – the mortgage credit cycle and the home price cycle - in the U.S., along with policy lessons learned out of the recent incidence. There is already a growing number of studies that examine the role of securitization during the current crisis.[3] While these studies tend to focus on micro aspects of mortgage securitization (e.g., moral hazard on the part of intermediaries, uninformed investors, parameter instability in bond rating, pricing failure for certain RMBS products), this paper examines its linkages to macro market outcomes by analyzing correlation and causality with various time-series variables involved, e.g., real home price changes, mortgage and RMBS origination volumes, interest rates and yield spreads, single-family housing starts, and other endogenous and exogenous variables.

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[1] There is a series of books examining various underlying causes of the 2007-2009 global financial crisis, including Martin Wolf (2009), Krugman (2009), Acharya and Richardson (2008), Shiller (2008), Gramlich (2007), among many others.
[2] Data from Securities Industry and Financial Market Association
[3] Among others, refer Mason (2008), Mason and Rosner (2007), Gorton (2008), Ashcraft and Schaumann (2009), Fender and Mitchell (2009), IMF (2009), Linneman and Cho (2009), Cho (2009), Benmelech and Dlugosz (2009), Shin (2009), Griffin and Tang (2010).

In the viewpoint of mortgage lending, the main driving force in the demand-side for the observed credit concentration from the early 2000s was the record low, or even negative, user cost of capital (UCC) for owning, the after-tax net cost of financing and maintaining home. Three particular factors are identified as responsible for this extremely low UCC between 2002-2006: namely, the record low mortgage interest rate, the practical removal of capital gains taxes for home sales from 1997, and high expected home price appreciation on the part of existing and prospective home owners. Easing borrowing constraints in mortgage lending, gradually from the early 1980s and abruptly from the early 2000s, is also shown to have lowered UCC, as reported by Duca, Muelbauer, and Murphy (2009). The implication is that, during this period, household tenure decisions were heavily skewed toward owning rather than renting, which also worked as a demand shifter in the housing market. The downturn started from 2006 was caused by the regime swift in the interest rate environment, rapid evaporation of expected home price gain, as well as the overhang from excess supply of new homes.

In the supply side, three factors are shown to be key drivers of the mortgage market boom-bust. First, the interest rate environment fostered by the expansionary monetary policy in the early to mid-2000s skewed investors' incentive toward borrow-short-lend-long investment behavior, which increased demand for long-term securities such as RMBS. Specifically, the very low (or negative real) short rates along with the large yield spread (about 250 to 300 bp spreads between 10-year vs. 1-year Treasury Bonds) in 2001-2005 incentivised many institutional investors, both domestic and international, to issue shot-term debts (e.g., ABCP) and to put mobilized funds into the RMBS sector. That practice, however, abruptly ended when the short-rates started rising rapidly from 2005, creating the inverted yield curve environment from early 2006.

Second, the generous bond ratings by the credit rating agencies (CRAs) made it possible to issue those RMBS products backed by subprime and Alt-A mortgage loans in a large scale. These products were new to the mortgage finance sector in that they were "credit-tranched," i.e., mortgage pools being sliced (or "tranched') to provide sub-segments with different levels of protection from borrowers' default risk. On the other hand, typical RMBS products backed by prime mortgage loans in the U.S. were "prepay-tranched," i.e., mortgage pools being segmented to different borrowers' prepayment risk. Yet, generous issuance of AAA tranches for subprime and Alt-A RMBS tranches despite the newness of the products has induced a large scale credit concentration to the non-agency sector. The oligopolistic industrial structure of CRAs, still dominated by the big three – Standard&Poors, Moody's and Fitch – is often quoted as one of the underlying reasons for this rating anomaly. (Acharya and Richardson, 2009) Nonetheless, both initial rating outcomes and post-issuance downgrading were extreme during the recent boom-bust of the RMBS market. As a case in point, only about 10% of all AAA tranches from subprime and Alt-A RMBS products issued by Standard&Poors during 2005-2007 remained as AAA, while more than 80% of them were downgraded to BBB or lower.

Third, the sudden rise of the private-label RMBS issuers from 2004, at the cost of GSEs (Fannie Mae and Freddie Mac) who suffered the accounting scandals from 2003, expanded the segment of the RMBS market in the U.S. where industry-wide mortgage lending criteria and risk measurement metrics did not exist. In comparison, the "conforming-conventional" RMBS sector has employed the GSEs' funding criteria since

mid-1980s (e.g., various eligibility rules regarding LTV, DTI, consumer credit score, mortgage product, documentation, and so on), as well as risk measurement tools such as prepay-OAS (Option Adjusted Spread). These standards and assessment techniques were accepted by its investor community, along with periodic disclosure of mark-to-market risk factors for each mortgage pool, the practice of which did not exist in the subprime mortgage·MBS sector until its demise. The rising mortgage defaults in the private-level RMBS sector, the large scale downgrades of private-label RMBS tranches, and the ensuing liquidity spiral right after the Lehman Brothers' bankruptcy were all contributed to the clashing end of the mortgage credit concentration. (Brunnermeier (2009), and Gorton (2010))

Pair-wise causality tests show that the share of PL RMBS in the total issuance Granger-caused the home price growth, particularly in 2000-2008, but not the other way around. Vector autoregression (VAR) also show that statistically significant determinants of the home price boom-bust in the 2000s include user cost of capital (negative), and the share of PL RMBS (positive and significant only in 2000-2008). The total issuance volume of RMBS neither Granger-caused nor influenced home price changes in statistically significant fashion. As expected, the yield spread (gap between long and short rates) had a positive and significant effect on the share of PL RMBS, but it did not affect the total issuance volume of RMBS. This outcome supports the hypothesis that the leveraged investment behavior thanks to the expansionary monetary policy was more prevalent in the non-agency RMBS sector than in the agency sector. Finally, single family housing starts Granger-caused the RMBS issuance volume, but not the other way around, indicating that both factors would have influenced by short interest rate dynamics.

Based on the findings obtained, several policy ramifications are briefly discussed in the final section. Specific issues discussed include encompassing "policy risk" in the scope of macro-prudence regulation, ensuring sound micro-prudence regulation as a pre-condition to macro-prudence supervision, expanding market for securitization in emerging market countries to heighten its intended benefits,[4] and developing risk assessment tools to be used by both regulators and market participants.

The remainder of the paper consists of the following six sections: a survey of what went wrong in the RMBS sector during the financial crisis (Section II); determinants of the home price cycle (Section III); determinants of the mortgage credit cycle (Section IV); findings from econometric analyses (Section V); and, policy implications along with concluding remarks (Section VI).

[4] As a case in point, the rate of securitization in the residential mortgage market in the U.S., which has been rising since the mid-1980s, is shown to be positively correlated with the increase in home ownership rates. See Green and Wachter (2007) and Cho (2007) for further discussions on the trends.

II. Mortgage Securitization: What went wrong?

Brief History of the U.S. RMBS sector

The first RMBS, in the form of "pass-through" security, was issued by Freddie Mac in 1971. As the name implies, it directly passes through monthly payments of principal and interest from borrowers to investors with no internal structure.[5] However, the RMBS market did not take off until mid-1980s with any meaningful market share. However, with introduction of CMO (Collateralized Mortgage Obligation) securities, a structured product that segments mortgage pool based on level of prepayment risk, its market share rapidly rises, changing the landscape of the U.S. mortgage market in two fundamental ways.

First, the deposit-based mortgage funding by S&L (Savings and Loan) institutions was gradually replaced by the MBS-financing, creating an unbundled mortgage intermediation process, that is, three key functions of mortgage finance – underwriting, funding, and servicing – being served by separate entities. Second, as the market share of two secondary market conduits – Fannie Mae and Freddie Mac (or GSEs, Government Sponsored Enterprises) - continuously expanded, their funding eligibility rules, various non-price lending conditions,[6] practically segmented the U.S. mortgage market into two sub-sectors: those that are in compliance with the GSEs' funding guide (i.e., "conforming conventional[7]" or "A" mortgages), and those that violate one or more of those eligibility rules (i.e., "non-conforming" or "B&C" mortgages). Loans originated in the latter segment are securitized by private-label RMBS issuers, mostly investment banks (until their demise in 2008) and large primary market lenders (e.g., Countrywide, Washington Mutual, and IndyMac).

