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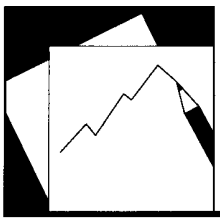

IMF Working Paper

What Goes Up Must Come Down? House Price Dynamics in the United States

Vladimir Klyuev

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What Goes Up Must Come Down? House Price Dynamics in the United States

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Abstract

This paper estimates the evolution of equilibrium real home prices in the United States and finds that despite recent declines, single-family homes remained 8 to 20 percent overvalued as of the first quarter of 2008. In the short run, the gap between actual and equilibrium prices does not exert powerful influence over price dynamics. Instead, that dynamics is driven by the inventory-to-sales ratio and by foreclosure starts in a highly inertial relationship. Taken together, this implies that price declines are likely to continue, including past the point where overvaluation is eliminated. The paper also finds that from the early 1990s onwards changes in regional home prices have been more synchronized than before, and that the recent movements in the average price index have reflected a nationwide housing boom, followed by a nationwide housing bust.

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I. INTRODUCTION

After several years of strong growth, home prices have started to decline in the United States. Activity indicators, such as housing sales and starts, are also dropping, caught in a self-reinforcing downward spiral. Falling house prices may lead to expectations of further declines, depressing the demand for housing. They also reduce owners' equity in their homes, undermining the incentive to service mortgage debt as well as the ability to sell or refinance the property. This increases the number of foreclosures, which adds to the inventory of homes for sale and prompts mortgage lenders to tighten underwriting standards. For these reasons, most commentators agree that real estate prices are playing a key role in the current housing market dynamics.

It is widely recognized that by the mid-2000s home prices had reached levels not supported by fundamentals, but the extent of overvaluation is uncertain. This paper estimates the equilibrium home prices, measures how far the prices are currently above equilibrium, and examines short-run dynamics of price adjustment. It also explores whether the current housing bust is national in scope.

Given the uncertainty about the right technique to model equilibrium house prices, we use two methods to estimate the level of overvaluation.[1] In one approach we link the equilibrium home price to plausible supply and demand fundamentals, such as the real disposable income per capita, the real interest rate, the unemployment rate, the average household size, and the construction cost, estimating the relationship on annual data for four U.S. regions. Our alternative approach is rooted in the asset-market perspective. We estimate a cointegrating relationship between the real home prices and the real interest rate and real rents, two variables that are taken to be summary statistics for the fundamental determinants of home prices, on quarterly national data.

Both techniques produce broadly similar estimates of equilibrium prices. The results indicate considerable overvaluation developing from 2001 on. While the market has started to correct, there is still a long way to go, with home prices, as measured by the OFHEO purchase-only index, exceeding their equilibrium values by 8 to 20 percent in the first quarter of this year.

This analysis also implies that home prices can deviate from equilibrium substantially and for long periods of time, suggesting that the extent of over- or undervaluation is not a good predictor of home price movements in the short term. Indeed, we find that the ratio of existing homes for sale to the sale rate—a measure of imbalance between supply and demand in the housing market—is the key determinant of house price appreciation. The inventory-sales ratio tends to evolve slowly, but over the medium term the gap between actual and equilibrium home prices affects that ratio, and through it, the rate of home price appreciation. We also find an additional short-term effect from foreclosures on house price dynamics.

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[1] Attempts to identify the determinants of home prices include Malpezzi (1999), Capozza and others (2002), and Iacoviello and Neri (2008).

Putting together our estimate of current extent of overvaluation and the equations describing the evolution of house price growth and its key determinant—inventory-to-sales ratio—we project home prices going forward. We find it very likely that home prices will swing well below their equilibrium level before starting to recover.

Finally, we address the question whether the current decline in U.S. housing prices constitutes a nationwide bust. While the national price level is falling on every measure, there is an opinion that this decline might reflect oversized drops in a few isolated markets rather than a countrywide phenomenon. We examine this issue using a variety of simple metrics and come to the conclusion that although the U.S. housing market used to be quite localized, there is a strong case for viewing regional home price movements over the last 15 years or so as reflecting common trends.

II. LONG-TERM TRENDS

While there are a variety of house price indexes for the United States, they all tell fundamentally the same story. As Figure 1 clearly demonstrates, home prices have risen dramatically in the United States over the last 40 years. Moreover, until recently, nominal price had marched inexorably upward, with an occasional dip in a particular quarter, but never a year-on-year decline. As is well known, price growth accelerated in the late 1990s and peaked in the mid-2000s. Now home prices have started to fall, with the extent of the decline depending on the measure used. The S&P/Case-Shiller national index, which focuses on large urban areas and includes a significant share of non-conforming loans, exhibited a particularly large upswing during the boom years, followed by a particularly large drop.

For our empirical work we focus on the OFHEO purchase-only index for single-family residences. Its advantages over the alternatives include wide geographic coverage, controlling for house characteristics through a repeat-sales methodology, absence of appraisal bias, and seasonal adjustment. One significant disadvantage is confining the dataset to properties financed in the secondary markets by housing enterprises (Fannie Mae and Freddie Mac). This largely limits its scope to the conforming market, and misses a large part of the subprime, Alt-A, and "jumbo" markets, where a lot of action has taken place in recent years.[2] As the OFHEO purchase-only index is only available since the first quarter of 1991, it is spliced with Freddie Mac's Conventional Mortgage Purchase-Only Home Price Index, which is based on a similar methodology but a smaller number of transactions and starts in 1970.[3]

[2] OFHEO's (2008) recent analysis indicates that variations in price patterns for inexpensive homes with alternative (non-enterprise) financing explain a large part of the difference between the OFHEO and the Case-Shiller indexes.

[3] For regional data, the OFHEO all-transactions index is used for the period 1975–1990. While the appraisal bias has been an important distortion in recent years, the difference between the OFHEO all-transactions index and the Freddie Mac purchase-only index at the national level is minimal before 1990.

To remove the effects of generalized inflation on home prices, we have divided the OFHEO purchase-only index by the CPI and normalized the resulting real home price index to equal 100 on average in 2000. This index is shown in Figure 2, along with a similarly calculated series for real rents.[4] The movements of real home prices have been less unidirectional than their nominal counterparts, with a combination of relatively high inflation and relatively slow home price appreciation producing meaningful declines in real home prices in the late 1970s–early 1980s, and again in the late 1980s–early 1990s. On the whole, however, home prices have appreciated substantially in real terms since 1970. The same is true for real rents, although the increase was considerably smaller, and its pace was much more uniform.

There may be good reasons why home prices rise over time faster than inflation. Limited land availability (partly natural and partly induced by zoning regulations) and relatively slow technological progress in construction increase the cost of producing residences compared to that of many goods and services. Demand factors may also play a role, since a modern home with various amenities may well be considered a luxury good (even though a simple shelter is a basic necessity), and the prices of luxuries tend to rise with income. At the same time, the fact that the price of owning a home has deviated so much from the price of renting one, even though the two are reasonably close substitutes in terms of the services they provide to the tenants, suggests that some of the increase may have been unwarranted by the fundamentals. Indeed, there is now a broad agreement that the price run-up in the early 2000s represented a bubble, which has now burst. But there is still a question of how far home prices are out of equilibrium and how much further they are likely to fall.

The economic literature has not been very successful in identifying the determinants of home prices. We follow two approaches to estimate the extent of overvaluation. In the first we link home prices to such supply and demand fundamentals as construction costs, household size, disposable income, interest rate, and the unemployment rate, despite the reservation expressed by some authors as to whether these variables cointegrate (Gallin, 2006). In the second, we focus on the relationship between home prices and rents, which might be considered a summary statistics for relevant fundamentals given the close substitutability between owned and rental housing over the medium term.

Fundamentals model

Our choice of fundamentals follows that of Kaufmann and Mühleisen (2003), who estimate the supply and demand equations for existing homes using annual regional data. They posit that housing supply is affected by real construction costs and the average household size, the latter variable "reflecting a relative supply shrinkage caused by an aging population." The demand curve is shifted by changes in the real disposable income per capita, the

[4] The measure of rent is the owner's equivalent rent from the CPI, which reflects the cost of renting properties similar to those belonging to owner-occupiers and thus makes a comparison with the OFHEO index more meaningful. For the pre-1983 period, where this measure it is not available, it is spliced with the rent of primary residence or with the shelter component of the CPI.

unemployment rate, and the real interest rate on mortgages.[5] The quantity and price variables are the number of sales and the median sale price for an existing home (deflated with CPI), respectively. All variables, except for the interest rate, enter the equations in logs. The model was estimated by three-stage least squares on annual data from 1976 to 2002 for four Census regions.[6] It included regional dummies and treated all variables other than the price and the number of sales as exogenous.

We replicate this methodology on an updated dataset, replacing the median sales price, which is not quality-adjusted and is affected by the mix of homes sold in a given period, with our preferred price measure—the OFHEO purchase-only index. We initially keep the estimation period to the original sample, so that the bubble years would not pull our estimate of equilibrium prices up.

