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Underwriting, Mortgage Lending, and House Prices: 1996-2008

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Abstract:

Lowering of underwriting standards may have contributed much to the unprecedented recent rise and subsequent fall of mortgage volumes and house prices. Conventional data don't satisfactorily measure aggregate underwriting standards over the past decade: The easing and then tightening of underwriting, inside and especially outside of banks, was likely much more extensive than they indicate.

Given mortgage market developments since the mid 1990s, the method of principal components produces a superior indicator of mortgage underwriting standards. We show that the resulting indicator better fits the variation over time in the laxity and tightness of underwriting. Based on a VAR, we then show how conditions affected underwriting standards. The results also show that our new indicator of underwriting helps account for the behavior of mortgage volumes, house prices, and GDP during the recent boom in mortgage and housing markets.

Keywords: Underwriting, standards, mortgages, house prices, LTV.

I. Introduction

Underwriting standards for residential mortgages (henceforth: underwriting) are now generally regarded as having been unusually lax during the middle of the 2000s. Underwriting then tightened up again during the financial crisis that began in 2007. The laxity of underwriting and its ensuing tightness since the middle of the 1990s likely contributed considerably to the unprecedented rise and subsequent fall of mortgage volumes and house prices.

Conventional data do not satisfactorily measure aggregate underwriting over the past decade: Easing of underwriting, inside and especially outside of banks, was likely much more extensive than they indicate. The Fed's survey data for banks' residential lending records, for example, that easing for 2004-06 was about the same as the easing recorded for 1992-94; the data also indicate the 2004-06 easing was also about the same as the tightening recorded for 2001-03. Easing inside and especially outside of banks was likely much more extensive during 2004-06. To the extent that underwriting eased more at nonbank lenders, the Federal Reserve (Fed) and Office of the Comptroller of the Currency (OCC) survey data omit an important part of aggregate lending standards.

Though we have several indicators of underwriting, none seems sufficient alone. Therefore, we sought to summarize the information about underwriting that was contained in several variables that we judged to be related to underwriting during this period. We used the data from the Fed's questions to banks and from the OCC surveys that ask their examiners about banks' underwriting. We supplemented those data with other data that are related to underwriting: credit spreads, the market share of adjustable rate mortgages, and mortgage delinquency rates.

We argue that, for this time period, the method of principal components (PC) can usefully summarize the information in those variables about underwriting. We used the PC method to generate a single, new data series. We show that the resulting indicator variable exhibits correlations with the input variables to the PC method that are consistent with its measuring underwriting. In addition, the indicator variable suggested that underwriting eased considerably in the late 1990s and dramatically more in the middle 2000s; it suggested that underwriting tightened in and after the recession of 2001 and tightened dramatically starting in 2007, as the financial crisis erupted. Thus, the derived indicator tightness fits current understanding of past underwriting much better than conventional measures or the individual variables that were related to underwriting.

For the practicing economist, having a single variable that both summarizes multiple measures and more accurately measures a phenomenon, like underwriting, can be very valuable. Being able to present a single, summary variable, for example in a time series plot, is often very informative. A summary variable can be especially useful in practice when other candidate variables have well known shortcomings. In the case at hand, for example, an audience might quickly understand the Fed and OCC surveys only cover commercial banks, whose market shares of mortgages originated and held dwindled over the past decade and whose underwriting probably loosened much less than underwriting outside of regulated banks.

To assess the caliber of the derived underwriting variable, we used the variable in a vector auto-regression (VAR). In light of our current understanding of how underwriting evolved over this period, the estimated effects on the underwriting indicator variable provide information about the caliber of indicator series itself. To the extent that the derived variable was estimated to respond in accordance with our understanding, that buttresses our confidence in the PC method and in the indicator that we derived.

Further, the estimated VAR suggests how, in turn, the other variables, such as house prices and the volume of and interest rates on mortgages, were affected by changes in underwriting. Again, to the extent that the estimated responses to underwriting laxity and tightening fit our understanding, they further raise our confidence in the indicator of underwriting that we derived. In fact, the VAR-based estimates suggest that our new indicator of underwriting helps account for the path of gross domestic product (GDP) and for the unprecedented movements of mortgage volumes and house prices during the mortgage and housing booms and busts.

Thus, we describe how PC helped in a specific instance with the challenges that economists generally face: (1) How to summarize several, related, imperfect indicators of a particular phenomenon and (2) how to convey the effects on, and the effects of, that phenomenon on other pertinent variables.

II. Events and Issues

Housing Markets since the Middle of the 1990s

Over the past decade, house prices and mortgages rose enormously, peaked, and then began their declines. Figure 1 plots two quarterly data series for 1996-2008: Real house prices (RHP) and mortgage balances relative to potential nominal GDP (MORTPOT)). Both series rose steeply, nearly doubling by 2006, before declining thereafter. (Appendix B describes the data series more precisely and provides their sources. All data series are national aggregates and seasonally adjusted as appropriate.)

Similarly, Figure 2 plots data for the four-quarter growth rate (%) of nominal house prices (GNHP) and data for the difference (%) between actual and potential real GDP.[1] Figure 2 shows that house prices not only rose considerably in the late 1990s, but that they accelerated thereafter, rising faster and faster through 2006, after which they decelerated and then, starting in 2007, the real and nominal levels of house prices declined. Figure 2 also shows that incomes (relative to potential GDP) also rose considerably during the late 1990s, but from 2001 onward, hovered just below potential GDP. Given the quite rapid advance of potential real GDP after

1 Because the inflation rate was so steady relative to that of the percentage changes in nominal house prices over this period, the correlation between the percentage changes in nominal and real house price was over 0.99.

2000, actual incomes rose considerably too. But, figure 2 also intimates that it would be difficult to attribute the strong and rising growth rate of house prices to accelerating income growth.

What is Underwriting?

At various times, various analysts include different aspects of lending under the rubric of "underwriting." For concreteness here, we take underwriting standards to consist of all non-interest-rate terms and conditions that affect decisions about mortgage applications. Thus, we consider, for example, a lender's choices about minimum FICO scores and documentation requirements and about maximum loan-to-value (LTV and applicants' debt-to-income (DTI) ratios.[2] This is consonant with the Fed's survey question, which asks banks about their "credit standards for approving applications from individuals for mortgage loans to purchase homes…" (See Appendix A.)

There are many ways that lender can ease or tighten underwriting. Lenders might lower the minimum FICO score or down-payment that they would consider. In addition to altering quantitative standards, lenders might also alter the nature of a standard. For example, during the housing boom of the mid 2000s, sellers (often builders) came to provide "gifts" of down-payments to buyers to help them qualify for Federal Housing Administration (FHA) mortgages. From a very small share around 2000, by 2005-06, the shares of FHA loans that included down-payment gifts from non-profits (which in effect were seller-funded) rose to nearly one-half of FHA mortgage originations.[3] Thus, there are myriad ways that lenders can ease or tighten underwriting.

Possible Indicators of Underwriting Tightness

Consider some of the better-known data series that we might use to better understand the time series of aggregate (residential mortgage) underwriting standards. Figures 3 and 4 plot average values of some variables for which lenders often have quantitative standards, say maximum LTV, based on data for loan-to-value at the time that mortgages were originated. Figure 3a plots the average LTV based on data from the Federal Housing Finance Agency (FHFA). The average LTV might have suggested that underwriting had been tightening, as evidenced by LTVs falling (and therefore down-payments rising), from the mid 1990s through the mid 2000s. Analogously, the higher LTVs in 2006-08 might have been a signal of more lax underwriting then.

Figure 3b shows the share of all mortgage originations that had LTVs greater than 90 percent (or equivalently, had down-payments of 10 percent or less). The data in Figure 3b could be seen as support for the pattern of underwriting tightening followed by laxity. The series shows

2 Altering points and other fees associated with originating mortgages is another way that lenders can adjust the terms of their mortgages.

3 A change in the law during 2008 attempted to outlaw the practice, presumably because the default rate on such mortgages was proving already to be much higher than on other FHA loans. *Wall Street Journal*, July 30, 2008, C10.

a rather steady descent from the mid 1990s until 2006, when it had fallen to about ½ its average value recorded over the full decade of the 1990s (not shown). The share then leapt, rising during the financial crisis to about twice the low levels recorded in the mid 2000s. A priori, one might have thought that the share would have tracked overall underwriting tightenings: If underwriting tightened, minimum down-payments likely would rise, thereby reducing the share of borrowers who made down-payments of 10 percent or less.

But, by virtually all accounts, the opposite was true: Underwriting eased during the mid 2000s and then tightened sharply when the financial crisis struck beginning in 2007. How then did average LTVs move opposite to underwriting laxity? The answer, as we now understand it, is that, at least in part, second mortgages originated at closing ("piggybacks") and other mechanisms allowed more borrowers to have first mortgages that had 80 percent or lower LTVs, thereby reducing the series in both figures 3a and 3b. To further upset the conventional correlation between underwriting and its indicators, Sherlund (2009) shows that, at least in the securitized portion of the subprime mortgage market, average FICO scores rose quite steadily over the 1997-2007 period.

However, some data series do conform more closely to underwriting having eased in the 2000s before tightening significantly during the financial crisis. For example, again based on securitized subprime mortgages, Sherlund (2009) shows that average ratios of debt to income (DTI) and of loan balance to house value (LTV) rose and the share of adjustable-rate mortgages (ARMS) rose. Figures 4a and 4b, taken from Sherlund (2009), show that the combined, first-plus-second mortgage-LTV (CLTV) rose and the share of originations that had full documentation declined throughout the 2000s, until the financial crisis began. And, the share of "low quality" mortgages, defined as those with low documentation and LTVs of at least 95 percent, rose markedly after 2002, before plummeting in 2007. Thus, the data in figures 4a and 4b suggest evermore lax underwriting until 2007. Therefore, although some commonly used data series seemed to signal tightening of underwriting standards, other series were simultaneously signaling laxity during the mid 2000s and tightening thereafter. Regardless, there is plenty of reason to suspect that the usual proxy variables for underwriting in the aggregate are unlikely to suffice for analyzing recent events in housing markets.

Survey Measures of Underwriting

Federal banking regulators regularly conduct surveys to ask more directly about banks' underwriting standards. The Fed asks banks themselves to report whether they have tightened underwriting; the OCC asks its own employees about whether the banks that they have directly examined have tightened underwriting standards.