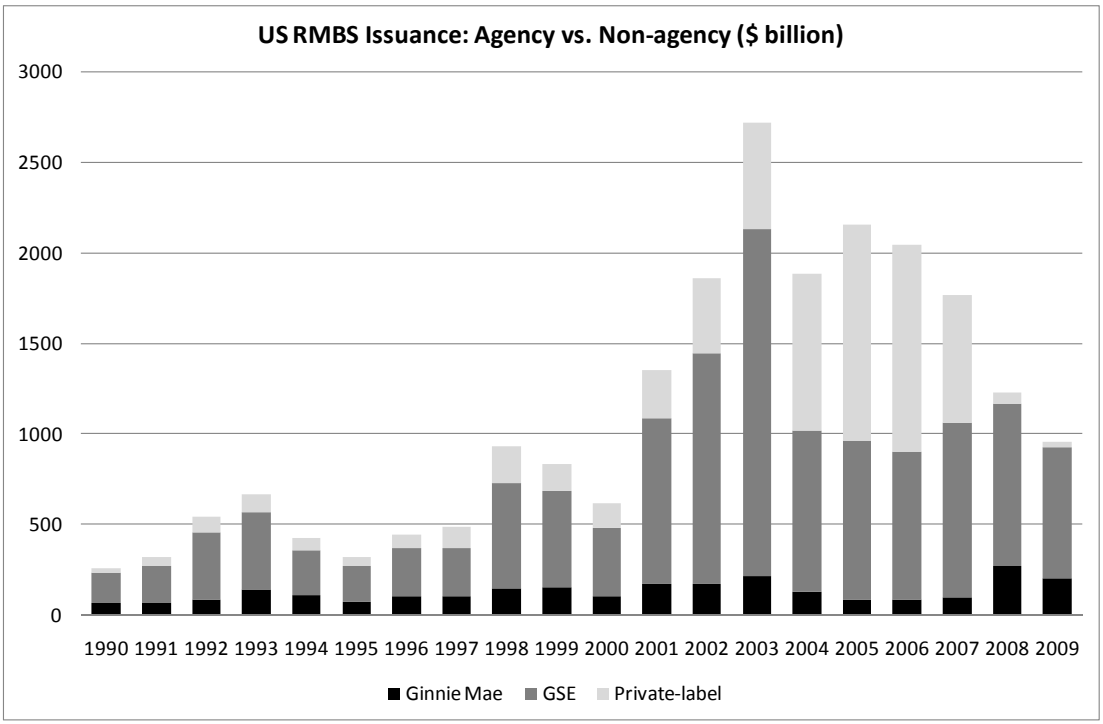
Figure 1 shows the RMBS issuance volumes in the U.S., categorized by security issuer – Ginnie Mae, GSEs (Fannie Mae and Freddie Mac), and Private-Label (PL) issuers.

Figure 1.

[5] There are competing products used in both Europe and U.S., that go back several hundred years of history, i.e., Covered Bond (CB) and Mortgage Backed Bond (MBB). Unlike the new breed of securities such as MBS and ABS, CB and MBB are essentially collateralized debts issued by financial institutions with double recourse – one by the security issuer and another by ring-fenced asset in issuers' portfolios. See Cho (2007) for more detailed evolution process of the U.S. mortgage·MBS markets.

[6] The eligibility is essentially a bundle of loan characteristics such as the maximum allowable loan-to-value (LTV) and debt-to-income (DTI) ratios, acceptable borrower credit scores, documentation requirements, interest rate variability, and so on.

[7] The term "conventional" means no government guarantee on default risk.



Data source: International Monetary Fund

As shown in Figure 1, the total RMBS issuance volume rapidly increased from 2001, reflecting the favorable interest rate environment. Another outcome to note is the substitution between GSEs and PLs from 2003: that is, the GSE issuance volume is reduced to less than half between 2003 and 2004, from $1.9 trillion in 2003 to $893 billion, while that of PLs rapidly expands from 2004. Though a more formal analysis is needed, the accounting scandals of both Fannie Mae and Freddie Mac would be the probable cause for this outcome for GSEs had to divert resource from their major business to restating earlier financial reports, which caused multi-billion dollar expenses.[8]

The main implications of the issuer substitution discussed above is that the rise of the non-agency sector in 2003-2007 resulted in relaxation of underwriting rules in that market segment, which has been documented in a number of studies (Duca et al. (2009) and Keys et al. (2010) among others). One hypothesis advanced for empirical testing is the likelihood that the deterioration of lending criteria caused by the rise of the non-agency sector influenced the home price cycle more than the increase in RMBS issuance volume itself.[9]

Social Cost vs. Social Benefit

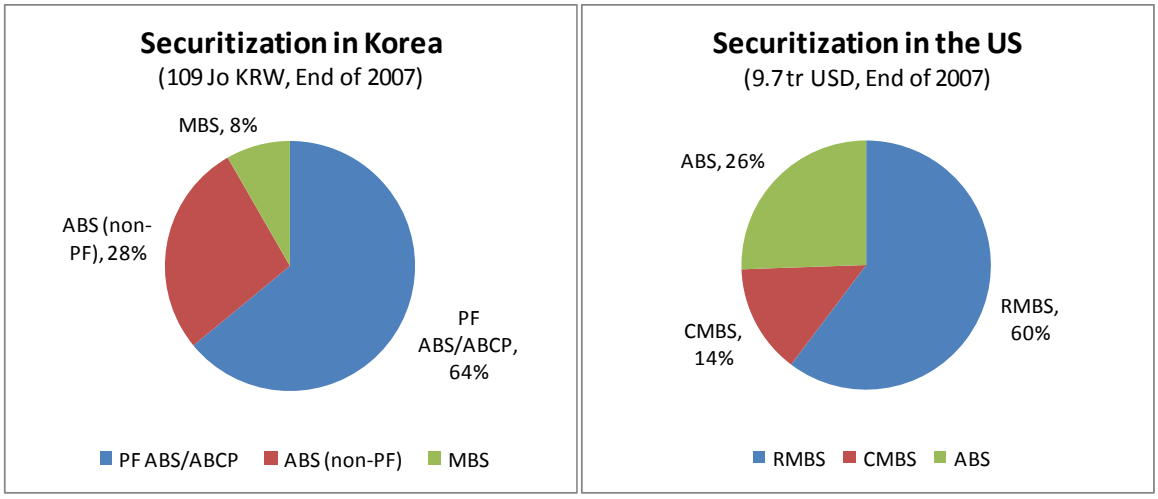
As will be elaborated in subsequent sections, the mortgage securitization during the recent financial crisis revealed social cost of various forms, including fee-maximizing and other principal-agent problems on the

[8] See Cho (2009) for more details on political economy in the U.S. RMBS sector.
[9] A simple observation of Figure 1 shows that the total MBS issuance volume actually peaked in 2003 with $2.7 trillion, which was dropped and stabilized around $2 trillion in the next several years.

part of primary market lenders and other intermediaries involved (Ashcraft and Schuerman (2008) and many others), pricing failure of complex mortgage products (e.g., Option ARMs) as well as the RMBS products (Gorton, 2008), excessive risk-taking by "too-big-to-fail" financial institutions such as GSEs and investment banks (Acharya and Richardson (2009)), extreme regime shifts by credit rating agencies before and after the turn of housing and credit cycles (Benmelech and Dlugosz (2009) and Griffin and Tang (2010)). Due to these observed market failures, and their fallouts to the global financial system and real economies of different countries affected, there has been more and more discussions on how to prevent similar failures from occurring again, and how to institute both micro- and macro-prudence regulations as necessary safety mechanisms.[10]

In upcoming policy debate as to how to restore the market for asset securitization, however, one should be cognizant about intended benefits of this financial innovation as well, along with the unintended costs as observed in the recent crisis. That is, a well-functioning market for securitization can be welfare-enhancing in that: it can expends financial service to borrowing-constrained consumer or business cohorts, can lower lending rates due to cost-saving whole-sale funding from capital market, can improve risk assessment and management via appropriate risk-sharing among different parties involved, and can help develop a long term bond market in emerging market country.[11] Based on findings in subsequent sections, I will discuss policy ramifications on how to safely expand the market for asset securitization in a given country.

Figure 6.



Data source: Bank of Korea, and the author

[10] In fact, developing a global financial safety network is one of key agenda in the upcoming G20 summit in November 2010 in Korea.