The results are shown in Table 1. As expected, smaller household size and larger real disposable income per capita are estimated to push up real home prices. Higher interest rates and unemployment rate appear to suppress housing demand, although the effect is not statistically significant. The coefficients on construction cost in the supply equation and on housing turnover in the demand equation have the wrong sign, but neither is statistically significant. The positive sign on sales in the demand equation could probably be rationalized by noting that higher turnover may lead to an expectation of future price increases, which would push up the current price.

Solving out the system, we can derive the equilibrium home price as a function of exogenous variables. Figure 3 shows the results for the four regions. As one can see, real home prices started climbing sharply in every region in the late 1990s and soon overshot their equilibrium values. The extent of overvaluation has differed dramatically across regions, with the gap between the average home price in 2007 and its fundamental value ranging from 5 percent in the Midwest region to 62 percent in the West.

At the national level, all model variables are available at quarterly frequency. The dashed line in Figure 4 presents results obtained by plugging quarterly national data into the equations.[7] We can observe that after stagnating in the early- to mid-1990s and falling increasingly below equilibrium, real home prices took off in 1997 and caught up with the equilibrium in 2001. Then, rather than slowing down, they actually accelerated, overshooting the equilibrium by a much larger margin than seen at any earlier point in the sample. Despite a

[5] Kaufmann and Mühleisen use a 30-year fixed rate mortgage rate from Freddie Mac, deflated with a year-on-year CPI inflation.

[6] The Census regions are Midwest, Northeast, South, and West. Due to data limitations, construction costs (proxied by the residential investment deflator in the national accounts), household size, and the mortgage rate are assumed to be the same across regions and are taken from national data. The same is true for the CPI, which is used to deflate nominal variables.

[7] Since constant terms differ across regions, the constants for the national equations were obtained by averaging regional constants using OFHEO weights.

subsequent 7 percent decline, the real home price was still 11 percent above equilibrium in the first quarter of 2008. This is a large number, which implies that the housing adjustment has a long way to go. At the same time, this model suggests that real home prices were undervalued when they started growing in the late 1990s, and that the equilibrium price has increased since then as well, mostly due to growth in real disposable income and declines in the interest rate and the unemployment rate. Hence, on the basis of this model, one would believe that real home prices would only have to fall by about a third of the 38 percent gap between their current and the mid-1990s levels to reach equilibrium.

One could take a few issues with the above methodology. With households being both the sellers and the buyers of existing homes, it is not obvious that the turnover is the right quantity variable in the supply and demand equations. In addition, while all the other variables in the system are invariant to scale, housing sales should be twice as high in a region twice as big, other things being equal. The inclusion of regional dummies addresses the issue imperfectly if the relative size of the regions changes over time. Another objection one could raise is that a smaller household size should arguably lead to greater demand for housing rather than tighter supply.

Since we are ultimately interested in the assessment of home prices, one way to obviate the above issues is to regress the home price directly on the fundamentals, without trying to identify supply and demand equations separately. The results of this estimation are presented in the first column of Table 2. All coefficients have the expected signs, and most are statistically significant. The equilibrium home price obtained in this approach tracks the actual price somewhat closer (the black line in Figure 4; regional graphs are available upon request), putting an estimate of current overvaluation at 9 percent. Some of that may be due to a large coefficient on construction cost. To the extent that home prices are used to estimate construction costs, endogeneity may be a problem. Re-estimating the relationship with construction cost excluded (Table 2, second column), which probably overcorrects the problem, produces a larger estimate of overvaluation in the recent period (the gray line in Figure 4).

A significant downside of this approach is that the system is quite sensitive to the end point of the sample period, which is not surprising given the run-up in prices in the mid-2000s without a commensurate improvement in the fundamentals. Figure 5 shows predicted price levels based on estimation periods ending in different years of the current decade. The estimate of the current gap becomes smaller, the closer to the present day we extend the sample. As argued above, 2002 reasonably qualifies as a pre-bubble year, so we are comfortable with that end-point. At the same time, there is clearly some arbitrariness in this decision. Given the sensitivity of the results to the sample choice, we apply an alternative and, in the end, more robust approach below.

As a final sensitivity check on the supply and demand model, we probe the assumption that the coefficients other than constant terms are the same across regions. Conceivably, the fact that home prices grew so much more in the Northeast and the West over the latest boom could reflect limited land availability in these two regions. Limits on new construction would make prices move more compared to less land-constrained regions in response to an increase

in demand, whether the latter is driven by fundamentals or not. Indeed, real estate analysts often divide U.S. states into those whose home prices are more and less cyclical.

To test the hypothesis that home price response to changes in the fundamentals could be different in the Northeast and the West than in the South and the Midwest, we estimate a single equation without construction cost which includes a dummy for the two land-constrained regions interacted with the fundamentals. As we can see (Table 3), the response to changes in the household size, personal disposable income, real interest rate and the unemployment rate is stronger in the land-constrained regions. The difference in price elasticity with respect to household size is highly statistically significant, and the hypothesis that all coefficients are the same across regions is strongly rejected. Allowing the coefficients to vary produces more uniform estimates of recent overvaluation. By this assessment, the Midwest was still closest to equilibrium in 2007, but even there prices were 18 percent too high, while in the other three regions the gap between actual and equilibrium prices ranged between 30 and 40 percent (Figure 6).

Asset price approach

Given that housing combines aspects of a durable consumption good with those of an investment asset, an asset market perspective may provide a useful alternative approach to evaluating house prices. Renting is an obvious alternative to home ownership, yielding a similar flow of housing services to a family. From a financial point of view, rent is the price to pay for that flow, or an opportunity cost of living in one's home rather than renting it out. The price-to-rent ratio should equalize the costs and benefits of home ownership and renting and should depend on the interest rate, depreciation rate of housing assets, the expected growth of home prices and rents, and the intangible benefits of homeownership. Hence, over time, one can expect a broadly stable relationship between real home prices, real rents, and real interest rates.

At the same time, one should not be surprised to see large and persistent swings in the price-rent ratio. Such swings are prevalent in all asset markets, but the extent and duration of deviations from the fundamental value may be particularly large in the housing market, which has lower liquidity and larger information asymmetries than, say, the stock market.

Statistical tests indicate the existence of a cointegrating relationship between the log of real home prices, the log of real rents, and the real interest rate. According to the Augmented Dickey-Fuller test, on the sample from 1972Q1 through 2008Q1, the real home price,[8] the real rent, and the real interest rate are all integrated of order one. Johansen's trace test and maximum eigenvalue test both indicate the existence of one cointegrating equation between these variables at the 10 percent level.[9]

[8] While the Freddie Mac purchase-only series is supposed to be seasonally adjusted, the graph in Figure 2 reveals some apparent residual seasonality in the early 1970s, which we remove before estimation.

[9] These pre-test results are available upon request.

We estimate the cointegrating vector using dynamic OLS (Stock and Watson, 1993). As Figure 7 and the first two columns of Table 4 demonstrate, the estimates are fairly sensitive to the estimation period. To improve robustness, we impose a coefficient of one on the log of rents, which is reasonably close to the values obtained on different samples, in line with asset-market model predictions. With this assumption, the results are much less sensitive to the sample (Figure 8 and Table 4, columns 3 and 4). The coefficient on interest rates is negative and highly statistically significant. As one would expect from theory, higher real mortgage rates increase the cost of homeownership (or decrease the present discounted value of rents or utility from living in a house) and push the price-to-rent ratio down.

Of course, a cointegrating relationship between home prices and rents does not tell us which is driving which. Indeed, both rents and prices should be driven by the same fundamental factors affecting demand for housing (population and income growth) and its supply (land availability, zoning restrictions, construction costs). However, as we have seen, rents are much less volatile than house prices. Hence, it is reasonable to assume that rents are close to the equilibrium value and take them as a summary statistics of fundamental forces driving housing prices. We can, therefore, consider the residual in a regression of the price-to-rent ratio on the interest rates to be a measure of home price misalignment with fundamentals. As above, we put more trust in the estimates obtained on pre-bubble years and hence use the regression results from the 1972Q1–2002Q4 period, but as we have noted, our preferred specification is quite robust to the choice of the sample period.

Figure 9 presents the equilibrium home price calculated on the basis of the rents and real mortgage rates along with a 95 percent confidence band around it indicating parameter uncertainty.[10] The trend in the equilibrium price level is broadly similar to that obtained in the two-equation framework. The point estimate of overvaluation in the first quarter of 2008 is 14 percent. Varying the equilibrium price by two standard deviations in each direction, we obtain a range of overvaluation estimates from 11 to 17 percent. As can be seen from Figure 10, the gradual increase in real rents largely accounts for trend real appreciation of home prices, while fluctuations in the interest rates are responsible for short- to medium-term variability, including the most recent dip and recovery. At the same time, real interest rates have declined substantially in the last ten years. Discounting their effect and focusing exclusively on the price-to-rent ratio would result in an overly large estimate of current degree of disequilibrium.