Figure 5 plots the net percentage of banks each quarter that were reported to the Fed (UWFED) and by the OCC (UWOCC) as having tightened underwriting.[4] (Appendix B lists the

4 The OCC reports data for the second quarter of each year. To obtain the data for the other quarters, we linearly interpolated between the values reported for the second quarter. This almost

questions and answers for the Fed's and for the OCC's recent surveys about residential mortgage underwriting. Note that the Fed includes mortgage interest rates in its question about underwriting standards.) The two series in figure 5 have been highly correlated (0.90). But there were also some notable differences. The net tightenings were reported to be generally negative (i.e., banks were easing underwriting) during the late 1990s in the OCC survey, but they averaged about zero in the Fed survey. Both surveys reported net tightening in 2001-03, during and following the 2001 recession. Underwriting then was reported to have eased (i.e., negative net tightening), especially in the OCC survey, during 2004-06. And both surveys then reported net tightening during the financial crisis, which began in 2007.

Figure 6 casts a different light on the same information used to compile figure 5. In general, we are more interested in the aggregate level of underwriting tightness, rather than the number of banks that tightened each period. As one approximation to the level of tightness, figure 6 displays the cumulative sum of net tightenings (which is shown in figure 5) of underwriting since 1996Q1 (when the series takes a starting value of zero).

The cumulated Fed series, SUMUWFED, in figure 6 implies no net change in underwriting during the late 1990s or even from 2002 through the end of 2006. By contrast, the cumulated OCC series, SUMUWOCC, implies that underwriting eased considerably before the 2001 recession. And perhaps especially notable given the widespread sense that underwriting had broadly and significantly eased from 2004 onward, SUMUWOCC exhibits a large and steep decline until 2007. Thus, the OCC data paint a quite different picture of banks' underwriting standards. We cannot, of course, be sure which series more accurately portrays actual underwriting practices—presumably each series has some virtues. But, we can see that different series, even those that presumably are meant to measure quite similar phenomena in similar samples, can carry quite different information.

Other series are also likely to add information. They may cover different lenders or measure different aspects of underwriting. For example, the Fed and the OCC conducted surveys of commercial banks. Over this sample period, banks' share of mortgage originations and holdings fell significantly. That decline may be partly attributable to other lenders' having lower and lowered underwriting standards relative to those of the much more heavily regulated and examined commercial banks. Other variables might well allow for such developments. Thus, we seek a manageable list of other variables that might affect aggregate underwriting and/or might reflect changes in underwriting.

Other Indicators of Underwriting

One less direct, but potentially useful, indicator of underwriting might be based on (non-mortgage) interest rate spreads. The spread that we used as proxy variable for spreads on risky bonds was the difference (in percentage points) between high-yield and yields of U.S. Treasurys

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guarantees that the OCC data here will be smoother and have more measurement error than the Fed data.

(with similar maturities). This spread is one indicator of the amount of, and return per unit of, credit risk.

Figure 7 plots SPREAD, the yield spread on high-yield corporate bonds. SPREAD declined until the Asian financial crisis of the late 1990s and then generally rose around the 2001 and thereafter. The spread then fell precipitously into 2005 and was at about record lows rose until the financial crisis that began in 2007. Thus, credit markets seemed to judge that there were was relatively low default probabilities and/or low rewards per unit of credit risk.

The results of Demyanyk and Van Hemert (forthcoming) can be used to estimate changes in underwriting for some of the years in the mid 2000s. Their estimates are based on a very large sample of mortgages that were originated in the 2000s by banks or by nonbanks. Their estimates control for the effects of a lengthy list of factors on delinquency rates: borrowers' FICO score, down-payments, house price growth, and so on. Given the controls, we interpret the remaining changes in default rates as reflecting the tightness of prior underwriting standards: The higher the ensuing delinquency rates (importantly, given their long list of controls), the more lax were underwriting standards.[5] The mnemonic for this variable is XSDEL.

Finally, we used an indicator based on the relation between the prevalence of adjustable-rate mortgages and the interest rates on adjustable- and on fixed-rate mortgages (ARMs and FRMs). Historically, and not surprisingly, the ARM share of mortgage originations has reliably risen as FRM rates rose relative to those on ARMS.

During this period, it appears that underwriting changes were perhaps concentrated among subprime and similar (e.g., Alt-A) borrowers. These borrowers disproportionately took on ARMs, which temporarily sometimes had fixed-rate-based payments and/or permitted negative amortization. Such "pay option ARMS" have become infamous. They also had become more numerous during the mid 2000s. Applications for these and other mortgages, as suggested by Figure 4b, were also subject to easing documentation requirements. Thus, through the middle 2000s, more and more borrowers were being approved for mortgages with essentially easier underwriting standards.

To allow for these developments, we constructed a data series, ARMRESID, which was the residual from a regression (over a longer, 1987-2008 sample period) of the market share of ARMs on a constant term, the nominal interest rate on FRMs, and the nominal interest rate on ARMs. The residuals from that regression indicate the otherwise-unexplained ARM share. We interpret the large positive values for ARMRESID over the 2003-06 period as indicative of generally eased underwriting standards. These market developments may well be peculiar to this sample period. So, one would not want to presume that this indicator would be valid for other

5 The Demyanyk-Hemert data cover 1997 through 2006Q2. We set observations before 1997 equal to the 1997Q1 value. For the quarterly values beginning with 2006Q3, we added 0.75 to the prior quarter. Beginning with 2007Q3, for each ensuing pair of quarters, we subtracted 1, then, 2, and then 3 units.

situations. But, for this period it may well have captured an important part of the underwriting conditions that prevailed.

Other series are likely to convey additional relevant information about underwriting. But, we deliberately chose to exclude many of them. For example, numbers and volumes of mortgages, housing starts and residential construction expenditures, and house prices are likely to be useful indicators of mortgage underwriting. But, because our goal is to construct an indicator that we can then use to help account for movements in those and other variables, we chose not to include them in the construction of our indicator of underwriting.

Variable Reduction via Principal Components

We have argued that we have five variables that serve as indicators of various aspects of bank and nonbank underwriting standards. Each of the five variables had some strengths and some weaknesses as indicators of aggregate underwriting standards. (If any one variable had been plausibly regarded as a "sufficient variable," we would have just used that variable.)

Because they each are related to overall underwriting, they tend to be somewhat correlated; the average simple correlation coefficient between them was 0.55; the multicollinearity of this group of five variables was naturally considerably higher than that. Because each variable pertained to underwriting, using the five indicators separately would render interpretation somewhat problematic. For all of these reasons, we applied the method of principal components (PC) to our five indicator variables to derive a single, composite indicator of underwriting.[6] The resulting first principal component (PC) is the single data series that most closely tracks the five variables used in the PC analysis: the Fed and the OCC underwriting data, the risky bond yield spread, the Demyanyk-Van Hemert "excess" default rates, and the "excess" ARM share variable. In that way, the PC method assimilates some of the information from each of the five series into a single indicator variable.

Use of the PC method in economics has often been hindered by the inability to attach persuasive structural interpretations to the results. In the case at hand, however, using input variables that are reasonably connected to underwriting increases our confidence that the first PC is a satisfactory candidate as an indicator of aggregate underwriting.

The First Principal Component as an Indicator of Underwriting Standards

Our confidence is buttressed by the resulting equation for the first principal component of the five chosen indicator variables. To the first PC, we assigned the mnemonic "UWPC:"

6 The PC method is theoretically the optimal linear scheme, in terms of minimizing mean square errors, for generating a few (say, one) data series from many more (say, five) series. In that sense, it is a method to reduce the number of variables to be analyzed. The PC method is non-parametric and it requires no hypothesis about data probability distributions. By construction, the average value of the first PC here is zero.

$$UWPC = 6.40 + 13.9*SPREAD - 9.16*XSDEL - 2.11*ARMRESID + 0.457*SUMUWFED + 0.576*SUMUWOCC$$

As we might expect from an indicator of underwriting tightness, UWPC rose both with the Fed and with the OCC measures of underwriting tightness. UWPC also rose with increases in the bond-yield credit spread, SPREAD. On the other hand, UWPC fell, and thus indicated underwriting easing, as "excess" Demyanyk-Van Hemert-adjusted delinquency rates (XSDEL) rose and as the "excess" share of ARMs (ARMRESID) rose. Thus, UWPC seems consistently to rise and fall with underwriting tightness and laxity.

By construction, UWPC is not perfectly correlated with any of the individual series but rather tends to reflect the common part of the movements that is present in each of the series. Nonetheless, the correlation with each of the series was quite high; the average of the five correlations with UWPC was 0.65, ranging from about 0.4 with ARMRESID to about 0.8 with SPREAD. To illustrate the differences in the time paths of some of the variables used to construct UWPC, Figure 8 plots SPREAD and the OCC-based cumulative tightening variable, SUMUWOCC. In general, SPREAD suggested episodes of tightening and loosening considerably before SUMUWOCC did. They both, however, pointed toward underwriting tightening starting with the 2007 financial crisis, an episode that everyone recognized.

Figure 9 shows that UWPC hovered near its average value (zero) from 1996 until 2000. UWPC then rose modestly into 2002. UWPC then declined significantly and quite steadily until hitting its lowest value in early 2007. In that respect, UWPC suggests that underwriting eased significantly from 2002 through 2006. As a result, UWPC may contribute significantly to explaining the housing boom of the mid 2000s.

The onset of the financial crisis in 2007 then saw UWPC rise very sharply, by more than double the prior decline, indicating extreme underwriting tightness. Again, the size and speed of the rebound of UWPC should not be too surprising in light of the extent to which the credit markets shut down in latter 2008, which was reflected in SPREAD and in the upward jolts to net increase percentages recorded in the Fed and OCC surveys. In that regard, too, UWPC appears to have generally tracked the tightening of underwriting standards during the financial crisis.

III. Using Underwriting Measures

Estimating a VAR

To assess the caliber of UWPC as an indicator of underwriting, we used estimates based on a vector auto-regression (VAR). In conjunction with our prior understanding of how underwriting evolved over the sample period, the estimated effects on the UWPC provide information about series itself. To the extent that estimated VAR's implied impulse response (IR) functions show that UWPC responded in accordance with our understanding, our confidence in the PC method and in the particular implementation that produced UWPC is buttressed.