[11] In assessing mortgage finance system, "intermediation efficiency," i.e., in what intermediation cost a given type of mortgage loan can be originated and serviced, was used as a criterion (Lea and Diamond (1993)). As the mortgage market expands in the U.S. and Europe, "market completeness," i.e., how diverse mortgage products are and how liberal the non-price rationing conditions are in a given country, was added to the first (European Mortgage Federation (2005), and Miles (2003) and (2004)). Issue to be addressed is the fact that the securitization involves with multi-dimensional costs and benefits, which are listed below along with relevant policy questions to ask. In subsequent sections, I will first discuss three inter-related cycles by using the U.S. RMBS sector as a case – housing boom-bust,

III. Determinants of the Home Price Cycle

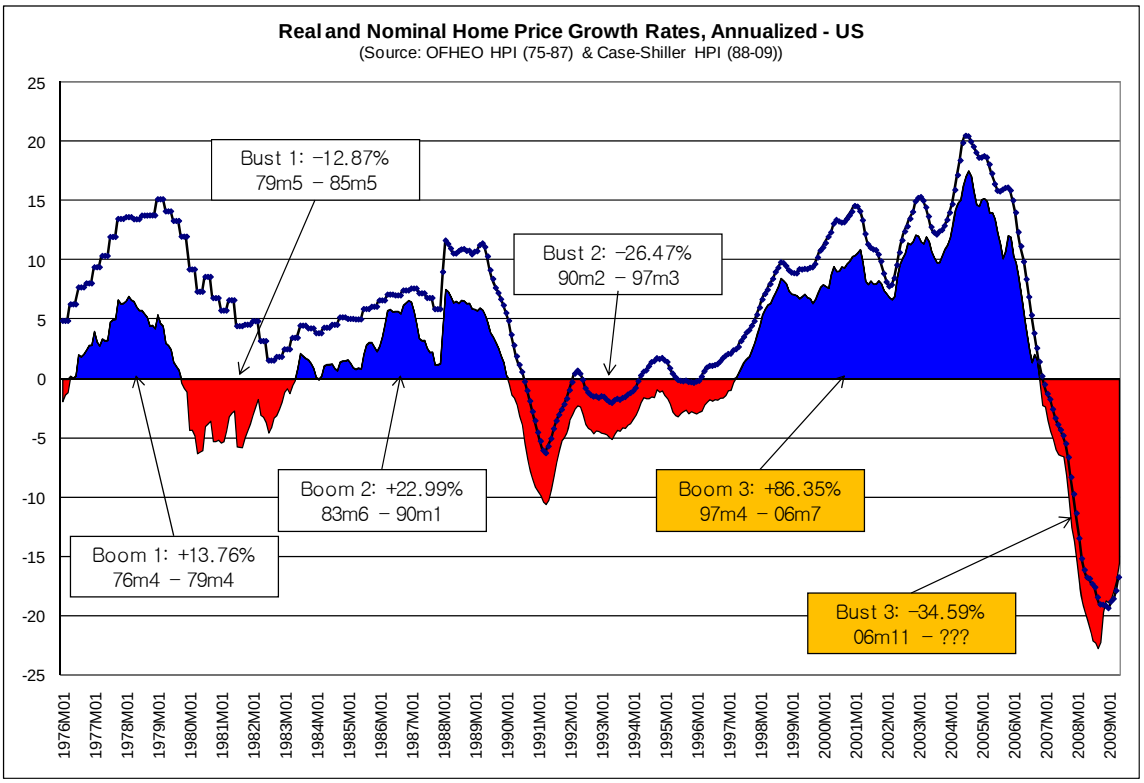
The home price boom in the U.S. between 1997-2006 was truly unprecedented. As shown by Shiller (2008), the real home price level in the US rarely moved during the 100 year period between 1890-2000, but noticeably spiked up since the early 2000. In particular, the price hike since 1997 produced the total real growth rate 86.35% before it changed the direction, several times larger than those of earlier booms (Figure 3). The price movement was even more accelerated between 2003 to 2006,[12] followed by a deep downturn that was also unprecedented. So far, the price decline records minus 35% from the peak (as of May 2008).[13] The trend has turned to a slight positive growth since April 2009.

Figure 2.

rise and fall of mortgage credit, and macroeconomic consequences; will try to establish causal relationships among key underlying factors from those markets; and, will organize and elaborate relevant policy issues.

[12] As shown in Figure 2, the total real home price growth rate during the first boom (1976 to 1979) was 13.67%, which was followed by a roughly comparable real price decline of -12.87% in the subsequent period (1979 to 1983). The second boom during a little longer time period (1983 to 1990) recorded 22.99%, which was again followed by a total decline of -26.47%. The gap in the second cycle may reflect the index difference, i.e., using the OFHEO home price index between 1975 to 1987 but the Case-Shiller index in the next period. Given that the OFHEO index is shown to have a smoothing problem, the smaller price appreciation in the second cycle may partially reflect the effect thereof.

[13] One myth that was invalidated from new data was the common belief that the nominal home price growth rate in the national level never turned negative in the U.S., which I would say contributed to the increased risk-taking in the subprime and Alt-A lending sectors in the first part of the 2000s. That was incorrect in that the nominal home price growth rate (month-over-same month year before) actually became negative, now as well as in the early to mid 1990s.



Data sources: OFHEO, and Fiserv (for the Case-Shiller home price indices)

A growing number of studies document evidences on the correlation between the recent price hike and the mortgage lending outcomes. That is, sub-national home price growth rates are shown to be positively (negatively) correlated with the amount of subprime mortgage lending in the localities during the upturn (the downturn). (Shiller (2008), Pavlov and Wachter (2008), and Wheaton and Nacheyev (2008), Coleman et al. (2008), Goetzmann et al. (2009)) For example, using metropolitan level data, Wheaton and Nchayev (2008) demonstrates that the growth in market fundamentals (e.g., local employment, and mortgage interest rates) from 1998 to 2005 forecast price growth that was far below that which actually occurred, and that forecast errors are greater in MSAs where second home and speculative buying was prevalent or the sub-prime mortgage market was most active. Nonetheless, there are studies that document either no such correlation (e.g., Dokko et al. (2009), and Thibodeau and Goodman (2008)).

The usual model employed to explain home price dynamics is a two-stage error correction model, as developed by Capozza, Hendershott, Mack (2004) and others, which are surveyed by Meen (2009), and Cho and Kim (2009) (the lower case h represents log home price change and the upper case H is log price level, $h_t = H_t - H_{t-1}$):

$$(1)\quad h_t = \alpha \cdot h_{t-1} + \beta \cdot [H_{t-1} - H^*_{t-1}] + \xi_t$$

where $H^*_t = f(UC_t, Y_t, SE_c, X_t; \hat{\delta}) + \hat{e}_t$. In this model, the price level in (2) is first estimated with usual market fundamentals, including user cost, UC, household income, Y, indicator of supply elasticity, SE, and

other variables, X (e.g., demographic variables, and construction cost). In the second stage, the gap realized vs. predicted price levels, $H - H^*$ where the latter represents a long-term equilibrium price level, is included with its , β, measuring speed of mean reversion in the price dynamics (usually assumed to be negative, $\beta < 0$).[14]

Before the crisis, inelastic housing supply caused by restrictive local land use regulations was quoted as the main reason for high price volatility (Glaeser and Gyourko (2005), Glaeser, Gyourko, and Saiz (2008), and Kim, Lee, and Park (2009), Thibodeau and Goodman (2008)). In particular, Glaeser, Gyourko, and Saiz (2008) develop a model showing that rational bubbles can exist when the supply of housing is fixed, but not when it is elastic and when there are a finite number of homebuyers. They also show that, under the assumption of adaptive expectations by households, more inelastic places might have bigger and longer bubbles, a smaller β in absolute term.

However, as indicated in the recent literature, the great home price run-up in the 2000s is shown to be more related to capital inflow from the financing sector. That linkage can be discussed based on UC, a relative after-tax cost of owning vis-à-vis renting:

$$(2)\quad UC_t = \frac{E_t[R_{t+k}]}{P_t} = [(1-t_I)\cdot(r_t^m + \pi_t^e) + \delta_t + t_p + \alpha_t] - [(1-t_c)\cdot E_t(g_{t+k} + \pi_t^e)]$$

where first bracket in the right hand represents total nominal cost of owning home, and the second bracket is the after-tax expected capital gain.