Overall, the results using different methods of estimating equilibrium home prices are reasonably close and tell a consistent story. In particular, regardless of the measure of equilibrium prices, real estate appears undervalued in the mid-1990s, before the start of the period of robust appreciation; prices had never been so far out of line with the fundamentals

[10] The confidence band is based on the variance-covariance matrix of the estimates of the constant term and the coefficient on the interest rate in our preferred specification. It does not reflect the uncertainty associated with the choice of the coefficient on rents, the model, and the estimated period. The true range of uncertainty about the equilibrium level of home prices is definitely much wider than indicated by the confidence band.

as in the mid-2000s; and, despite the recent declines, home prices exceeded equilibrium values by 8 to 20 percent in the first quarter of 2008.

III. SHORT-RUN DYNAMICS

With considerable deviations from equilibrium persisting for long periods of time, the equilibrium price level does not appear to have much anchoring power for the actual home prices in the short run. Indeed, we have not been able to identify a stable, statistically-significant error-correction relationship in which home prices respond to the long-term gap identified by the cointegrating equation estimated in the previous section. As Table 5 shows, the gap between actual and equilibrium prices does not appear to be a significant determinant of quarterly home price growth. The coefficient on the gap is not statistically significant and implies a half-life of several decades in regressions estimated on different time periods with various measures of the gap identified in the previous section, regardless of whether other plausible drivers of short-term price dynamics included. Indeed, in certain specifications it has the wrong sign. The one exception is the regression that includes the measure of price gap identified by the supply and demand model and estimated on the period from 1972 through 2002 (column 7). However, as the next two columns demonstrate, altering the time period or adding the inventory-sales ratio, which as we argue below is an important factor affecting house price movements in the short run, renders the coefficient insignificant. Attempts to estimate both the short- and the long-term dynamics of home prices in one equation using an error-correction framework have also been unsuccessful.

The most important determinant of house price dynamics in the short run is the inventory-to-sales ratio where data is available since 1982.[11] The sharp increase in that ratio since the mid-2000s, driven by both falling turnover and a rising number of homes for sale (Figure 11), has reflected a growing imbalance between demand and supply and put a downward pressure on home prices. As Table 6 (column 1) demonstrates, a 20-percent increase in the ratio would accelerate the quarterly rate of home price decline by a quarter percentage point in the next quarter. Foreclosures, which have spiked recently and feature prominently in the current political discourse, not only add to inventories, but also exert additional downward pressure on prices.[12] Finally, home price dynamics shows some persistence, with the coefficient of 0.43 on the lagged dependent variable.

The gap between actual and equilibrium home prices appears to matter only through its medium-term impact on the inventory-to-sales ratio. This ratio moves higher, the bigger is the gap identified in the cointegrating relationship (Table 7, column 1). However, the short-

[11] Sales and inventories of existing single family homes for sales are reported by the National Association of Realtors.

[12] Foreclosure starts as a percentage of the total number of outstanding mortgages, as reported by the Mortgage Bankers Association, were entered in the equation with an additional lag, as it takes time both for foreclosure process to run its course and add to inventory, and for the information about, say, rising foreclosures to affect market sentiment and lending standards. Regressions with a first lag of foreclosure starts produce very similar results.

run elasticity of that ratio to the price gap is relatively small (0.22), while the coefficient on the lagged dependent variable is very large (0.92). This high degree of persistence explains why it is difficult to discern the anchoring influence of the gap on house prices directly in an error-correction framework.

Given the fact that the inventory-sales series is relatively short, and believing that capturing current cycle dynamics is essential for short-term forecasting, we ran the above regressions on the sample extending through 2008Q1. To check the robustness of the results, we have varied the end point of the sample. As can be seen from columns 2 and 3 of Tables 6 and 7, the general contours of the story remain intact—in particular, the coefficients on lagged dependent variables and on the inventory-to-sales ratio remain large and the coefficient on the price gap stays small, although the magnitudes of the coefficients do change with the sample. Linking the two equations in a seemingly unrelated regression does not make much of a difference (last columns of the two Tables).

Figures 12 and 13 demonstrate the results of simulating the model of house price changes defined by equations in Tables 6 and 7 (last columns) two years forward under the assumptions that the equilibrium real price stays at its 2008Q1 levels, and foreclosure rates linger until the end of this year at their current elevated levels and then gradually start coming down but remain well above historic norms.[13][14] Over that horizon the rapid decline of home prices is expected to continue, with the pace of depreciation first accelerating, and then gradually tapering off. Because of the inertia in the system, even after dropping below equilibrium in the first quarter of next year, prices would continue drifting downward as the inventory-to-sales ratio recovers only gradually. While the parameters of the system are not estimated very precisely, and hence uncertainty over the future trajectory of home prices is substantial, the potential for property values to swing well below equilibrium appears to be high.

IV. Is the United States Experiencing a Nationwide House Price Bust?

Home price growth has turned negative in the United States on virtually every national measure. This does not necessarily imply a countrywide bust, as the fall in the national measure could reflect very large drops in a few major areas, while the rest of the country might be relatively unaffected. To see whether this is the case we consider the evolution of home prices—using the OFHEO purchase-only index—in the nine Census divisions.

If we simply plot the growth rates of home prices across the divisions—as we do in Figures 14 and 15—we can observe an increased synchronicity in price movements from around 1990 on, particularly noticeable in the quarter-on-quarter growth rates.[15] This

[13] For convenience, in Figure 12 prices are normalized so that the equilibrium level equals 100 in 2008Q1.

[14] Foreclosure starts are assumed to go down from 1 percent per quarter in 2008Q4 to 0.65 percent in 2010Q2. The average level of foreclosure starts since 1972, when the series became available, is 0.3 percent.

[15] This is not the result of splicing—using the OFHEO all-transactions index for the whole period, the decline in dispersion is as visible.

impression is confirmed by calculating the standard deviation of home price inflation across divisions for each point in time—as Figure 16 clearly demonstrates, it tends to be smaller in the post-1990 period.

Focusing on the direction of price movements rather than their magnitude, we note that while until the beginning of the recent national price run-up it was not uncommon for regional home prices to head in different directions, from 1996 through 2005 they marched uniformly up in all nine divisions, as the diffusion indexes[16] in Figures 17 and 18 demonstrate. Over the space of two years, this broad-based growth has been replaced by an almost equally widespread decline, with home prices lower in 2008Q1 in all nine divisions than in the previous quarter, and in seven divisions lower than in the first quarter of 2007.[17] In real terms, year-on-year home price growth has been negative in all divisions since 2007Q4.

Hence, while there is no denying that housing markets remain significantly influenced by local conditions, and our own work demonstrates that the extent of home price run-up and overvaluation has differed considerably across regions this decade, we conclude that both the housing boom and the subsequent bust were nationwide phenomena. The reasons for the increased synchronization of regional housing cycles likely lie in the development of a national, market-based system of securitized mortgage finance (Schnure, 2005) stimulated by technological and financial innovation and regulatory changes. In the same vein, prices across the country were helped on the upswing by increasing recourse to non-traditional mortgages, while currently they are being pushed down by a nationwide tightening in lending standards.

V. CONCLUSION

In the last few years, home prices had risen to unsustainable levels and then started to decline. In this paper we use a variety of techniques to assess the current extent of overvaluation. We put the most stock in the estimate based on a cointegrating relationship between the price-rent ratio and the real interest rate, which is quite robust to the choice of the sample period. According to these estimates, home prices were undervalued in the 1990s, but overshot equilibrium in 2000 and remain overvalued despite recent declines. In our best judgment, single-family home prices as measured by the OFHEO purchase-only index were around 14 percent above equilibrium in the first quarter of 2008, with a plausible range of 8 to 20 percent.

We have also analyzed the dynamics of home prices and found the inventory-to-sales ratio to be the most important driver of changes in property values in the short run. Starts in foreclosures, which obviously add to inventory, seem to also exert additional downward pressure on prices. Home price dynamics is fairly inertial, with a coefficient of around 0.4 on

[16] The diffusion index equals the percentage of divisions in which home prices go up minus the percentage in which they go down.

[17] In April prices fell on year ago in all but one division, with East South Central eking out a 0.1 percent increase.

the lagged dependent variable in regressions for quarterly growth rates. However, we have failed to identify a direct, robust impact from the gap between actual and equilibrium house prices on short-term house price inflation.

The gap does exert long-term influence on the inventory-to-sales ratio, and through that it provides an anchoring role in long-term house price dynamics. However, the inventory-to-sales ratio is very persistent, and the influence of the gap is quite small, making it difficult to identify a direct effect of the gap on short-term price movements.