Further, the estimated IRs indicate how the other VAR variables, such as the volume of and interest rates on mortgages and house prices, were, in turn, affected by changes in underwriting. Again, to the extent that the estimated responses to underwriting laxity and tightening fit our understanding, that further increases our confidence in the caliber of the derived data series for underwriting. In fact, the VAR estimates indicate that our new measure of underwriting helps account for the behavior of mortgage volumes, house prices, and GDP during the housing boom.

One way to assess VAR results is to examine the estimated dynamic responses of each endogenous variable to "shocks" to other endogenous variables. These shocks, or innovations, are the movements in each variable that could not be explained by the past (and sometimes current) movements of the other variables included in the VAR. In the case at hand, the resulting impulse-response (IR) functions can be used to help assess not only the dynamic structure of housing and mortgage markets, but also the caliber of the constructed underwriting variable, UWPC.

We used quarterly data from 1996Q1-2008Q4 to estimate a VAR. In addition to constant term and a linear trend, the VAR included five endogenous variables in the following order: GAP, GNHP, MORTPOT, UWPC, and IMORT. GAP measures the difference between actual and potential real GDP. GNHP is the growth rate of nominal house prices. MORTPOT is mortgage balances relative to potential GDP. And, IMORT is the interest rate on fixed-rate mortgages. (Further descriptions and sources are given in Appendix B.) These variables were chosen because of the judgment that they were important, aggregate variables that were likely to affect or be affected by underwriting, or both.[7]

Estimated Responses

Figures 10-14 display the IRs for the five variables in the VAR. Each figure shows the responses of the other four endogenous variables to a one-unit shock to an endogenous variable. (Not shown are the responses of each variable to a prior shock to itself.)

Overall, there were relatively few surprises or puzzling results. In general, the impulse response functions were consistent with UWPC serving as an effective indicator of aggregate underwriting standards. Almost all of the IRs are consistent with that interpretation. And most of the other IRs are consistent with our prior understandings about the interactions of housing and mortgage markets.

Figure 10a shows that both incomes (GAP) and, on balance, house prices (GNHP) rose in response to an innovation in the amount of mortgage balances. Those responses are consistent with the shock emanating either from the demand or supply sides of the mortgage market. Nor does figure 10b sort out the source of the shock to mortgage balances. Figure 10b shows that the mortgage interest rate (IMORT) rose (consistent with responses to a demand shock) and the

7 The results were not very sensitive to a number of alternative specifications. For example, the results were not much affected by substituting real for nominal house price growth.

indicator of underwriting tightness (UWPC) declined (consistent with responses to a shock to mortgage supply) in response to a positive shock to mortgage balances.

Figures 11a and b display the responses to an upward shock to GDP (GAP). Figure 11a shows, not surprisingly, that both house prices and mortgage balances rose following a shock to incomes. Figure 11b shows that a shock to GDP raised mortgage interest rates. On the other hand, it lowered UWPC. Again, that adds support for UWPC's serving as an indicator of underwriting tightness: As incomes rose, and therefore the likelihood of borrowers having payment problems receded, and as incomes also carried house prices upward, lenders may well have found it optimal to reduce their underwriting standards.

Figures 12a and b display the responses to an increase in mortgage interest rates. Again, conforming to conventional wisdom, higher mortgage rates were estimated to reduce GDP, to lower mortgage balances, and to lower house prices. The estimated IR in figure 12b suggests that higher mortgage interest rates were associated with lenders' tightening their underwriting standards. This suggests that the effect of mortgage interest rates might, in effect, operate not just through their impact on explicit borrowing costs, but also through tighter underwriting terms and conditions. That tightening of standards effectively adds to borrowing costs and reduces effective demand for mortgages and housing. To the extent that underwriting standards do systematically rise with mortgage interest rates, the IR in Figure 12b further supports UWPC as a useful indicator of underwriting.

In Figures 13a and b, the responses to a positive shock to house prices are shown. Figure 13a shows that an increase in house prices (controlling for all of the effects that are embodied in the lags of all of the variables in the VAR), not surprisingly, tended to raise both mortgage balances and incomes (or, equivalently, aggregate output).

More intriguingly, both UWPC and IMORT tended to fall (at least for the first two years) following of an upward shock to house prices. Given the strong momentum observed in house prices, an upward shock reasonably presages even further increases in house prices. Sensibly forecasting that the prices of houses, which collateralize residential mortgages, were likely to continue to rise, it then seems entirely rational for lenders to ease their underwriting standards when house prices rise. And that is what the responses in Figure 11b point to: UWPC declines consistently in response to higher house prices.

For the same reason, lenders may have also been willing to reduce the spreads of their mortgage rates above a benchmark rate in response to higher house prices. Higher house prices reduce expected mortgage losses, thereby warranting lower mortgage interest rates. For the first two years following the shock to house prices, the responses of IMORT are consistent with lower rates.

Finally, figures 14a and b display the estimated responses to estimated shocks to (the estimated indicator of) underwriting, UWPC. In figure 14a, an increase in UWPC, interpreted as a tightening of standards, led both to lower GDP (GAP) and to lower growth rates of house prices (GNHP). Both responses are consistent with UWPC as an indicator of underwriting

tightness. Figure 14b shows that tighter underwriting, in the form of an upward shock to UWPC, also tended to reduce total mortgage balances outstanding. The responses of mortgage interest rates to UWPC were mixed. It might well be that the positive effects result from lenders' business practices that tend to raise price and non-price terms sympathetically. On the other hand, the negative effects might reflect that tighter underwriting would slow housing and mortgage markets and lead to lower rates. On balance, the effects on mortgage rates of UWPC did not come down as being consistently negative or positive.

IV. Implications for Extrapolations

Summary

Underwriting standards may have contributed much to the unprecedented recent rise and subsequent fall of mortgage volumes and house prices since the mid 1990s. Conventional data do not satisfactorily track aggregate underwriting standards then. We used the method of principal components to construct a superior indicator of underwriting. We briefly discuss how and why the method can be usefully applied more generally in economic analysis and presentations.

Unlike many conventional indicators, the underwriting indicator that we constructed, UWPC, tracks the increasingly lax underwriting the mid 2000s, followed by the extreme tightening of effective underwriting standards during the financial crisis that began in 2007. Our analysis then showed how the indicator of underwriting affected, and was in turn affected by, house prices, mortgage balances, GDP, and mortgage interest rates. The underwriting indicator, as well as the mortgage and housing variables, generally responded in the directions that we expected. Taken together, then, the estimated responses to the indicator of underwriting provided considerable support for the interpretation that UWPC serves as a useful indicator of mortgage underwriting tightness. Thus, the method and its implementation here do help us understand better some of the developments in mortgage and housing markets over the past decade.

Double Bubble Trouble?

That is not to say, however, that all of the patterns in these variables are explicable or even economically sensible. Estimating one, constant-coefficient VAR over this, particular, sample period is subject to at least two concerns. One is that the estimation period is short. The brevity of the sample was resulted in part from the absence of data before 1996 for at least two of the five input variables that we used to construct the indicator of underwriting, UWPC. A consequence of the limited data is that sampling errors for the estimated responses loom unusually large.

Second, during part, but maybe not all, of the sample period, a mortgage and housing "bubble" may have taken place. It is standard to have various multiplier effects in the economy and in estimated models. But, bubble-like behavior may have imparted even stronger, extrapolative, or even temporarily explosive effects in mortgage and housing markets (and thus data) for some of the sample period. Such data movements may dominate much of the sample period here, which is partly what makes it so intriguing and worth analyzing. For example, the

ever-increasing growth rates of house prices through the mid 2000s, as shown in Figure 2, hint as such extrapolative patterns in the data.(To the extent that underwriting then responded to (forecasted, future) house price growth, as the estimates suggest, those extrapolations might then be transmitted to underwriting standards as well. And our indicator of underwriting does trend downward significantly until the financial crisis strikes in 2007.

When extrapolative behavior is long and strong enough, its resulting effects on data may show up in estimated responses. For example, in the estimated VAR, for both house prices and for the underwriting indicator, the estimated coefficients on their own lags summed to more than one. Those sums then can translate into estimated responses, like those in figures 10 through 14, that do not dampen out soon, or maybe ever. Such estimates then may be accurate reflections of the operation of these markets in these years. But they are unlikely to be representative of the responses during more normal periods.

Thus, the estimates based on data from periods of mortgage and housing bubbles of the magnitude and character of those in the mid 2000s are not likely to be representative. Extrapolating them to other times or places entails atypically high risks. At the same time, such estimates are of independent interest, helping us to better understand recent tumultuous events in mortgage and housing markets.

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Appendix A

The Fed and the OCC Surveys of Banks' Underwriting Standards

In their separate surveys, the Fed and the OCC ask about banks' mortgage underwriting standards.

The Fed conducts a "Senior Loan Officer Opinion Survey on Bank Lending Practices at Selected Large Banks in the United States." The sample of banks "is selected from among the largest banks in each Federal Reserve District. In the table, large banks are defined as those with total domestic assets of $20 billion or more as of December 31, 2008. The combined assets of the 31 large banks totaled $6.2 trillion, compared to $6.5 trillion for the entire panel of 56 banks, and 10.7 trillion for all domestically chartered, federally insured commercial banks." (Source: April 2009 survey results report.)

In the April 2009 survey the Fed asked the following question:
"Over the past three months, how have your bank's credit standards for approving applications from individuals for mortgage loans to purchase homes changed?" In earlier periods, the questions typically did not distinguish between prime and other applicants.

The survey gives banks the following five choices for their responses: Tightened considerably, tightened somewhat, remained basically unchanged, eased somewhat, or eased considerably.

The Fed, and many other sources, commonly report an aggregate measure of net percentage tightening which is calculated as the sum of the shares of banks tightening considerably and tightening somewhat (each equally weighted) minus the sum of the shares of banks easing somewhat and easing considerably (each equally weighted).

The OCC conducts an annual "Survey of Credit Underwriting Standards." "The 2008 survey included examiner assessments of credit underwriting standards at the 62 largest national banks. This population covers loans totaling $3.7 trillion as of December 2007, approximately 83 percent of total loans in the national banking system." (Source: June 2008 survey.)