In a competitive housing market, the rent-to-price ratio, E[R]/P, of a given quality housing should be equal to the imputed net annual cost of owing, the right-hand-side of (3) or μ_t, so that consumers are indifferent between owning and renting. By using metropolitan-level data covering up to 2004, Himmelberg, Mayer and Sinai (2005) reported that there was no evidence of housing bubble based on the above framework, i.e., no significant deviation of the rent-to-price ratio from the imputed cost in the right hand side. They also raise the issue of the base level bias: that is, the lower the UC, the larger the impact of unit change in any RHS variables.

In more recent studies, Kim (2007) and Duca, Muelbauer, and Murphy (2009) document the effect of relaxed mortgage underwriting criteria on UC. That is, as theoretically derived by Kim (2007), when rental agency costs along with binding LTV ratios affect marginal home buyers' decisions, then UC reflects those additional factors. As a long term trend, Duca et al. show that average LTV for first-time home buyers in the U.S. gradually rose from 85% to around 88% between 1980 to 2002; It suddenly ramped up to 95 percent between 2003 and 2007 and is declining since then. That LTV trend also closely tracks the rise and fall of the

[14] In order for the deviation to be converted to long-term equilibrium price level, two conditions should be met, $0 < \alpha < 1$, $\beta < 0$. The second term in (1) represents over- or under-valuation of price level vis-à-vis fundamentals-driven level.

private-label RMBS issuance. As one conclusion, the study claims that the recent boom is explained by a major easing of credit standards for first-time homebuyers, as shown in the following regression outcome:

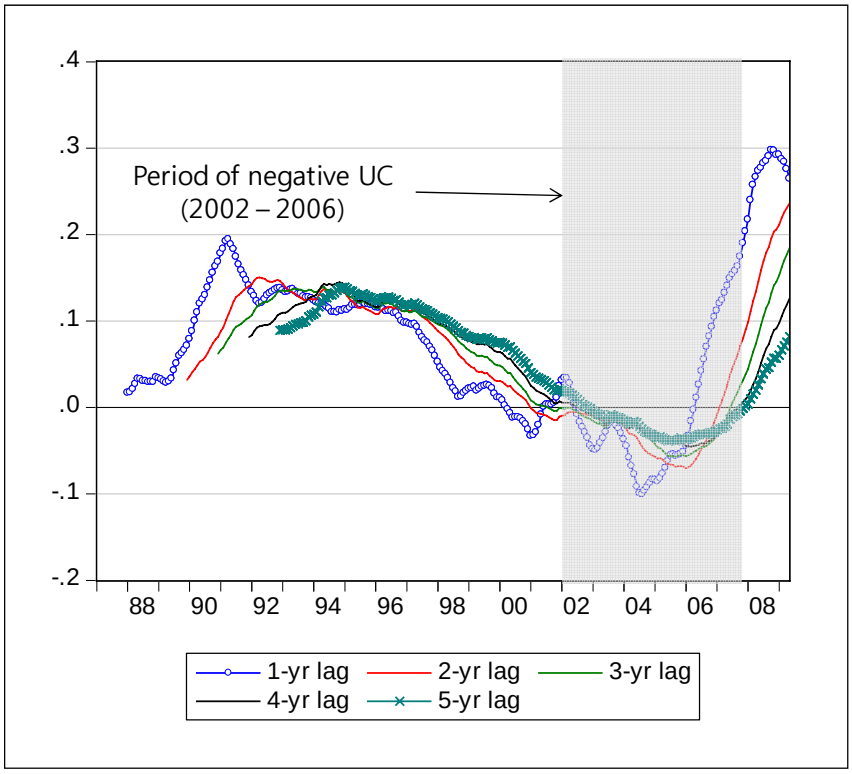
To decompose effects of other driving forces on UC, the RHS of (3) is calibrated with real data. Specifically, time-varying nominal mortgage interest rates, 2.5% annual depreciation rate (Harding, Rosenthal and Sirman, 2004) plus 1.5% property tax rate (δ), 25% marginal income tax rate for typical home owner (t_I) are used as values (following Himmelberg et al.). One hard-to-decide factor in (5) is the expected price appreciation, $E[g_{t+k}]$, for which recent studies generally use past price growth rates with different time lags (e.g., one year lagged by Duca et al, long term mean by Himmelberg et al., and so on). To examine effects of different empirical measures, I use five alternative lagged price growth rates, from one year to five year lags as average annual growth rates.

The result shows that UC in the U.S. has been declining since mid-1990s, turned to negative from 2002, and stayed being sub-zero for the next 3 to 5 years depending on different price lags used (Figure 4). The implication of this prolonged negative UC is that the cost of owning was extremely low during the period of negative UC, making home ownership as a highly attractive tenure choice option to consumers. As to what drove this low UC, three factors are discussed below.[15]

Figure 3.

[15] The lower the UC, the higher the impact of 1% change in RHS factors (in particular, expected HP appreciation and mortgage interest rate). Thanks to the great moderation from the early 1980s, the inflation and interest rates kept declining (pretty much) until mid-2000s; The further reduction in the rate in 2001-2005 plus high expectation of HP growth on the part of consumers at that time must have had a much bigger bang on UC, a la their argument

Imputed user costs in the U.S., w/ different price lags



First, the record low mortgage interest rate (along with the low expected inflation) was a driving force for the low and negative UC for owning. On this point, there are conflicting empirical evidences as to the role of interest rate environment in the price boom. (Dokko et al. (2009) and Bernanke (2010)) However, as will be discussed below, there was a powerful combined effect of the low interest rate on UC along with two other factors. There was also the base level effect: that is, the lower the UC, the higher the impact of one percentage point change in the mortgage interest rate can result in.

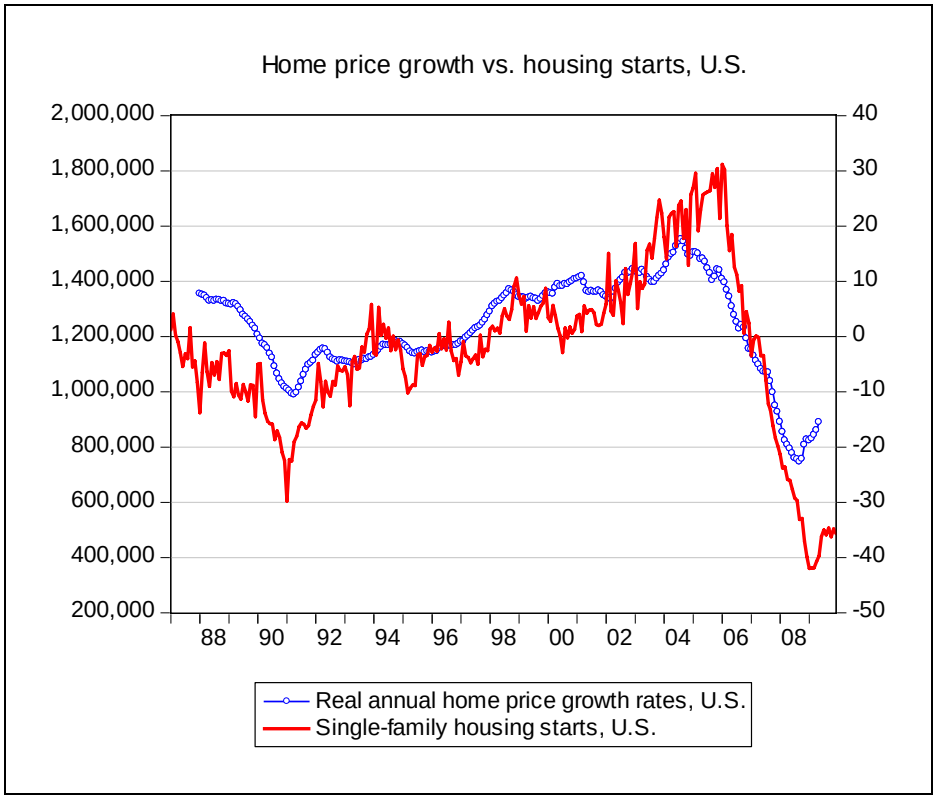
Second, the Taxpayer Relief Act of 1997 (TRA 1997) practically made the capital gains tax rate, t_c, close to zero, by allowing home sellers to exclude $500,000 (or $250,000 for single filers) capital gains when they sell their homes and to potentially claim such an exclusion as often as every two years. Before the new law, only those 55 years or older could claim a one-time exclusion of $125,000 against their capital gains. (See Farnham (2006), Biel and Hoyt (2007), Cunningham and Engelhardt (2008), and Shan (2008) for effects of TRA 1997.) In particular, Shan (2008) documents that the tax elasticity of home sales during the post TRA97 period suggest that a $10,000 increase in capital gains taxes lowers semiannual home sale rate by 0.16-0.25 percentage point

Third, the high expected home price appreciation, g, was another major driving force for the low and negative UC during the mid 2000s. As reported by Case and Shiller (2004) and Shiller (2008), the main incentive of home buyers in the U.S. tends to be driven by pure demand for future home price appreciation,

even in those areas where home price movement is stagnant, e.g., Cleveland. The strong home price growth since 1997, and the accelerated price run-up since 2003, have strengthened this capital gains motive for consumers in broad geographical areas in the U.S., we can surmise. The expected capital gain, g, can be viewed as one of the transmissions of monetary policy, as argued by Mishikin (2008) [16], and, as such, its price effect can be viewed as an indirect consequence of the accommodative monetary policy in the early 2000s.