While we have examined the evolution of housing prices and their determinants over the past 40 years, our focus at the current juncture is on what these relationships forebode for the near future. We find that the bloated inventory-to-sales ratio, high foreclosure rates, and the large degree of inertia in housing markets imply that recent price declines are likely to continue. Moreover, with the gap between actual and equilibrium home prices playing only a weak anchoring role, the downward momentum could well take home prices considerably below equilibrium.

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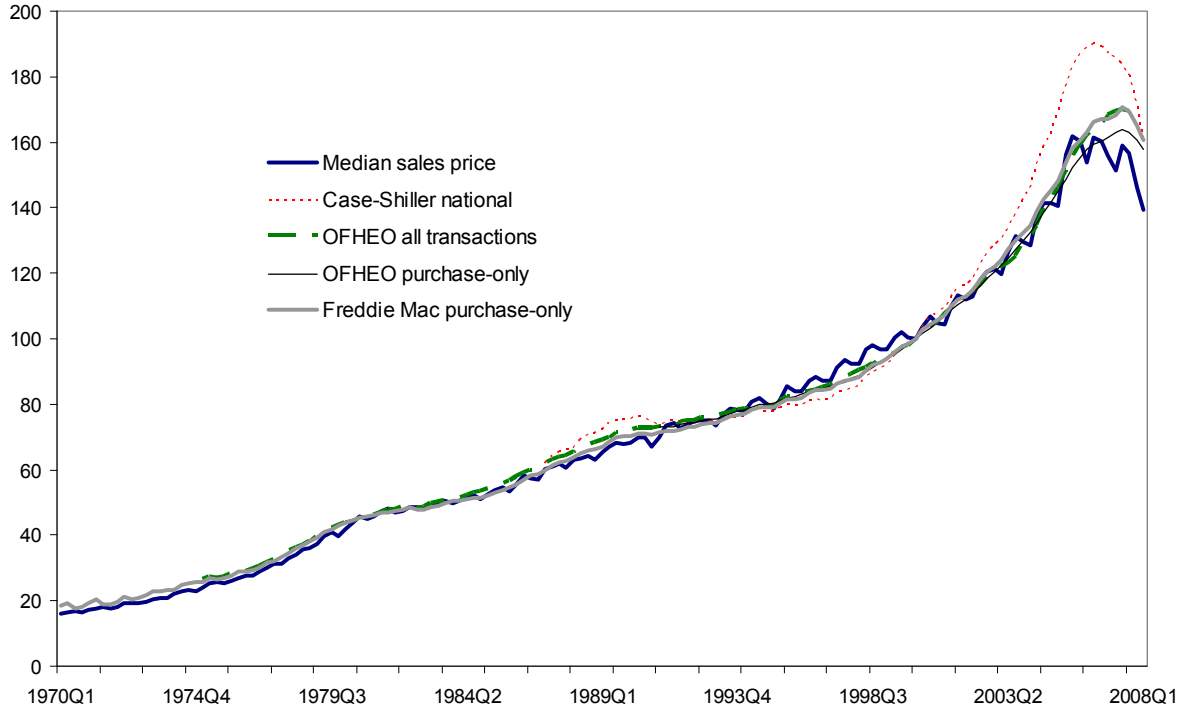
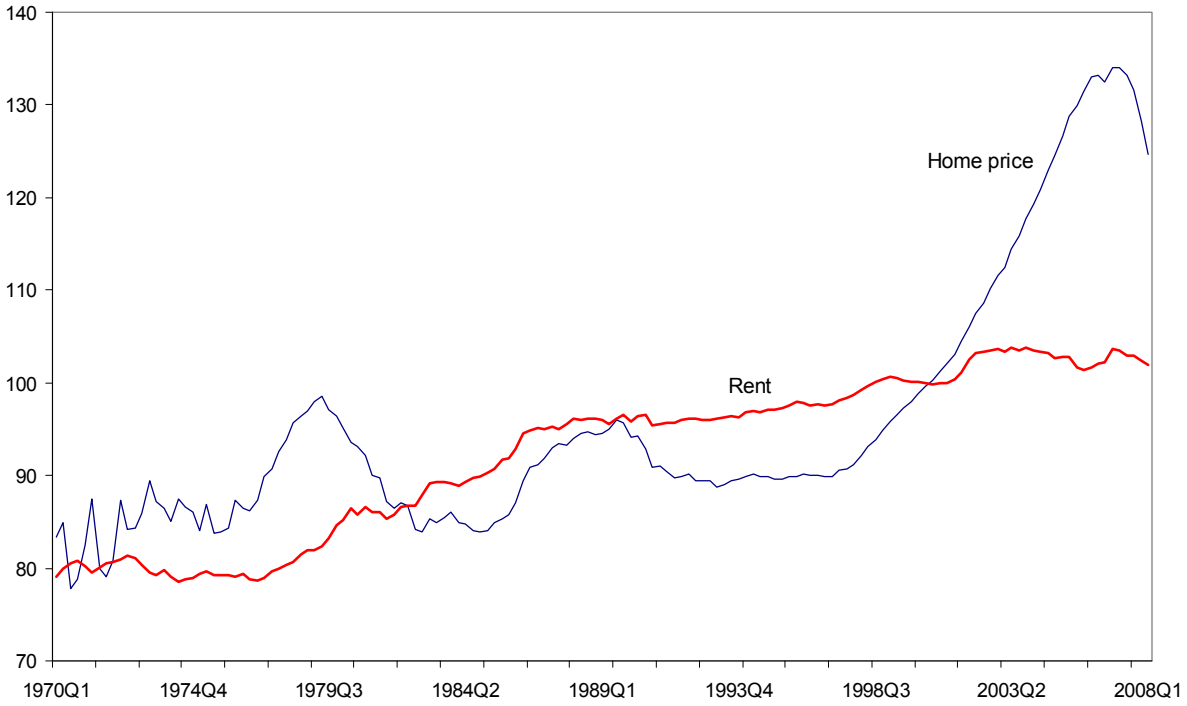
Figure 1. Price indices for existing single-family homes, 2000Q1=100



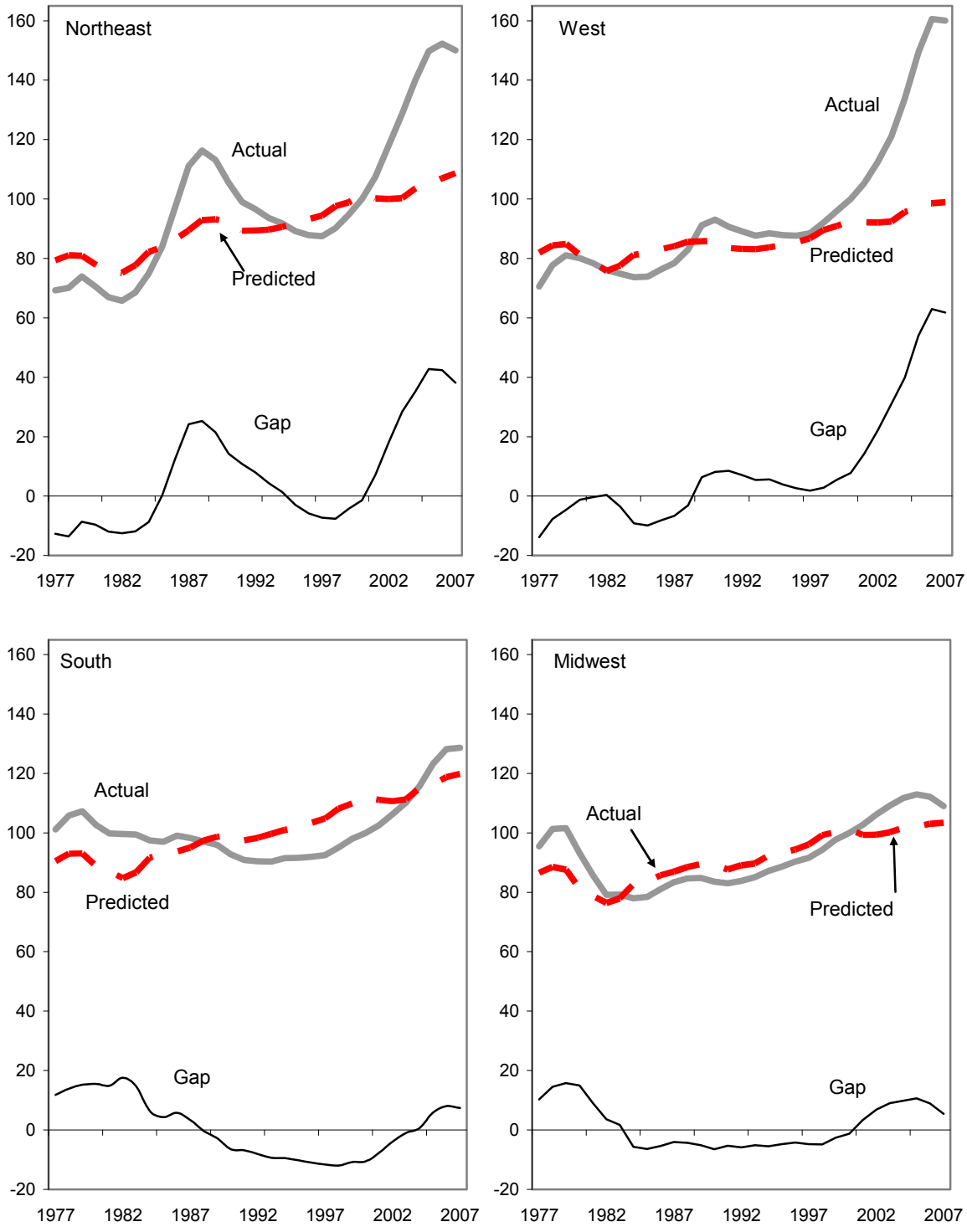
Source: Haver Analytics; and staff calculations.