In 2008, the survey included assessments of the change in underwriting standards in residential real estate loan portfolios for the 55 banks engaged in this type of lending among the 62 in the survey. The survey gives examiners the following three choices for their responses: tightened, unchanged, and eased. We computed net percentage tightening as the share of banks tightening minus the share of banks easing.

Appendix B

Data Descriptions and Sources

GAP, the aggregate income variable, was calculated as the percentage difference between real GDP and real potential GDP. Real GDP was obtained from the Bureau of Economic Analysis (BEA) and real potential GDP from the Congressional Budget Office (CBO). Both series are seasonally adjusted.

RHP, real house prices, was calculated adjusting nominal (i.e., not adjusted for inflation) house prices using the GDP implicit deflator, which we obtained from the BEA. As data for aggregate house prices, we used the quarterly Freddie Mac conventional mortgage home price index.

GNHP, the variable used to measure the growth rate of nominal house prices, was calculated as the percentage change in house prices over the most recent four quarters.

IMORT, the mortgage interest rate, was measured as the quarterly, national-average, interest rate on 30-year, conventional, conforming fixed-rate mortgages as reported by Freddie Mac.

MORTPOT, our measure of mortgages outstanding, was calculated as the ratio (%) of total, nominal, mortgage balances to nominal potential GDP.

UWPC, the indicator of aggregate underwriting standards, was the first principal component from five data series. The five series and the method of principal components are described more fully in the text.

Figure 1: Real house price (RHP) and residential mortgage loans per potential gross domestic product (MORTPOT), indexed: 1996:1 = 100, Freddie Mac, BEA, Federal Reserve, quarterly data, 1996-2008

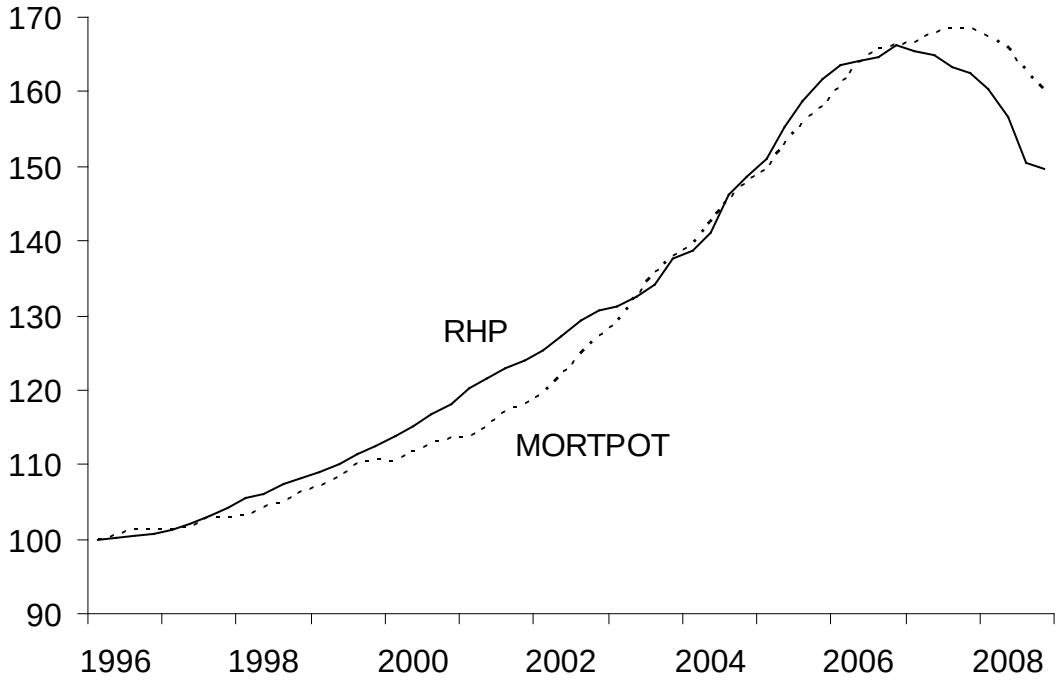

Figure 2: Growth in nominal house prices, year-on-year (GNHP) and output gap (GAP), Freddie Mac, BEA, (%), quarterly data, 1996-2008

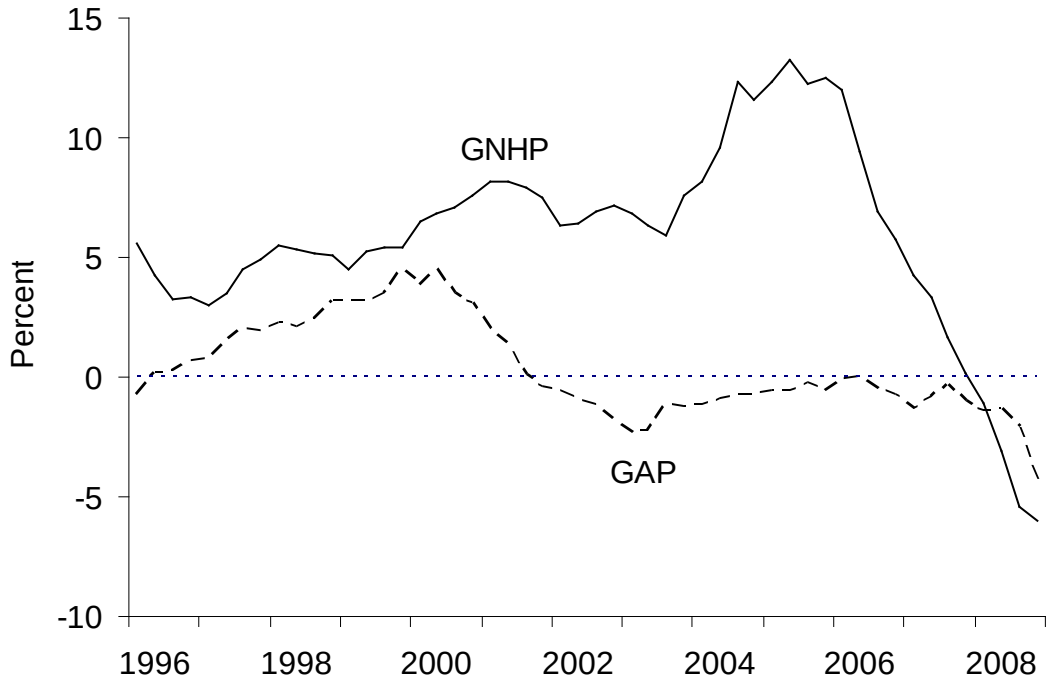

Figure 3a: Loan to value (LTV) ratio (%) for all conventional single-family non-farm mortgage loans, Federal Housing Finance Agency, quarterly data, 1996-2008

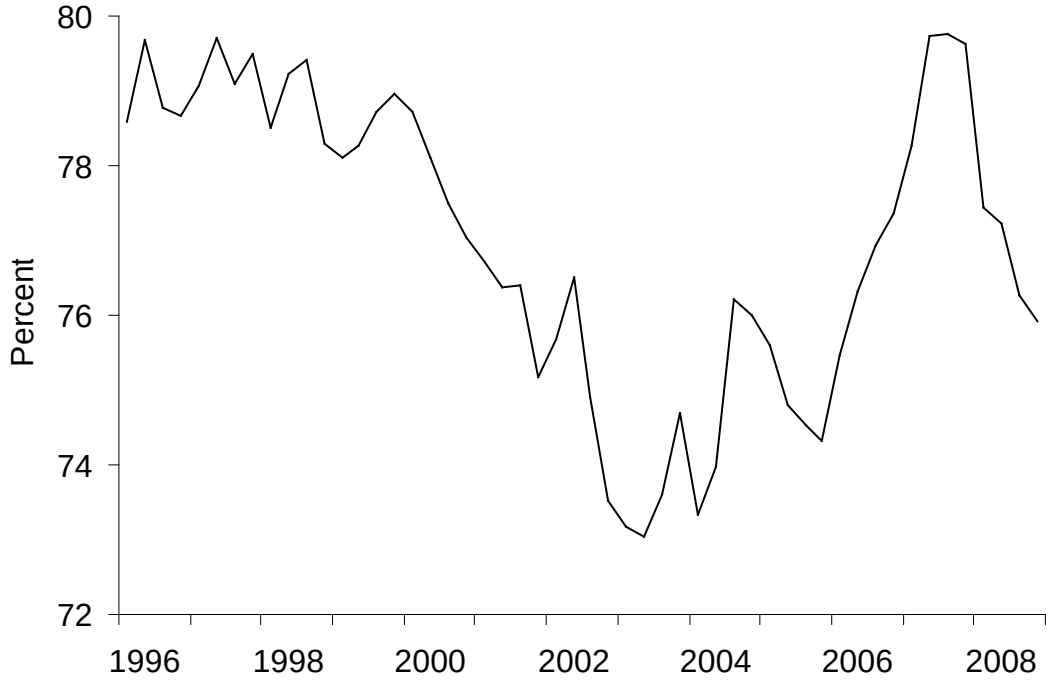

Figure 3b: Percent of conventional single-family non-farm mortgage loans with loan to value (LTV) ratio greater or equal than 90%, Federal Housing Finance Agency, quarterly data, 1996-2008.