The downturn of the price movement since mid-2006 can be explained by swift change in the interest rate environment from 2005 (to be discussed more in detail in the next section) and over building. As to the latter, Ellis (2008) provides a comparative analysis and reports that the U.S.: seems to have built up a larger overhang of excess housing supply; experienced a greater easing in mortgage lending standards; and ended up with a household sector more vulnerable to falling house prices. The point about the role of overbuilding in real cycle in general is consistent with findings of earlier studies (e.g., Wheaton (1999), and Grenadier (1996)).[17]

Figure 4.



[16] Related to this point, Mishikin (2008) demonstrates that g is one of six transition mechanisms of monetary policy.
[17] Transition mechanisms of the monetary policy (Mishikin, 2007): ΔST rates affects housing market through at least six channels: directly on (1) UC, (2) expectations of future price movements, (3) housing supply, and indirectly on (4) wealth effects on HP, (5) balance sheet, credit channel effects on consumer spending, and (6) balance sheet, credit channel effects on housing demand.

IV. Determinants of the Credit Cycle

Aggregate demand for mortgage securitization MS^D (at time t in a particular location) can be viewed as a filtered demand from housing and mortgage markets. As such, UC and other market fundamentals (X^D) discussed earlier will influence the demand side. In addition, mortgage origination and securitization will also be influenced by refinancing activity, REFI, which is determined by mortgage interest rate dynamics:

(3) $MS_t^D = f(UC_t,\ REFI_t,\ X^D)$

Aggregate supply, on the other hand, is determined by three factors: a set of regulatory taxes on the part of mortgage lenders, RT, yield spread, SPREAD (differences between long and short rates), and extent of credit rationing, CR, along with other supply-side fundamentals, X^S:[18] Each will be elaborated in the following.

(4) $MS_t^S = f(RT_t,\ SPREAD_t,\ CR_t,\ X_t^S)$

RT represents benefits on the part of primary market lenders due to capital savings by selling mortgage loans to the secondary market, rather than holding them in portfolio. Main cost-saving items with this regard include reductions in regulatory capital reserve, in cash reserve to hold deposits, and in deposit insurance premium.[19] Though important in gauging effect of securitization, this variable does not play significant role in the current analysis.

SPREAD is difference between long and short rates, e.g., yield spread between 10-year vs. 1-year CMT (Constant Maturity Treasuries). As mentioned earlier, this variable serves as an indicator of the leveraged investment behavior in the RMBS market: that is, the higher the SPREAD, the stronger the incentive to borrow-short-lend-long on the part of RMBS investors. Detailed dynamics of this variable in the U.S. during the financial crisis will be discussed below.

CR represents an indicator of risk appetite in the mortgage finance industry, assessed based on two factors - a vector of non-price terms used by loan underwriting to allocate mortgage capital under information asymmetry (Jaffee and Russell (1976), Stiglitz and Weiss (1981), and Kent (1987)) and a market-maker in security trading with provision of risk assessment service. The first factor consists of various ex ante indicators of mortgage default risk (e.g., DTI, consumer credit score, loan type, documentation, loan

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[18] For sake of simplicity, the supply function is assumed to represent all different intermediaries involved, although it is certainly true that different intermediaries (lenders, security issuers, asset managers) must have different incentives. This part of the model will be further elaborated. Also, compare NIM to NII,
$NII_t^p = M_t \cdot [r_t^m - (r_t^f + \phi_t)] - r_t^o \cdot [(a+b) \cdot D_t + C_t]$, where a is reserve required, b is deposit insurance, C is capital to be reserved, and r is opportunity cost of capital. If M = D, then 100% deposit financing.

[19] See Saunders and Cornett (2008), Ch. 27, for details.

purpose[20], and so on), while the second factor includes RMBS credit rating outcomes. As shown by Duca et al. (2009), the share of PL RMBS in the total issuance volume closely resembles the relaxation of CR (e.g., the rising pattern of average LTV among first-time home buyers) since the 1980s.

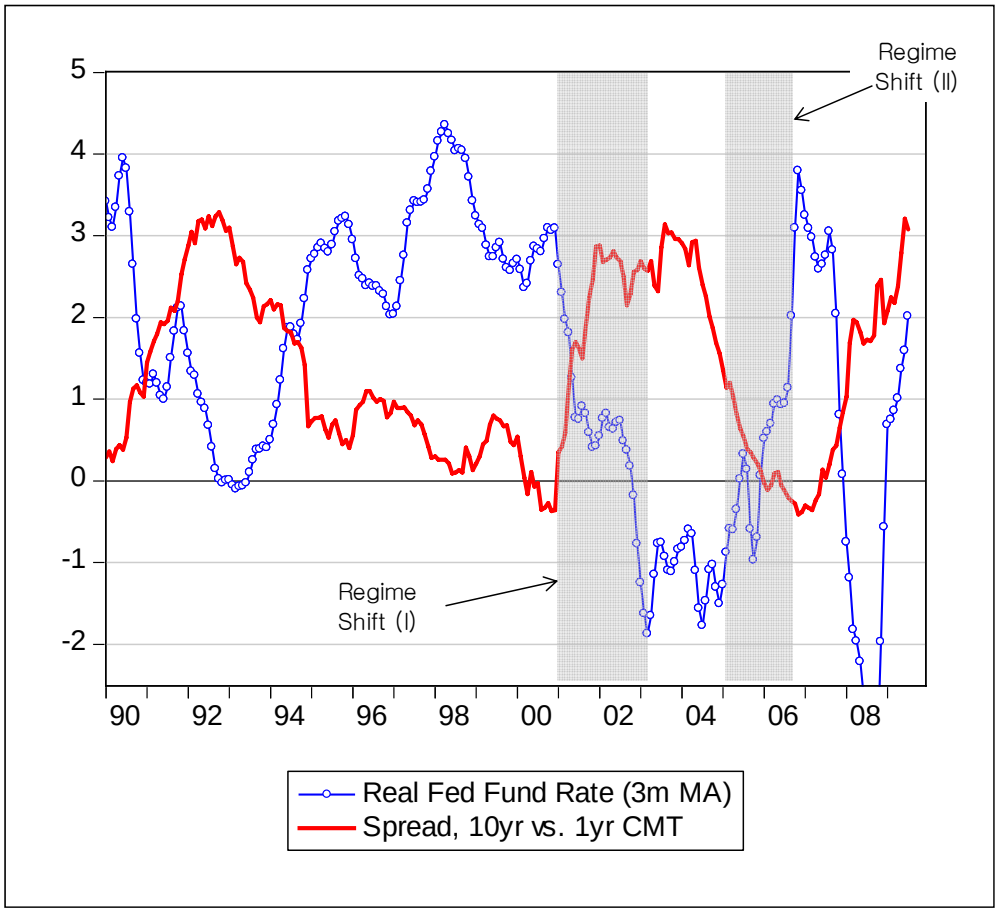
Two particular market outcomes that this study focuses on include the total origination of RMBS (in the U.S.) and the share of PL RMBS, which are determined by interaction of the demand- and supply-side as sketched in equations (3) and (4). In the econometric analyses in the next section, I will also examine their causal relationships with two housing market outcomes – real home price growth rates and housing starts. In this section, main driving forces of the mortgage funding market outcomes will be further elaborated.