Figure 2. Real home price and rent, 2000=100



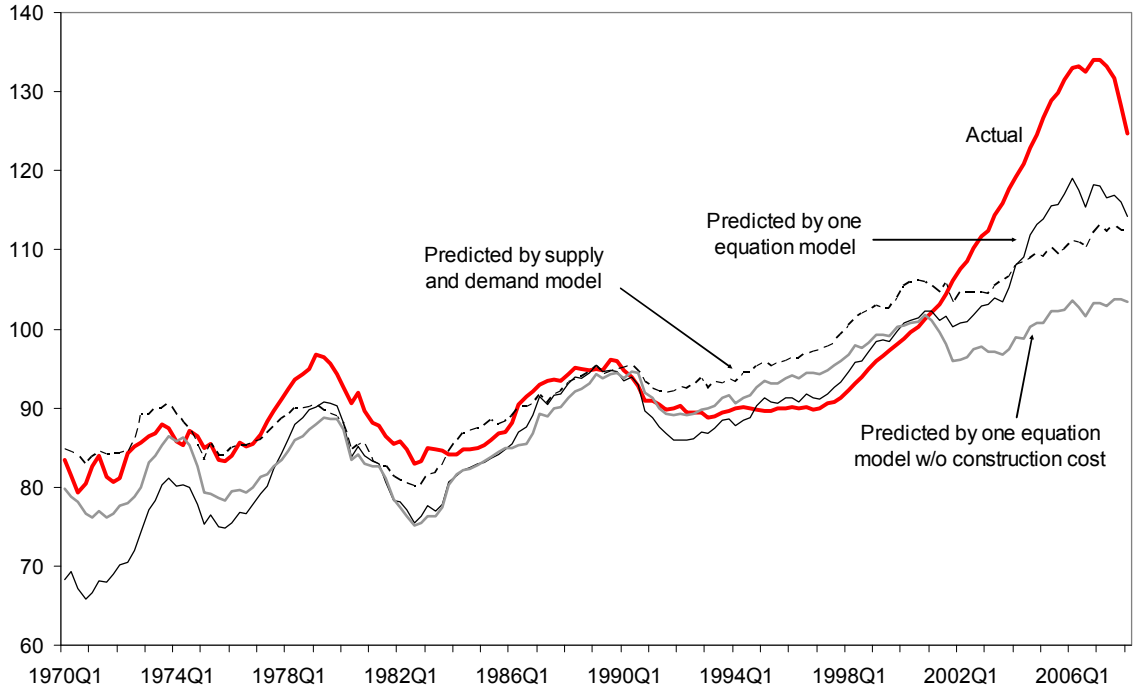
Sources: Haver Analytics; and staff calculations.

Figure 3. Actual and predicted real home prices by region. Supply-demand system.
Actual 2000 = 100



Sources: Haver Analytics; and staff calculations.

Figure 4. Real OFHEO purchase-only house price (index; 2000 = 100)
Fundamentals model



Sources: Haver Analytics; and staff calculations.

Figure 5. Predicted prices with different estimation end points.
Supply and demand system.

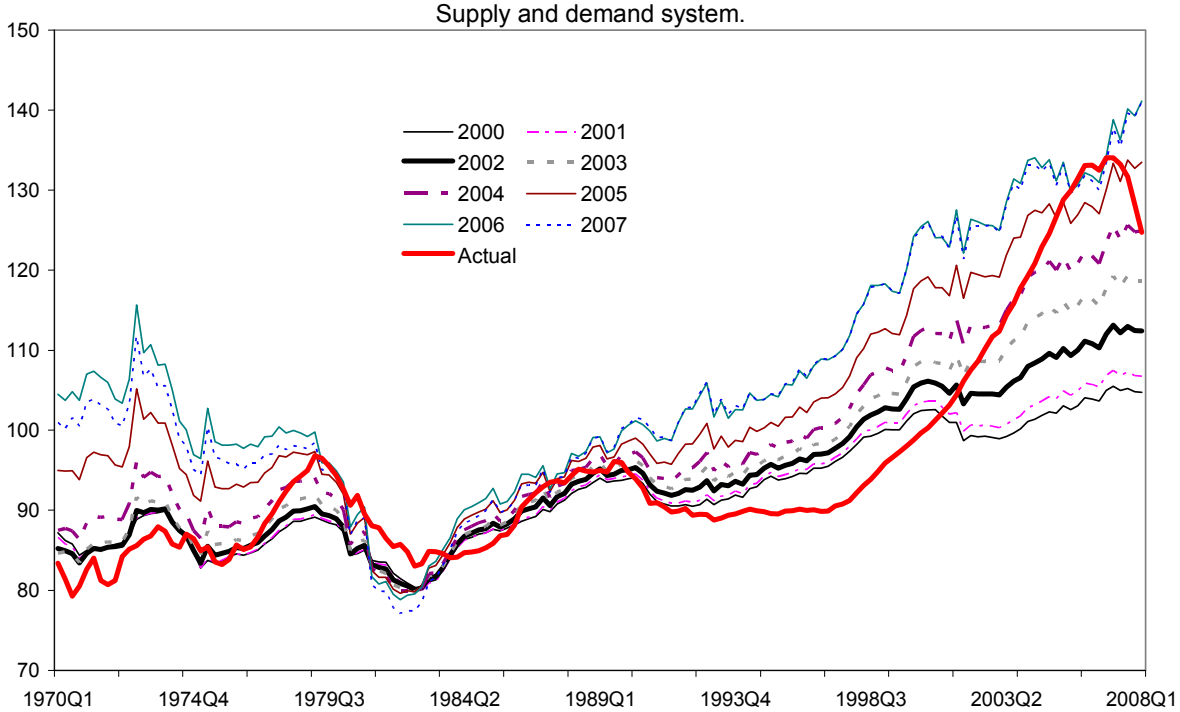
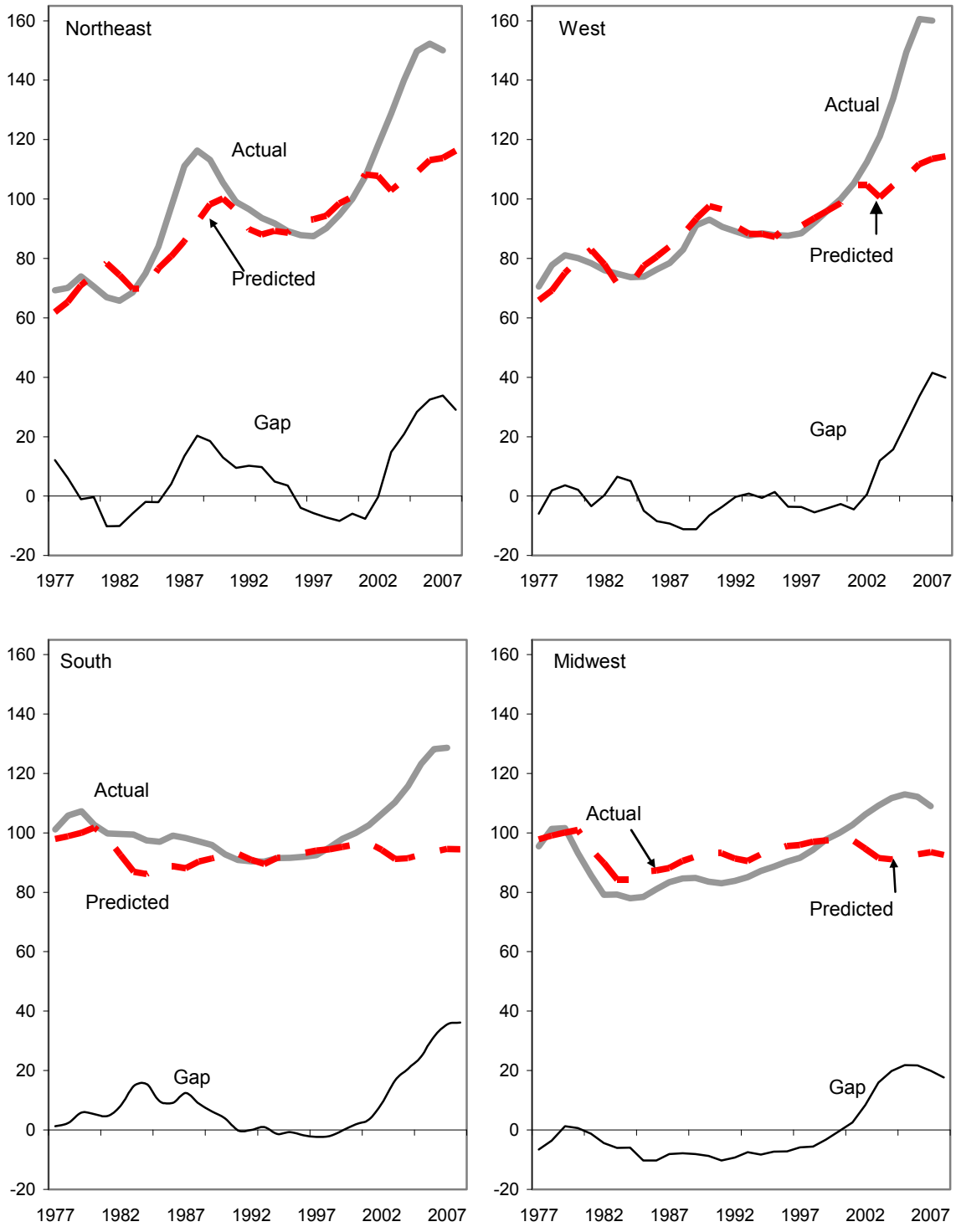