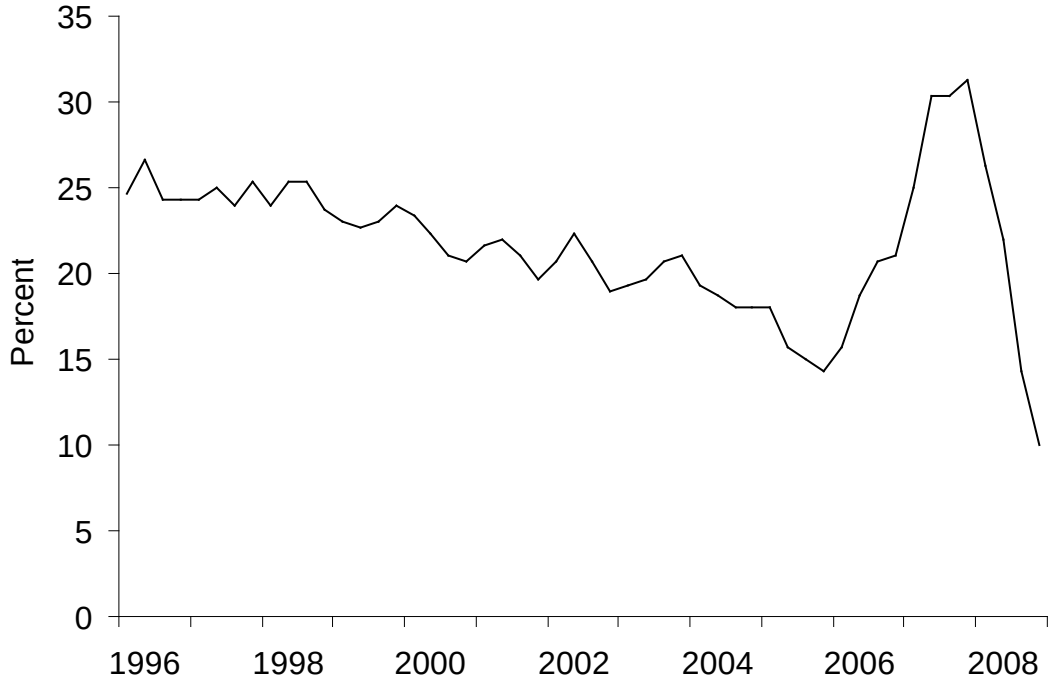

Figure 4a: Average CLTV at Origination (%), Source: Sherlund (2008), monthly data, 2000-2007

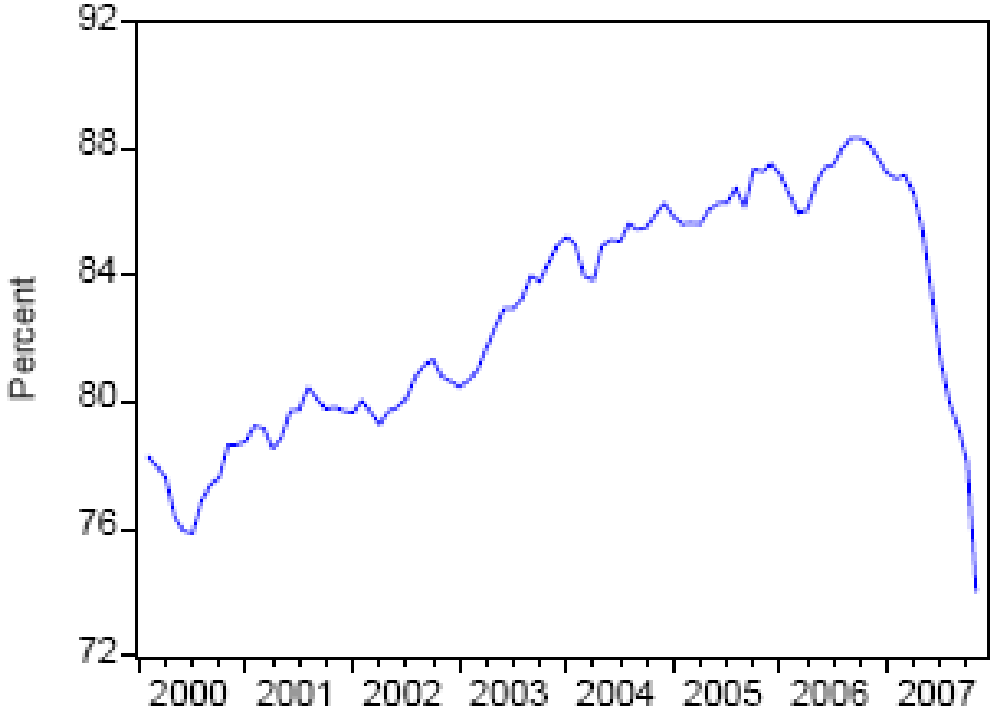

Figure 4b: Loan Documentation at Origination (%), Source: Sherlund (2008), monthly data, 2000-2007

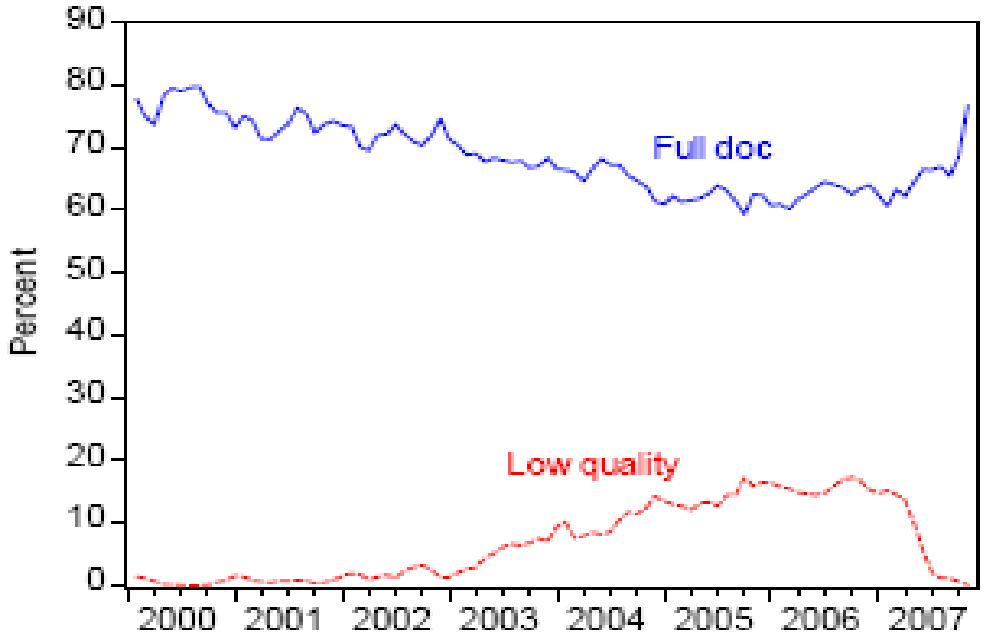

Figure 5: Net percentage tightening of residential mortgage underwriting standards (percentage of banks tightening minus percentage loosening) from surveys of banks by the Federal Reserve (UWFED) and the Office of the Comptroller of the Currency (UWOCC), quarterly data, 1996-2008, OCC source data pertains to Q2; remaining quarters are linearly interpolated

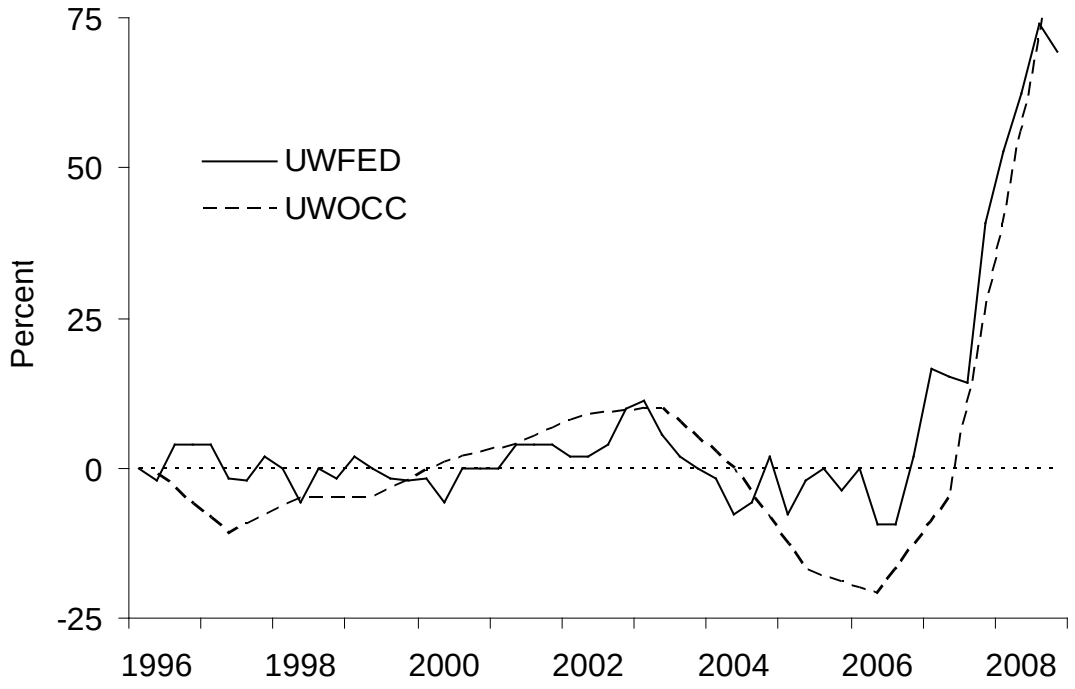

Figure 6: Cumulative net percentage tightening of residential mortgage underwriting standards (percentage of banks tightening minus percentage loosening, indexed 1996 = 0) from surveys of banks by the Federal Reserve (SUMUWFED) and the Office of the Comptroller of the Currency (SUMUWOCC), quarterly data, 1996-2008

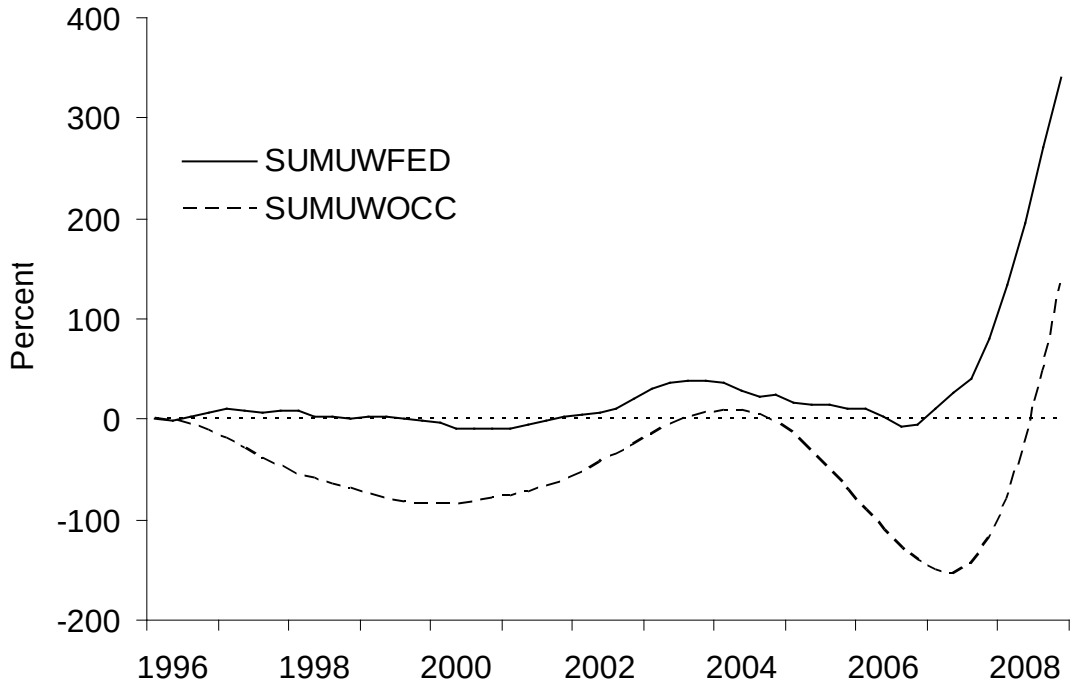

Figure 7: Residuals (ARMRESID) from regression of ARMs' share of conventional mortgage originations on a constant and on the interest rates for fixed and for adjustable-rate mortgages, Federal Housing Finance Agency, (%), quarterly data, 1996-2008