Driving Force (1): SPREAD and Regime Shifts in the Interest Rate Environment

The interest rate environment in the early to mid 2000s was highly unusual. Specifically, there were two regime shifts. First, the policy rate (the Fed fund rate) rapidly dropped from 2000 until early 2003 with about five percentage points decline, and became negative in real term from mid 2002. (Figure 5) Furthermore, the drop in the short rate was faster than long rates, resulting in a steep yield curve with 250 to 300 basis points (bp) difference between 10-year and 1-year CMT[21] rates in 2001 to 2004. Second, the short rate reversed its course from early 2005, with the Fed fund rate rising from negative 1.5 percent in real term to plus 4 percent in the early 2007, about 5.5 percent swing in the opposite direction. The short rate also moved faster this time as well, resulting in an inverted yield curve from early 2006 for about an year.

Figure 5.
Regime Shifts in the Interest Rate Environment

[20] Traditionally, loan purpose (residence vs. investment or second home) has been one of differentiating factors in mortgage underwriting (at least in the U.S.), with the latter having higher risk premium or lower chance of being approved, ceteris paribus.
[21] Constant Maturity Treasury



As a comparison, there was only one occasion during the last 40 years when the real Fed fund rate was negative for such a long time period, the mid 1970s. At that time, the U.S. home prices also appreciated rapidly in the middle of that negative short rate period. However, the difference this time is the fact that the price growth has been building up from 1997 and has accelerated from 2003, while the price growth during the negative short rate period in the 1970s actually started from sub-zero rate. We will have a formal test on whether or not home prices influenced the mortgage market outcomes, the composition and volume of RMBS issuance.

The first regime shift created a fertile ground of the "borrow-short-lend-long" practice among institutional investors globally, incentivizing them to borrow from short rate markets (e.g., ABCP) and to have levered investment in the long rate market (e.g., RMBS), resulting in an increase in funding into the RMBS sector. That shot-funding investment strategy produced a much higher net interest margin (NIM) for RMBS investors than a matched-funding strategy during this period, as expected.[22] The magnitude of the difference in NIM between the two strategies is demonstrated with a simple example in Appendix 1.

However, the second regime shift from 2005 resulted in an opposite outcome for investors with the

short-funding strategy with a deep loss in net interest revenue, resulting in a quick change in the mood among RMBS investors toward reducing the funding level. As expected, the swing in NIM based on the short-funding strategy was much larger than that of the matched funding, indicating a much greater risk of the former during these regime shifts.

Driving Force (2): Rise and Fall of Risk Appetite (RA), Underwriting Rules

The lax underwriting practices during the booming period have already been documented in a number of recent studies. (Mason and Rosner (2007), Gorton (2008), IMF (2009), Duca et al. (2009) among others) As to why such a rampant relaxation occurred, the problem of moral hazard on the part of loan originators and security issuers are quoted as culprit: that is, due to the incentive of fee maximization inherent in the OTD business model, neither primary market originators nor secondary market security issuers did not perform proper due diligence in assessing creditworthiness of borrowers and were simply in the volume maximization mode of operation. (Ashcraft and Schaumann (2009) and Fender and Mitchell (2009))

The outcomes are incrementally high-risk loan cohorts originated over time in early to mid 2000s, which exacerbated home price decline during the downturn due to high-frequency defaults and distressed sales of foreclosed homes. For example, Mian and Sufi (2009) show that the expansion in mortgage credit from 2002 to 2005 to subprime ZIP codes occurs despite sharply declining relative (and in some cases absolute) income growth in these neighborhoods, and that the expansion in mortgage credit to subprime ZIP codes and its dissociation from income growth is closely correlated with the increase in securitization of subprime mortgages.

The incrementally lax underwriting can also be linked to the rise of the private-level MBS issuance from 2003, and the role of the accounting scandals of GSEs as discussed earlier. The GSEs' underwriting rules, along with reps and warrants required for appropriate applications of those rules by primary market lenders, have served as industry norm in the agency RMBS sector for the last 20 years or so. As the non-agency segment of the market expanded so much so fast from 2003, a growing portion of the mortgage·MBS market lacked such established rules, and the rule-setting was done in a more decentralized fashion by individual PL RMBS issuers.

The critical factor that triggered the downturn was the opaque mortgage·MBS products, e.g., negative amortization loan products such Option ARM, resecuritized MBS products such as ABS CDO and CDO-squared, complicated investment vehicles such as SIV, CPDO (Constant Proportion Debt Obligations), and ARS (Auction Rate Securities). (See Mason (2008) and Gorton (2008) for descriptions of these products.) These products contributed to the rapid liquidity spiral started from the second half 2007, and most of them have disappeared from market place as of today.

Driving Force (3): Discrete and Large Scale Rating Migrations

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[22] See Linneman and Cho (2009) for further discussion on this investor incentive.

More and more studies document findings that help decipher the black box of subprime ABS and CDO credit ratings. (Benmelech and Dlugosz (2009), Ashcraft and Schaumann (2009), and Griffin and Tang (2010)) As discussed these and other studies, the overly optimistic ratings by credit rating agencies (CRAs) played an important role in both upturn and downturn of the credit cycle. For example, Calomiris (2008) claims that CRAs did not change the 6 percent mean loss assumption for subprime and Alt-A mortgage pools from the early 2000s, despite the worsening loan quality up until 2007. More importantly, the abrupt and broad-based rating downgrades from November 2007 is viewed as the key for quickly evaporating investor confidence and drying up transactions of subprime RMBS products. As one illustration, among all AAA-rated subprime ABS CDO tranches issued between 2005 and 2007, only about 10 percent stay as AAA as of June 2009 and close to 60 percent are downgraded to B or below! (Standard & Poor's (2009), "Where did all the AAA go?")

Bond rating is essentially an application of a series of stress scenarios, employing a VaR (value-at-risk) methodology. The computational step involved is to estimate scenario (specific) default rates (SDRs) or loss rates (SLR) by assuming a specific default timing (e.g., 7 years forward or loan life). Based on computed SLRs, an empirical loss distribution can be formed, and the economic capital (a stress loss with a particular confidence level minus expected, or mean, loss) is used as the key input in determining the subordination level, referred to as "sizing" decision. (See Cho, Yang, Lin (2010) for further details.) In addition, rating agencies perform sensitivity analyses by changing assumptions (e.g., alternative default timings, alternative LGD levels (if it is not empirically fit), and so on) to confirm for appropriateness of the sizing determined (referred to as BDR (Breakeven Default Rate) analysis).[23]

Several studies have recently discussed problems involved with this computational step. First, parameters of the underlying performance models, in particular, probability of default (PD) and loss-given-default (LGD) models as well as asset correlation, were unstable, partly because of the newness of mortgage products and the paucity of loan performance data thereof. (Tarashev and Zhu (2007), and Heitfield (2009)) Second, the stress scenarios adopted, say with 99th percentile stress loss, were not stressful enough: that is, the stress scenario used for deciding subordination level for AAA tranche of subprime CDO was claimed to be one out of 753 years event; yet, the ratings had to be downgraded so much so fast in the down cycle of the credit market. (Griffin and Tang (2009)) Finally, the scenario generation method was not well-established in the mortgage finance industry as a whole. That is, as demonstrated by Yang, Lin and Cho (2009), forward-looking home price distributions are critically dependent upon how home price volatility is modeled, which, in turn, is an important determinant of economic capital level (hence, sizing decision). These issues would have affected not only the initial rating decisions, as well as post-issuance rating updates, which can be a subject of future research.

[23] Cash flow for each tranche will be generated with alternative assumptions (e.g., 4 default timing, 4 interest rate processes, and 4 recovery rates, yielding 64 cash flow scenarios with 10,000 simulations for each). After that, rank simulated SLRs from each CF scenario and compute BDR (Break-even Default Rate), min[64 BDRs] > SDR to maintain the rating grade. If BDR > SCR, then the CDO tranche is deemed able to withstand the level of default stress at the desired rating category (SDR – the level of default in the collateral pool that a tranche much be able to withstand to earn its rating; BDR – the level of portfolio defaults that each tranche can withstand, according to the underwriter's CF models).

V. Econometric Analyses

In order to test causal relationships among key variables discussed in prior sections, preliminary econometric analyses are performed. In particular, vector autoregression (VAR) analyses are done with the following endogenous and exogenous variables (with monthly observations).

Endogenous variables:

- Real annual home price growth rates (in the U.S.)
- Single-family housing starts, in log
- RMBS issuance volume, in log
- Share of PL RMBS issuance

Exogenous variables:

- User cost of capital for owning, with one-year lagged home price
- Yield spreads between 10-year and 1-year CMT (Constant Maturity Treasury) rates
- Credit spreads between BBB and AAA corporate bond rates
- Median household income, in log

Separate estimations are done for two time periods, 1990 to 2008 and 2000 to 2008. In addition, pair-wise Granger causality tests are performed among endogenous variables included.