Figure 6. Actual and predicted real home prices by region.
Single equation without construction cost and with land-constraint dummy. Actual 2000 = 100



Sources: Haver Analytics; and staff calculations.

Figure 7. Real home prices - actual and estimated in a cointegrating relationship between home prices, rents, and interest rates. Estimation with different end points.

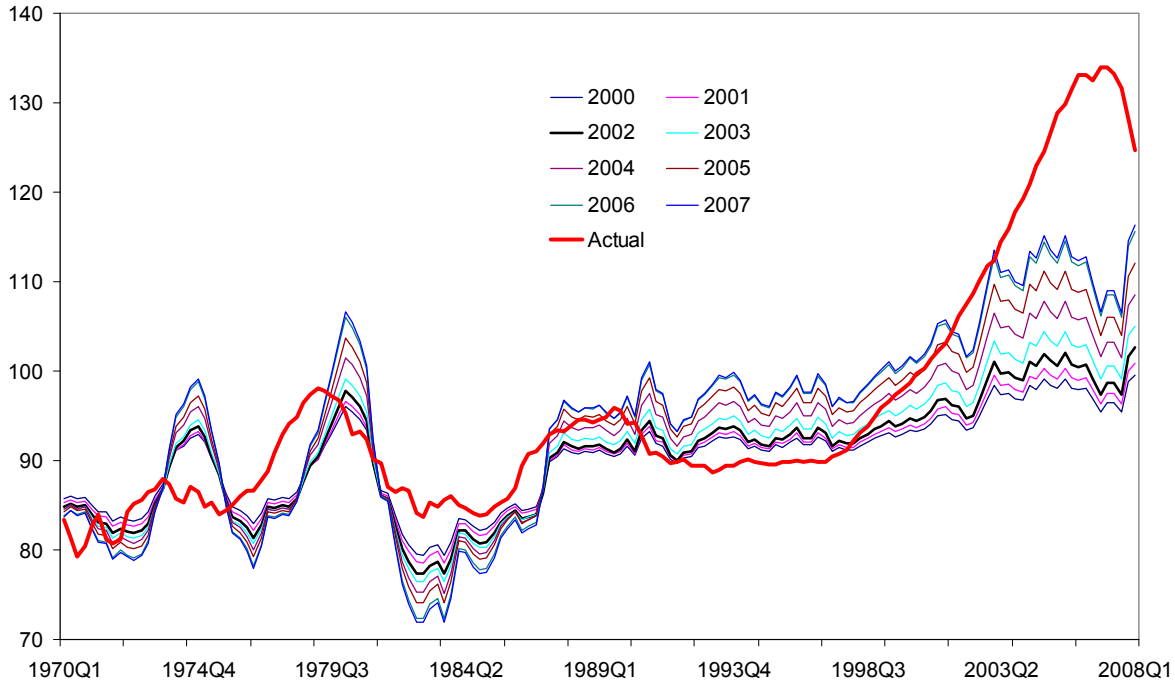


Figure 8. Real home prices - actual and estimated in a cointegrating relationship between home price-to-rent ratio and interest rates. Estimation with different end points.

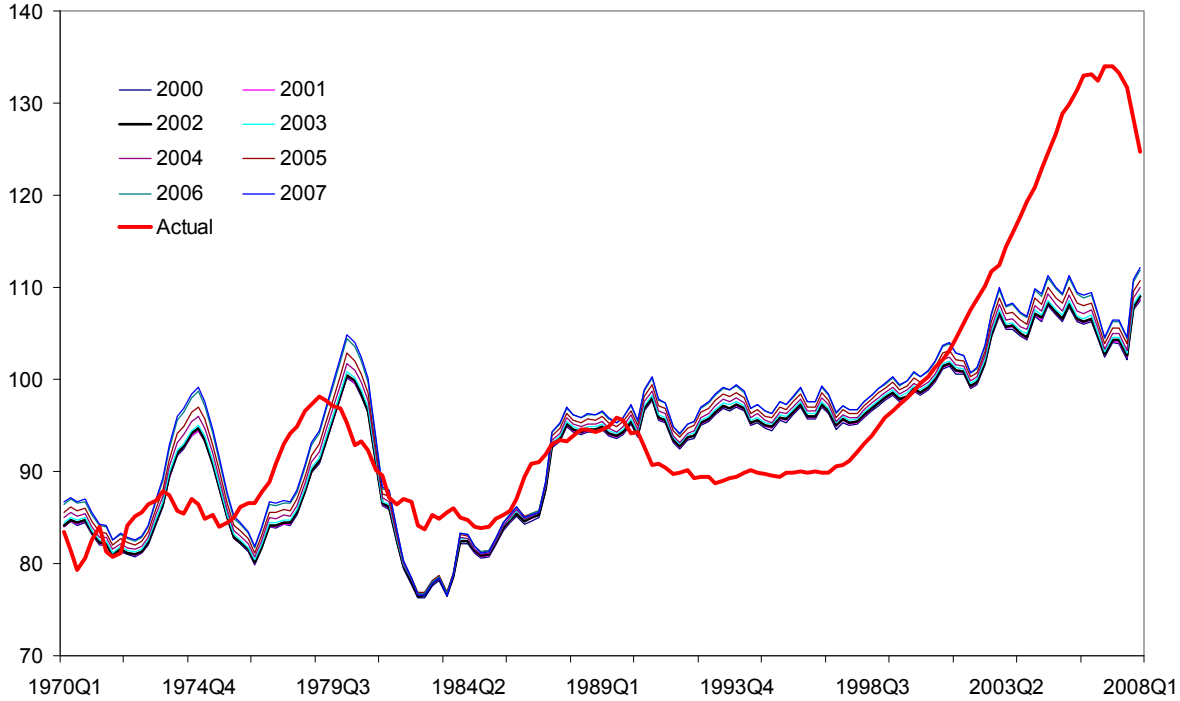
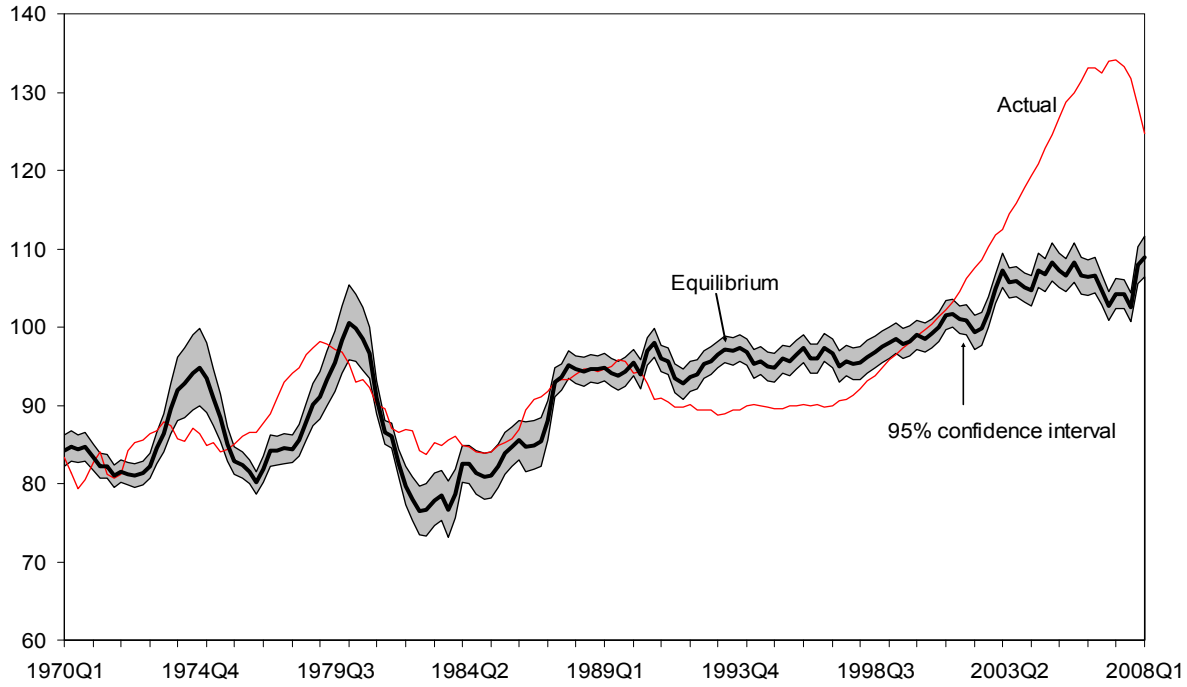
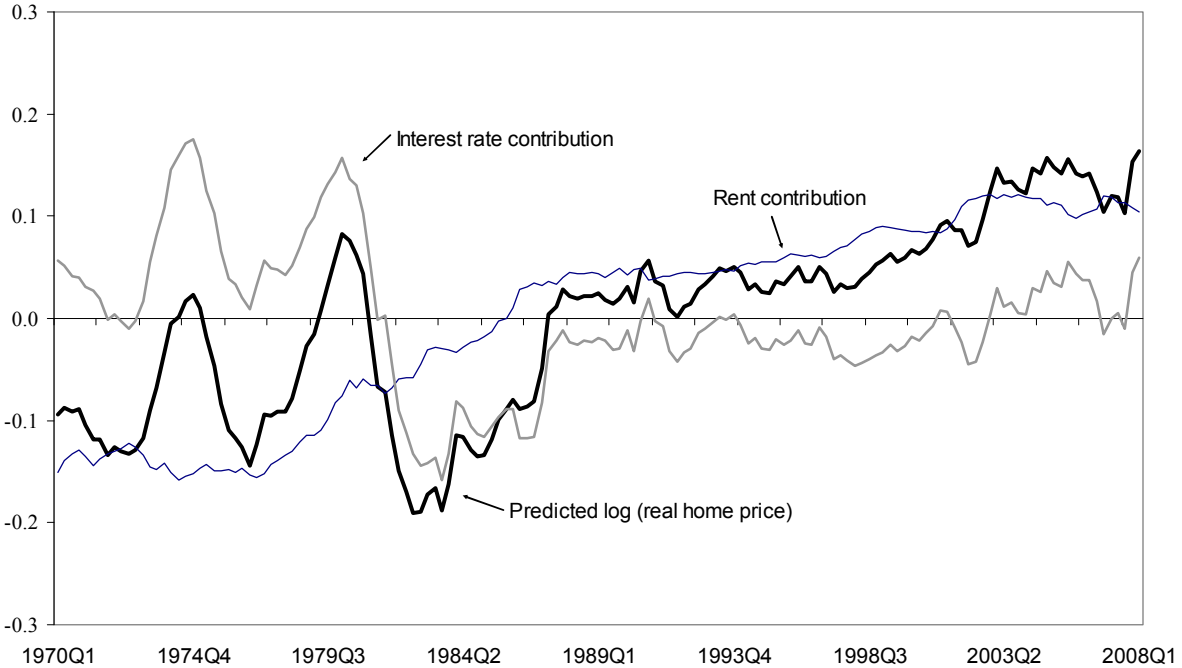