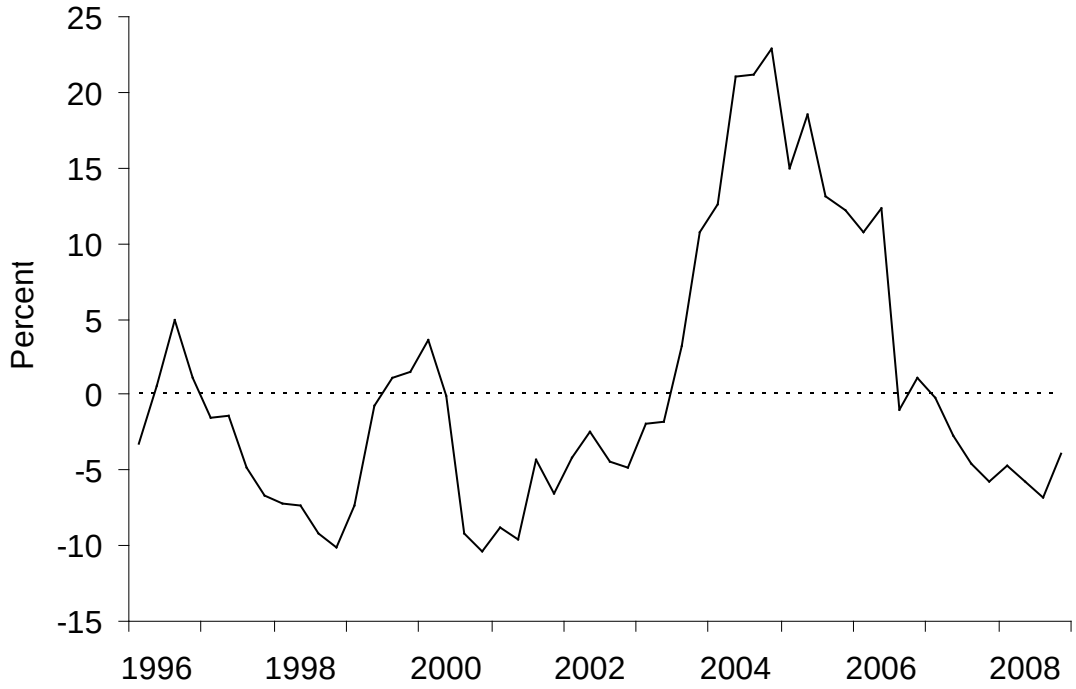

Figure 8: Cumulative net tightening (SUMUWOCC) and the yield spread between junk bonds and U.S. Treasurys (SPREAD) (%), Economy.com, quarterly data, 1996-2008

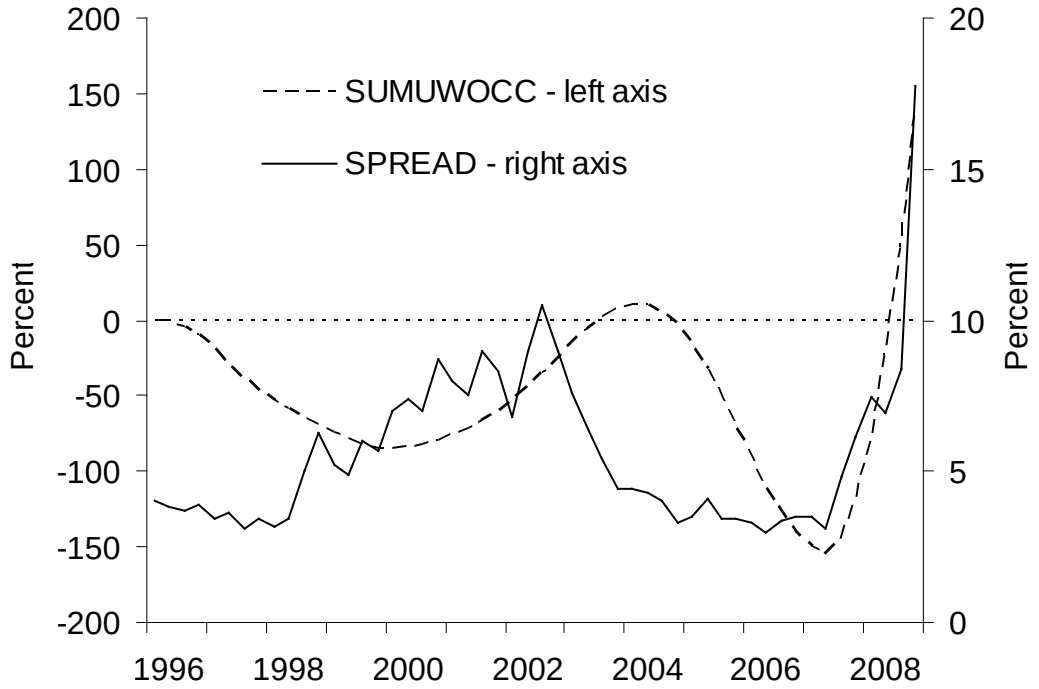

Figure 9: Underwriting standards estimated by first principal component (UWPC) of SPREAD, ARMRESID, SUMUWFED, SUMUWOCC, and XSDEL, quarterly data, 1996-2008

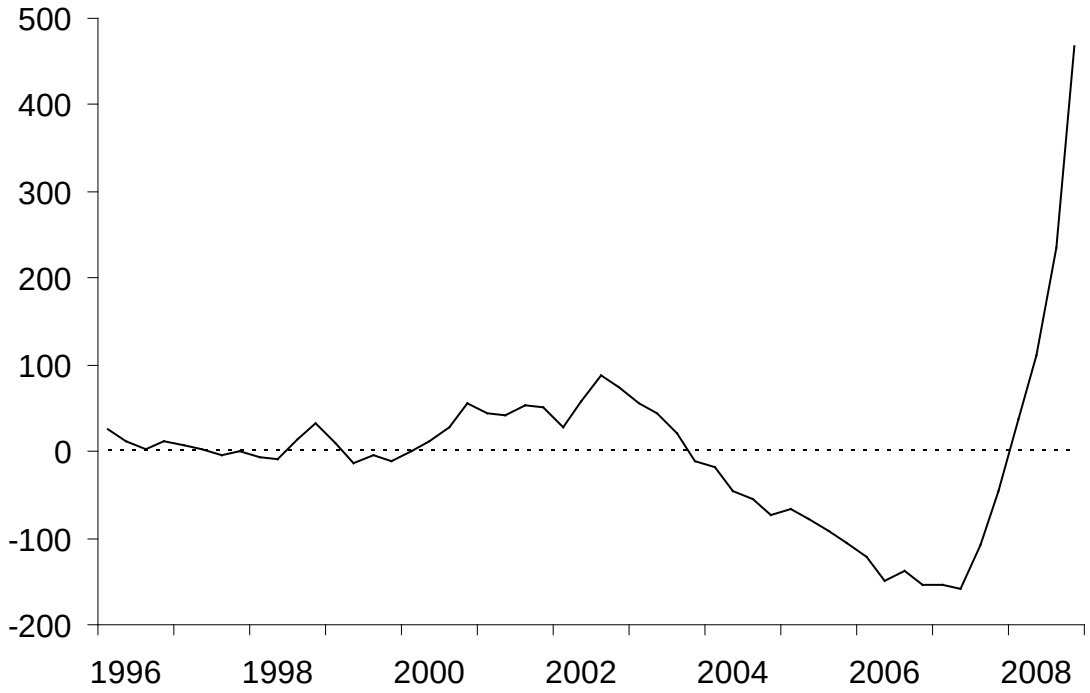

Figure 10a: Response of the output gap (GAP) and of growth in nominal house prices (GNHP) to a unit shock to mortgage balances (MORTPOT)

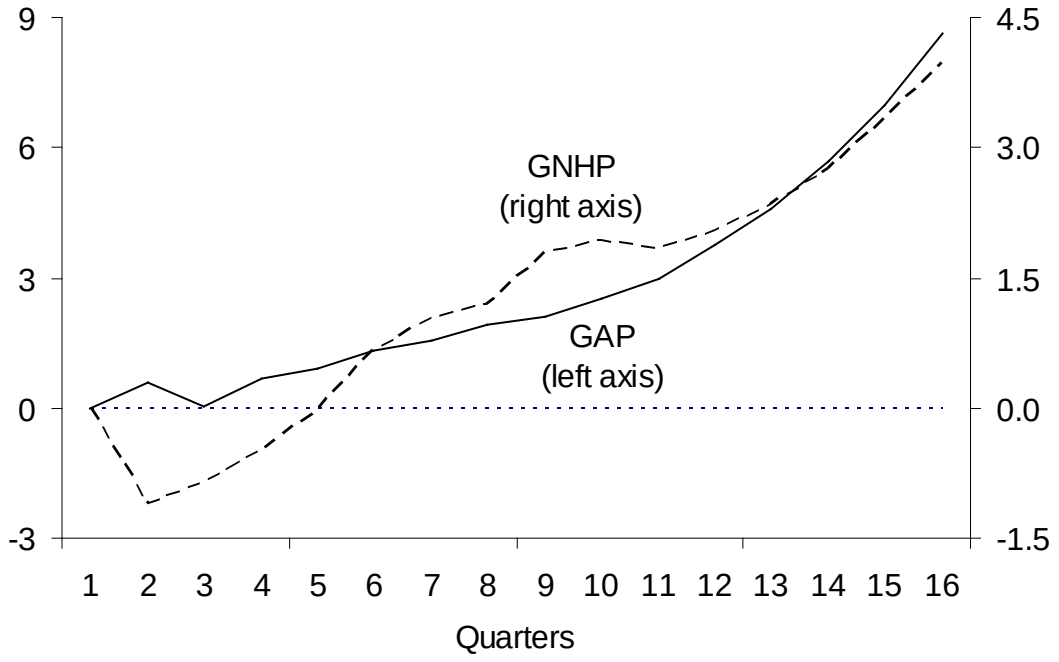

Figure 10b: Response of mortgage interest rates (IMORT) and of underwriting standards (UWPC) to a unit shock to mortgage balances (MORTPOT)