Regression results are reported in Tables 1 through 3. Main findings from the results are summarized below:

- As hypothesized, the share of PL RMBS Granger-caused the home price growth in both time segments, but not the other way around. In the home price VAR model, statistically significant determinants found include user cost of capital (negative), and the share of PL RMBS (positive and significant only in 2000-2008), but not issuance volume of RMBS (see Table 5 for the 2000-2008 results). This finding supports the hypothesis that the home price boom-bust was more influenced by the deterioration of mortgage underwriting quality, as indicated by the share of PL RMBS, than by the amount of credit supply via mortgage securitization.

- As expected, the yield spread had a positive and significant effect on the share of PL RMBS (both in 1990-2008 and in 2000-2008), but not the total issuance volume of RMBS. The outcome supports the likelihood that the leveraged investment behavior with short-funding strategy, thanks to the expansionary monetary policy in the early to mid 2000s, was more prevalent in the non-agency RMBS sector than in the agency sector

- Housing starts Granger-caused the RMBS issuance volume (in 1990 to 2008), but not the other way around. And no significant causality between housing starts and home price changes was observed. Finally, credit spread is shown to be a significant determinant of housing starts (negative), implying

that in a period of high credit risk investors decrease capital supply to the home building industry.

Table 1. Pairwise Granger Causality Tests (Chi-square statistics)

2000 - 2009

	Real HP growth rate	**SF Housing starts**	**PL MBS issuance, share**	**All MBS issuance**
Real HP growth rate	n/a	0.0863	0.1567	0.3663
SF Housing starts	0.0452	n/a	1.4560	0.1604
PL MBS issuance	7.3953**	7.1778**	n/a	0.4353
All MBS issuance	0.0539	11.9560**	2.4200	n/a

Table 2. VAR Model Estimation (2000 ~ 2009)

	Real HP growth rate	SF Housing starts	PL MBS issuance	All MBS issuance
Constant	194.7336**	16.6180**	-2.1574	-0.0467
	(3.4222)	(3.2151)	(-1.1347)	(-0.0102)
Real HP growth rate(-1)	0.6219**	-0.0021	-0.0010	0.0037
	(8.0657)	(-0.2937)	(-0.3959)	(0.6052)
SF Housing starts(-1)	0.2114*	0.5706**	0.0401	-0.0319
	(0.2125)	(6.3167)	(1.2067)	(-0.4005)
PL MBS issuance(-1)	4.3649**	0.3906**	0.9343**	-0.0849
	(2.7194)	(2.6791)	(17.4203)	(-0.6598)
All MBS issuance(-1)	-0.0987	0.1336**	-0.0221	0.9513**
	(-0.2321)	(3.4578)	(-1.5557)	(27.9042)
User cost	-28.1557**	-0.238425	-0.247907	-0.057573
	(-4.7493)	(-0.4428)	(-1.2515)	(-0.1212)
Spread, yield	0.0326	-0.0089	0.0074*	-0.0050
	(0.3625)	(-1.0891)	(2.4707)	(-0.6940)
Spread, credit	0.9285**	-0.0823	0.0112	0.0190
	(3.5791)	(-3.4917)	(1.2898)	(0.9125)
Household income	-18.3556	-1.0811	0.1649	0.0799*
	(-3.7543)	(-2.4343)	(1.0094)	(0.2039)
R-squred	0.9970	0.9698	0.9856	0.9796
Adj. R-squared	0.9968	0.9674	0.9844	0.9779
Sum sq.redids	38.5073	0.3177	0.0430	.2474

Table 3. VAR Model Estimation (1990 ~ 2009)

	Real HP growth rate	SF Housing starts	PL MBS issuance	All MBS issuance
Constant	-5.8809	4.5549**	-0.2268	2.5543**
	(-0.5819)	(5.0233)	(-0.9386)	(2.9128)
Real HP growth rate(-1)	0.7642**	0.0055	-0.0020	0.0018**
	(14.3696)	(1.1426)	(-1.5649)	(0.3794)
SF Housing starts(-1)	0.9921	0.7310**	0.0103	-0.1818
	(1.8651)	(15.3186)	(0.8269)	(-3.9394)
PL MBS issuance(-1)	-1.7817	0.0911	0.9844**	.00564
	(-3.0677)	(1.7491)	(72.2130)	(1.1189)
All MBS issuance(-1)	-0.4291	0.0317	-0.0144	0.97944**
	(-1.9360)	(1.5923)	(-2.7632)	(50.9367)
User cost	-25.6175	0.0319	-0.2811	-0.3216
	(-5.0825)	(0.0705)	(-2.3760)	(-0.7354)
Spread, yield	0.1303	0.0060	0.0050**	0.0011
	(1.9113)	(0.9791)	(3.1356)	(0.1923)
Spread, credit	0.4334*	-0.0773	0.0076	-0.0148
	(2.2092)	(-4.3938)	(1.6468)	(-0.8693)
Household income	-0.2936	-0.0934	0.0179	0.0141
	(-0.3753)	(-1.3311)	(0.9732)	(0.2083)
R-squred	0.9951	0.9516	0.9887	0.9939
Adj. R-squared	0.9949	0.9498	0.9883	0.9936
Sum sq.redids	87.0498	0.7006	0.0480	0.6553

VI. Post-Crisis Policy Reform

Fallouts from downturns of the two cycles – home prices and mortgage credit supply – in the U.S. are not well-known: that is, increasing mortgage defaults and worsening financial soundness of key intermediaries involved, significant reductions in household consumption and private investment, contagion effects to other countries through various transmission channels, and so on. Another fallout is on-going policy debate on how to re-structure safety and soundness regulations, in particular how to ensure system-level soundness via

macro-prudence financial supervision in addition to the traditional micro-prudence supervision in financial institution level. Based on findings discussed in prior sections, several policy ramifications are discussed in this section.

First, the analyses and empirical findings here show that the macro-prudence supervision in fact has to encompass "policy risk" in its scope, given that the fundamental cause of the boom-bust in the U.S. RMBS sector was the expansionary monetary policy and the resulting yield curve environment. As discussed in Section IV, the swift regime shifts in the monetary policy impacted incentives of RMBS investors accordingly, both in the declining and rising short-rate environments, and that policy instability was eventually led to instability in the market. Therefore, financial supervision authorities in different countries should be cognizant about possibility of unstable monetary policy and financial market regulations to become a source of systemic risk. As a related point, the conventional focus of the monetary policy, i.e., the inflation targeting in the U.S. with 2% target inflation rate, should not be made in isolation from, but should be made in conjunction with, other financial market regulations (e.g., DTI and LTV regulations in real estate market and margin ratios in stock market), as argued by Blanchard (2010).

Second, sound micro-prudence supervision can reduce the need for, or even un-necessitate, macro-prudence supervision. That is, the main lessons from the demise of the non-agency RMBS sector in the U.S. are the failures of initial risk assessment by mortgage lenders and of properly pricing and rating securities by RMBS issuers and rating agencies. Hence, had the underlying risks embedded in the collateral (i.e., mortgage loans) and securities traded been properly assessed and supervised by regulatory authorities, we would not have experienced this unprecedented global financial crisis after the Great Depression in the first place. In that regard, my findings show that it was the deterioration of credit quality, but not necessarily the increase in RMBS issuance itself, that caused the boom-bust in home price dynamics and that in the mortgage credit supply. In order to have such sound micro-supervision, it is also imperative to empower supervision authorities with capable staff with right skill sets to be able to measure and assess underlying risks of new and existing financial products.

Third, as mentioned in Section II, asset securitization is supposed to have a number of social benefits as well, and the current event should be work as a red flag for this innovation itself such that those benefits can be further realized in future in the U.S. and other countries. As a case in point, Figure 6 below compares the size and composition of the markets for securitization in the U.S. and Korea. In terms of relative size (i.e., percent to GDP), the market is much bigger in the U.S., about 70% total value of outstanding securities to GDP vs. 11% in Korea. Also, the maturity of the securities in Korea tend to much shorter than those in the U.S., with about 40% of securities outstanding having less than one year maturity and another 43% having maturities between one and three years. Hence, it is fair to say that potential benefit of more expanded market for securitization is to be realized in future, which can expand the financial service to more underserved consumer and business borrowers. Even in the U.S., it was not the securitization itself, but the moral hazard problems on the part of intermediaries involved, that contributed to the 2007-2009 financial crisis. In short, the securitization as a whole-sale funding method should be fairly assessed in terms of both intended benefits and unintended costs, and also in comparison with its competing products such as the European covered

bonds.