Figure 9. Real home price predicted by a cointegration model



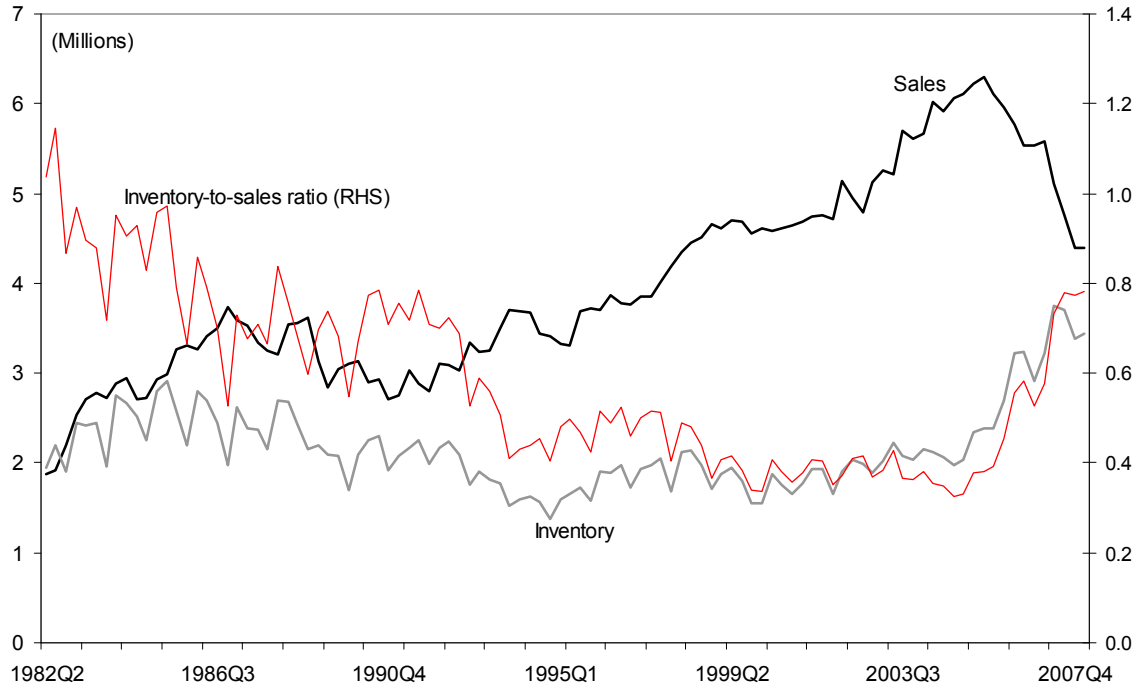
Sources: Haver Analytics; and staff calculations.

Figure 10. Predicted log real home price (cointegration method) and contributions
Differences from the mean



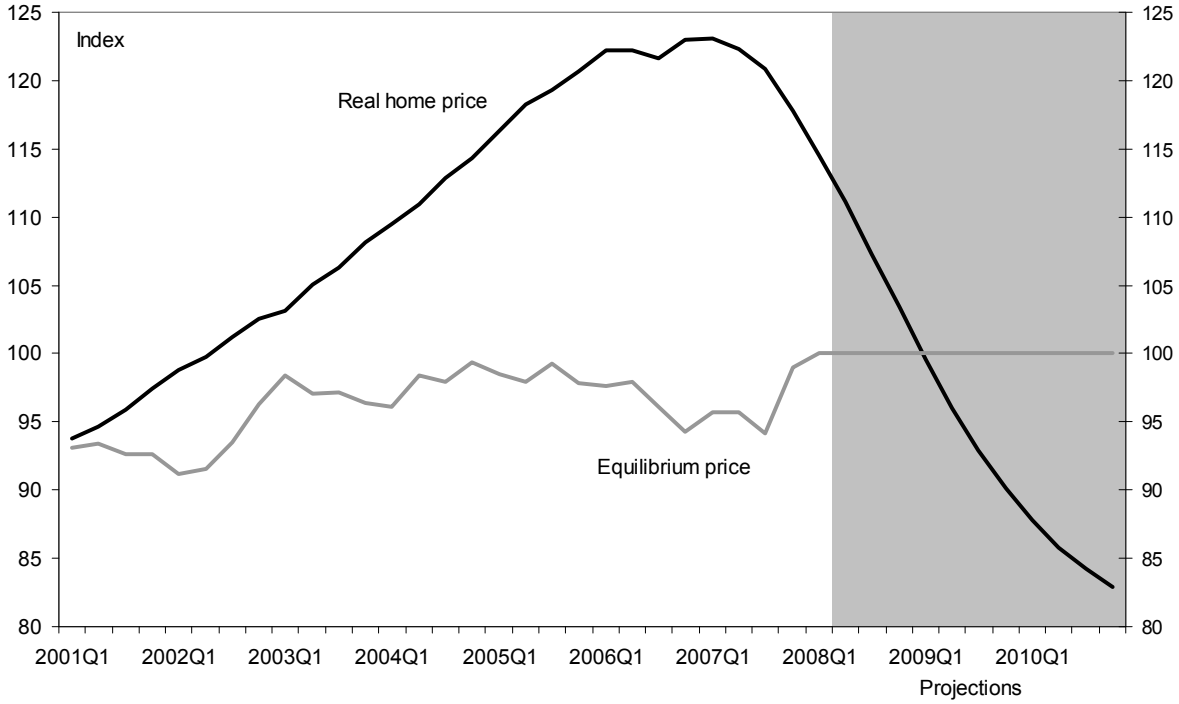
Sources: Haver Analytics; and staff calculations.