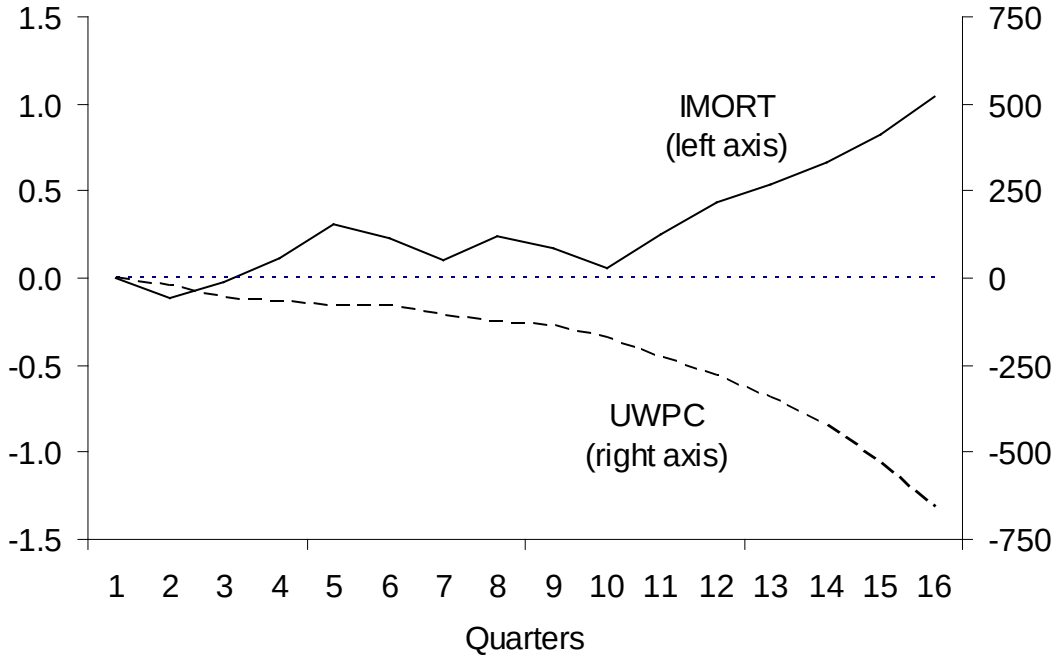

Figure 11a: Response of mortgage balances (MORTPOT) and of growth in nominal house prices (GNHP) to a unit shock to the output gap (GAP)

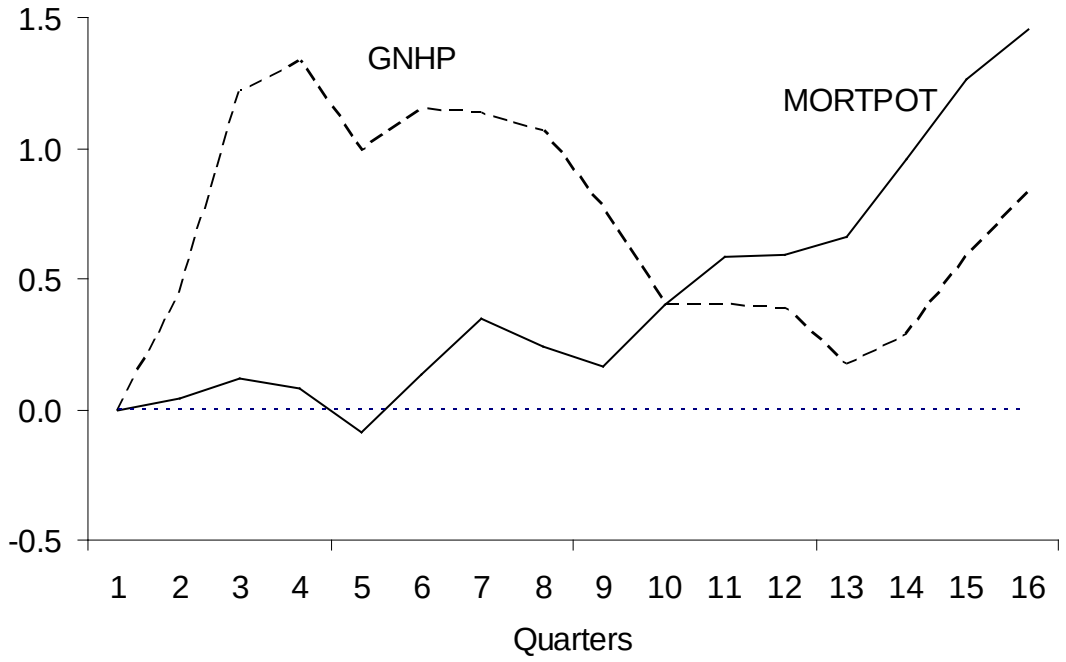

Figure 11b: Response of mortgage interest rates (IMORT) and of underwriting standards (UWPC) to a unit shock to the output gap (GAP)

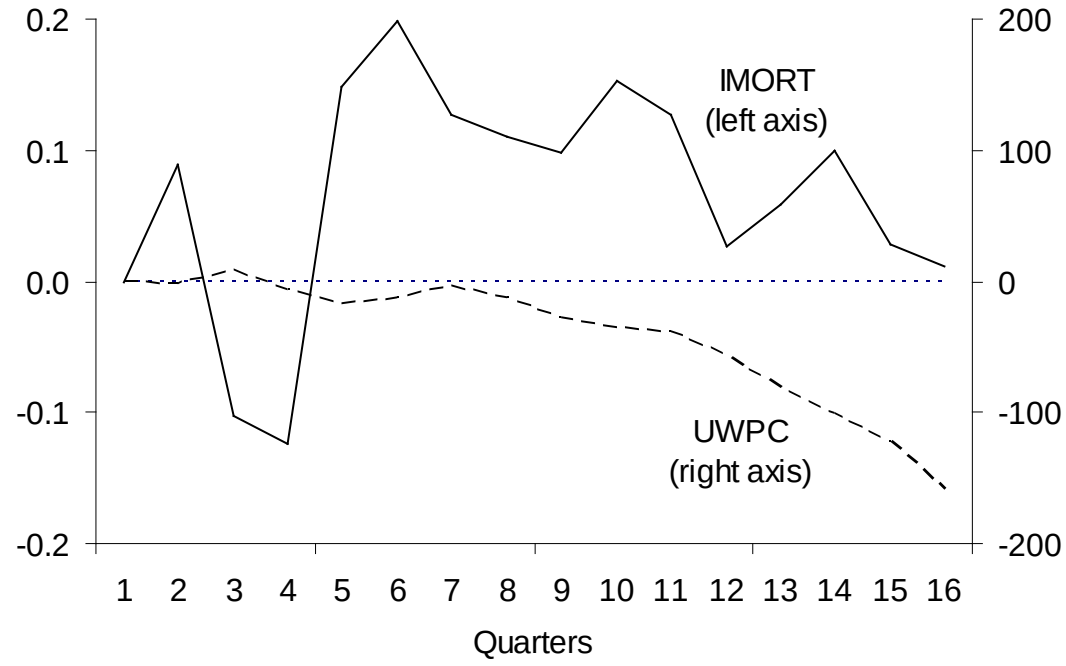

Figure 12a: Response of the output gap (GAP) and of growth in nominal house prices (GNHP) to a unit shock to mortgage interest rates (IMORT)

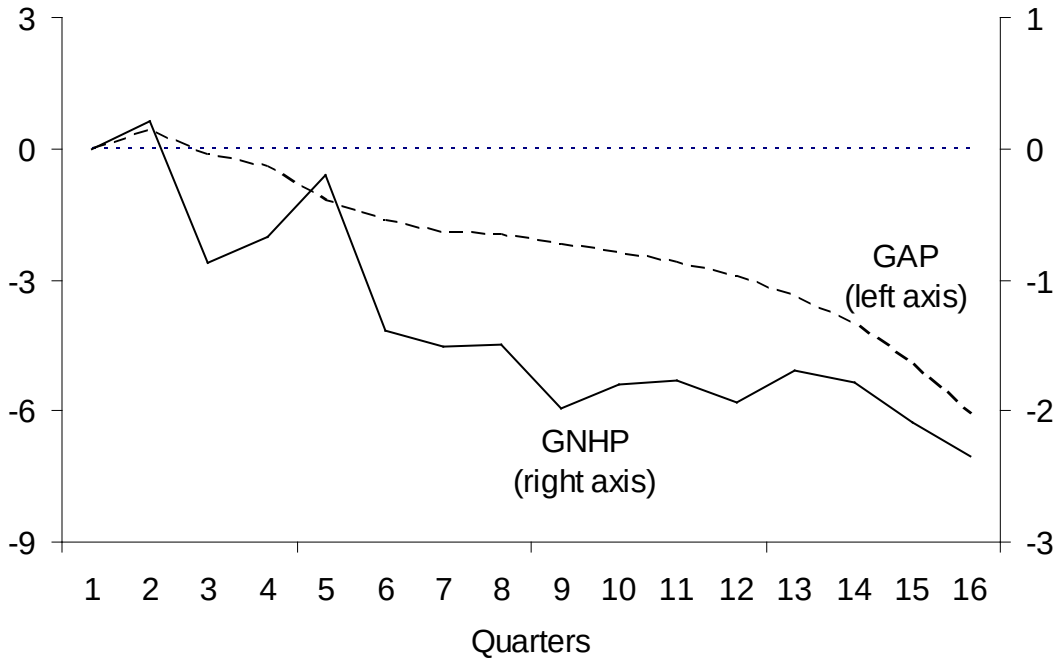

Figure 12b: Response of mortgage balances (MORTPOT) and of underwriting standards (UWPC) to a unit shock to mortgage interest rates (IMORT)