Finally, there should be a new breed of risk assessment tools that can work as industry norm in trading securitized financial products. In that regard, there has already been a number of new measures introduced from academia and policy circles, e.g., Co-VaR (Adrian and Brunnermeier (2009)), dynamic capital provisioning method (Jimenez and Saurina (2006)), as well as "z-score" based asset bubble detection techniques (IMF (2010)). These new tools, I expect, will help not only regulatory authorities in executing their micro- and macro-supervision but also market participants involved with securitization process in perform appropriate due diligence on financial products to be traded.

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Appendix 1. Securitization, Intended Benefits vs. Unintended Costs

Intended Benefits	Description & Policy Questions
A. Lowering financing costs	• Reducing lending rates in mortgage, high-yield bond, & other liquidity-constrained sectors • Due low COC, does lending rate go down? ➔ Partially yes in the U.S. mortgage market; Hard to tell in Korea
B. Expanding financial service	• Serving more underserved consumer cohorts, & making financial system more complete • How to determine underserved consumer groups (or "marginal borrowers)? How to effectively manage heightened risk? ➔ The subprime & Alt-A mortgage markets as example; Low-income & low creditworthy borrowers in Korea (CB > 7)
C. Improving risk allocation & risk sharing	• Market-wide, or even global, risk-sharing, making it possible to manage lending risk by those who are more capable • Global trade of the U.S. MBS as example; Mortgage insurance as another example; Transparency in embedded risk as a must
D. Developing long-term bond market	• Developing a long-term bond market (in emerging market countries), to help reduce duration mismatches • What infrastructure is necessary for trading and risk management? Will a regional bond market (e.g., the Asian bond market initiative) be a solution?
Unintended Costs	
A. Inflicting market instability (i.e., asset price boom-bust)	• Increasing chance of instability in real estate and other related sectors in economy (national, regional, or global) • Will micro prudence regulations (e.g., LTV, DTI, DSCR) and macro prudence regulations (dynamic capital provision) regulations be a solution?
B. Increasing intermediation cost	• Lengthening intermediation process with more fees involved (e.g., servicing, credit guarantee, monitoring, and so on) • How to ensure a competitive & cost-effective intermediation process? Will a globalized security market help?
C. Raising possibility of moral hazard on the part of intermediaries	• Maximizing (short-term) fee revenue by intermediaries, and minimizing risk assessment & monitoring cost • How to overcome information asymmetry (lenders vs. issuers, issuers vs. investors, managers/traders vs. supervisors)? How to use external governance mechanisms (capital market, M&A markets, & board of director)? How to design disclosure and "skin-in-the-game" requirements?
D. Inflicting systemic risk	• Increasing systemic risk to a national, or even global, financial

	system (counterparty risk externality & problem in the FI-level regulation) • How to define systemically important FIs (TB-TI-TF FIs or LCFIs)? By whom and based on what regulatory instrument to supervise them?

Appendix 2. Comparison of Short-Funding vs. Matched Funding

To illustrate, suppose a levered investor whose balance sheet consists of $100 million worth MBS/ABS products in the asset side funded with 10% margin (or a leverage ratio 10, $100m asset over $10m equity).

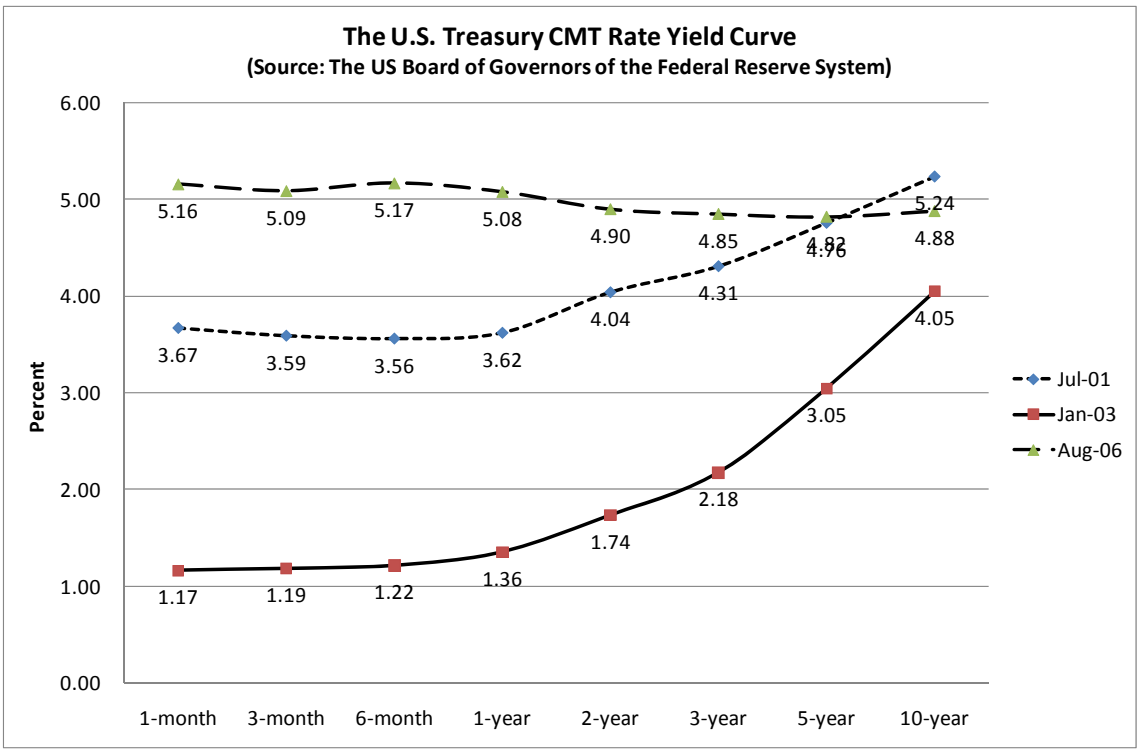
MBS Investors, short-funded vs. matched-funded

A. MBS, Prime	$	30.0	D. Debt	$	90.0
B. ABS CDO, AAA	$	50.0	E. Equity	$	10.0
C. ABS CDO, BBB	$	20.0			

Effective durations of RSA & RSL:
A. 10 years (30 FRMs as collateral w/ housing turnover & prepay option)
B. & C. 5 years (backed by subprime ARMs, following Citigroup (2007))
D.1. 0.25 years (short-funded via ABCP, 90% debt-to-asset ratio)
D.2. 6.5 years (perfectly matched funding, the weighted average durations of A, B, C)

The P&L of the above investor depends on her funding strategy, that is, (1) the matched funding with comparable effective durations between asset and liability (D.1 in the table) vs. (2) the short 3-month ABCP based funding (D.2). It is trivial to show the income effects of these strategies: for example, in the declining interest rate environment between Jan 2001 – Dec 2002, the expected NII under the matched funding strategy is $2.2m, which is much higher that $1.2m under the matched funding. The yield curve environments are shown below:

Figure A.2.1.



Data source: Flow of Fund, Board of Governor of the Federal Reserve System

However, the balance sheet effect of the latter shows the risk of the short-funded strategy. As shown in the table below, changes in equity value (ΔE) in the two two-year periods (the declining rate environment in Jan 2001 to Dec 2002 and the rising rate environment in Jul 2005 to Jun 2007) are much smaller under the matched funding strategy, about $6.1m swing under D.2. compared to only $0.2m shift under D.1.[24]

Balance sheet effect of duration mismatch

Short-funded	ΔA	ΔL	ΔE	ΔE Vol
01m1 - 02m12	3.464	0.497	2.966	
05m7 - 07m6	-3.352	-0.205	-3.147	6.113
Match-funded				
01m1 - 02m12	3.464	3.476	-0.012	
05m7 - 07m6	-3.352	-3.165	-0.186	0.174

01m1 - 02m12: Declining interest rate environment
05m7 - 07m6: Rising interest rate environment

As shown in the table below, changes in equity value (ΔE) in the two two-year periods (the declining rate environment in Jan 2001 to Dec 2002 and the rising rate environment in Jul 2005 to Jun 2007) are much smaller under the matched funding strategy, about $6.1m swing under D.2. compared to only $0.2m shift under D.1.

[24] Insert the duration-based computational formulae

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