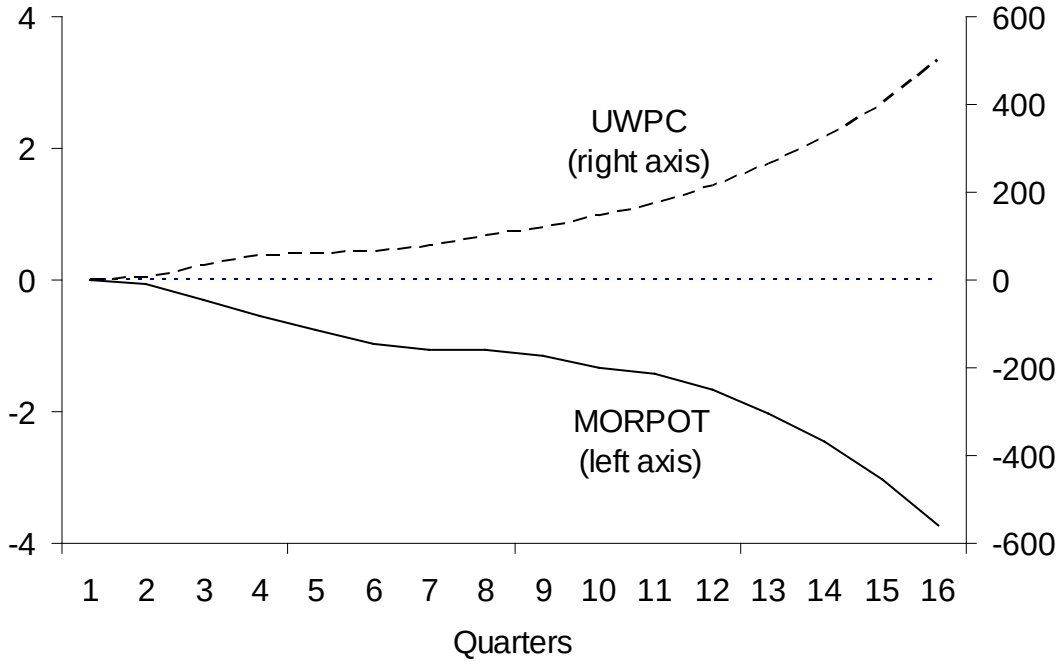

Figure 13a: Response of the output gap (GAP) and of mortgage balances (MORTPOT) to a unit shock to growth in nominal house prices (GNHP)

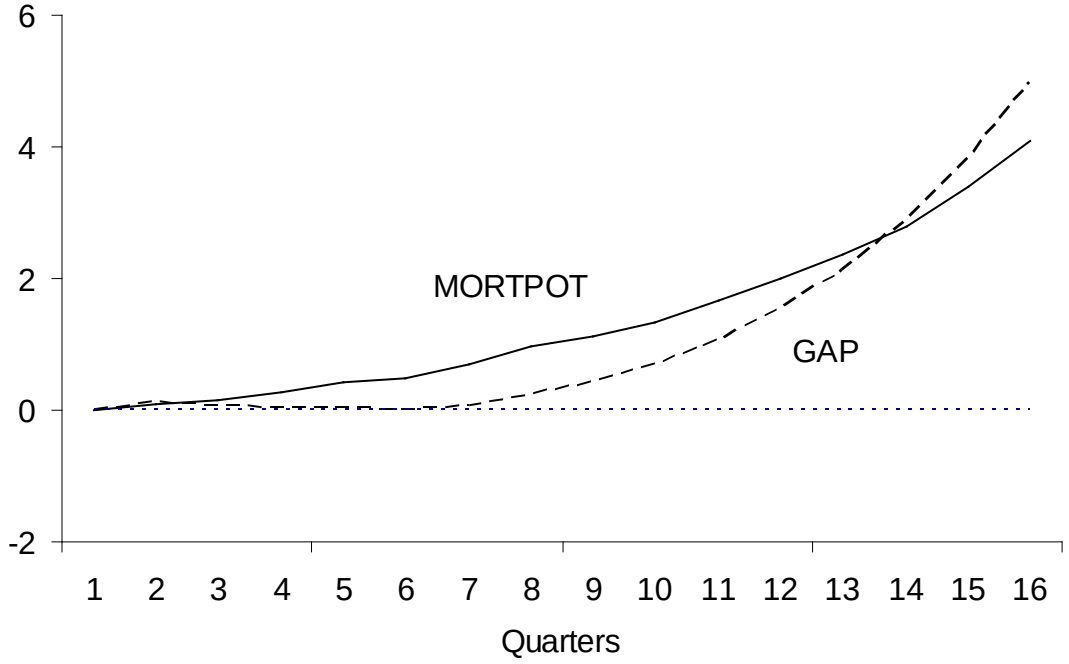

Figure 13b: Response of growth in mortgage interest rates (IMORT) and of underwriting standards (UWPC) to a unit shock to growth in nominal house prices (GNHP)

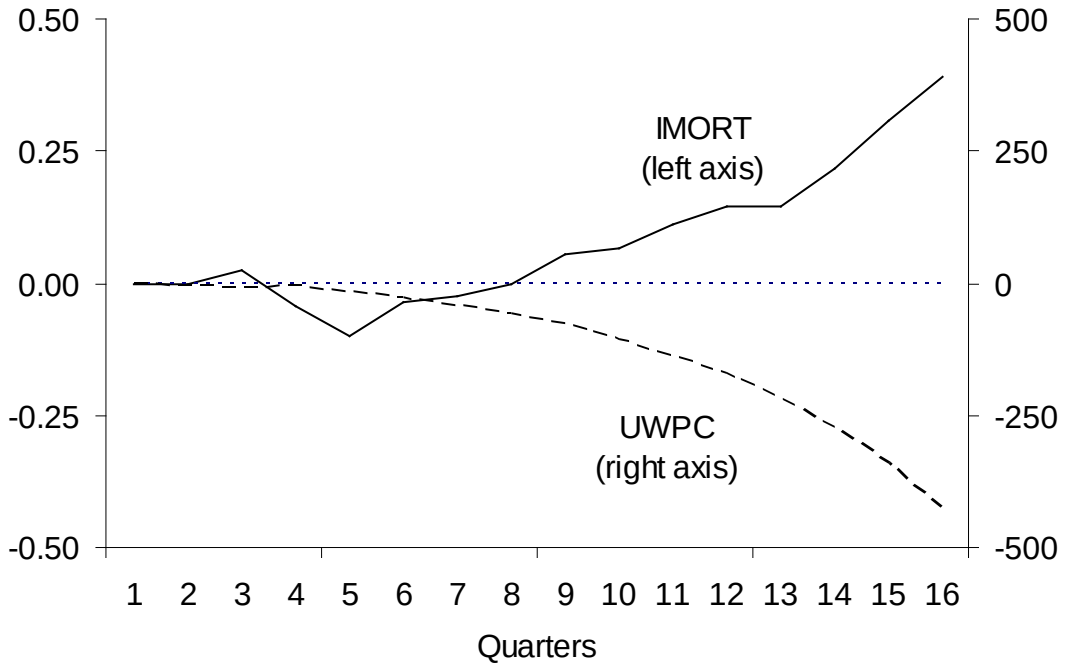

Figure 14a: Response of the output gap (GAP) and of growth in nominal house prices (GNHP) to a unit shock to underwriting standards (UWPC)

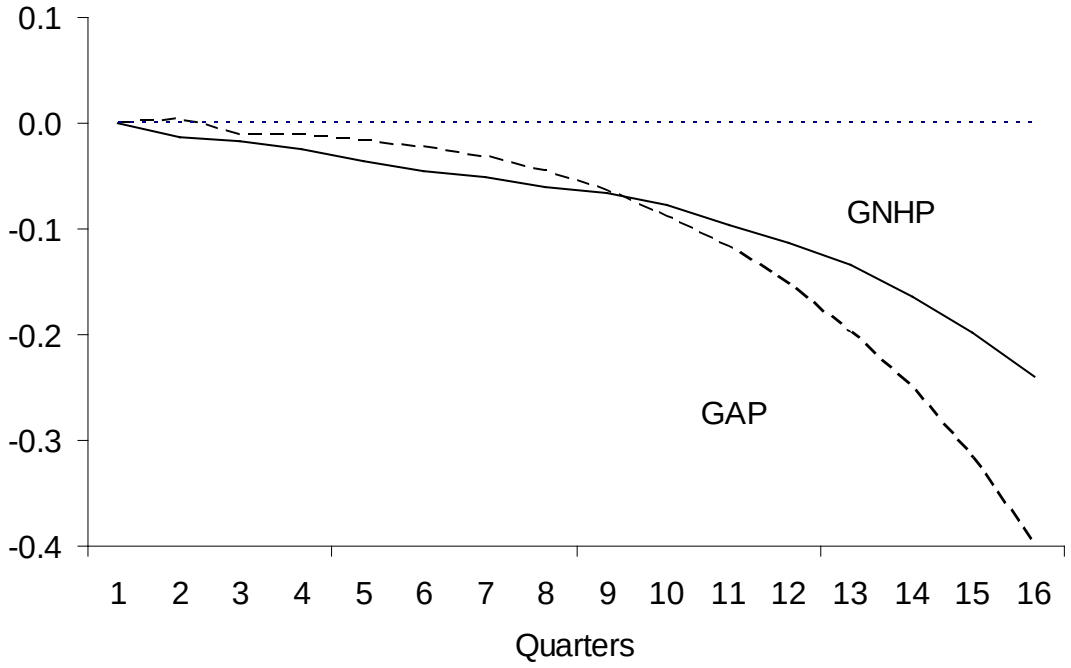

Figure 14b: Response of mortgage interest rates (IMORT) and of mortgage balances (MORTPOT) to a unit shock to underwriting standards (UWPC)