Figure 11. Sales and inventory for sale of existing single family homes.



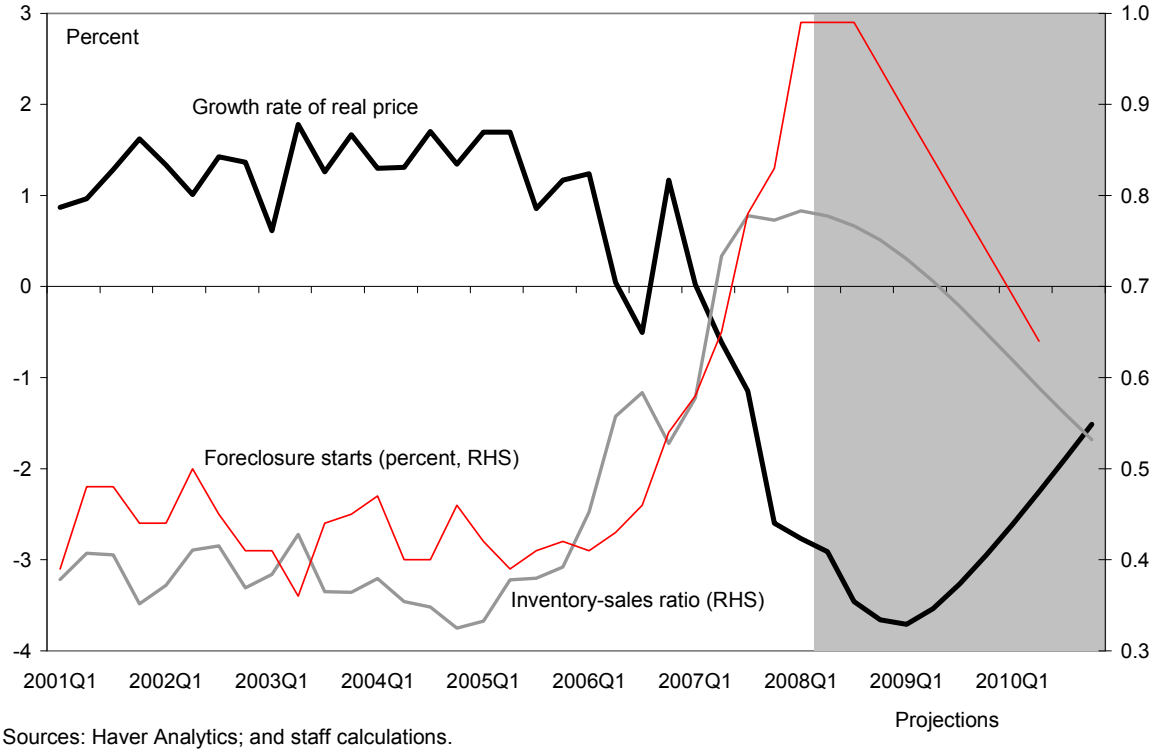
Sources: Haver Analytics; and staff calculations.

Figure 12. Simulation of real home price level



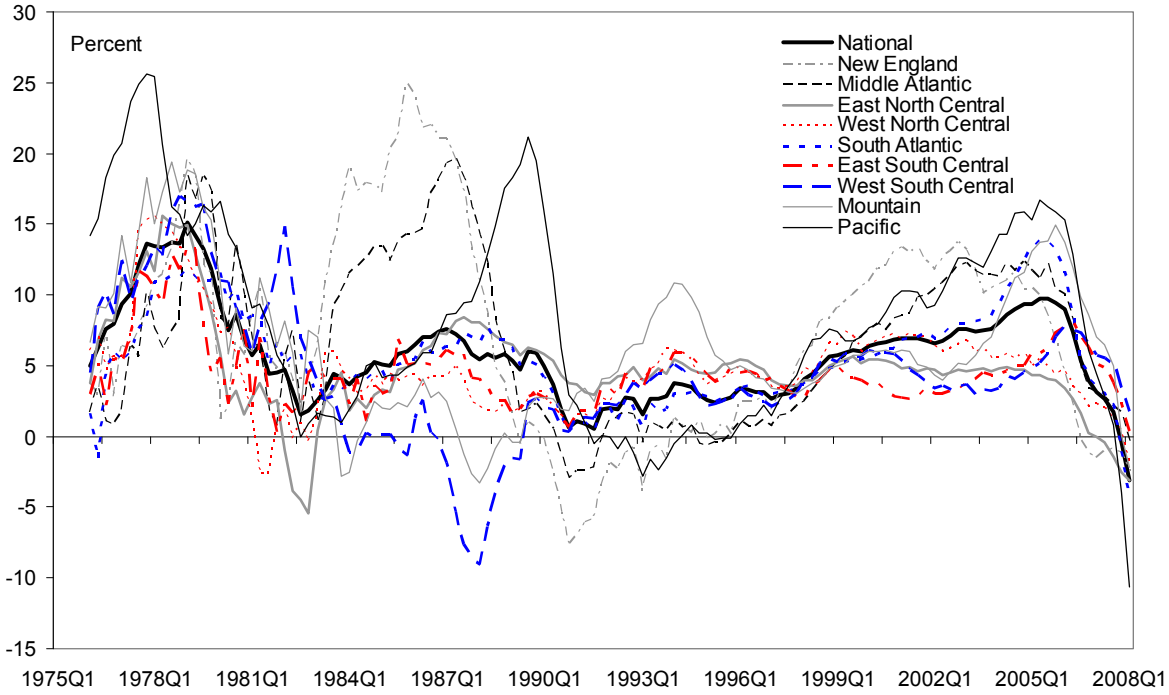
Sources: Haver Analytics; and staff calculations.

Figure 13. Simulation of real home price quarterly growth



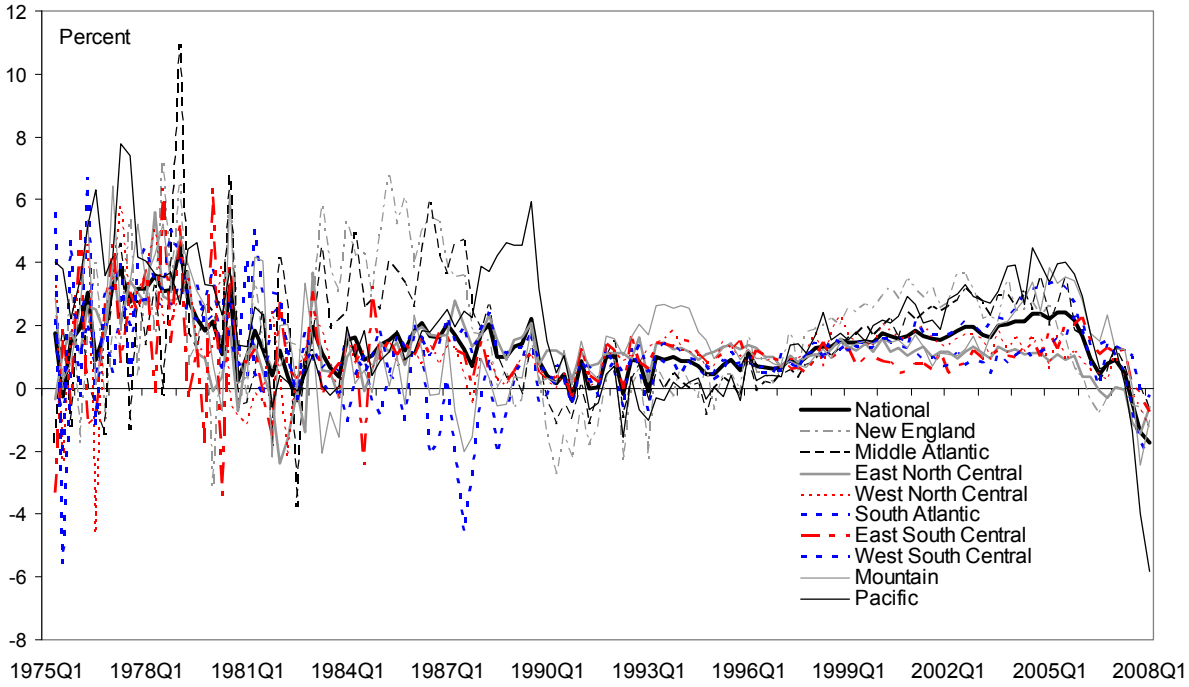
Sources: Haver Analytics; and staff calculations.

Figure 14. Year-on-year growth rates of home prices



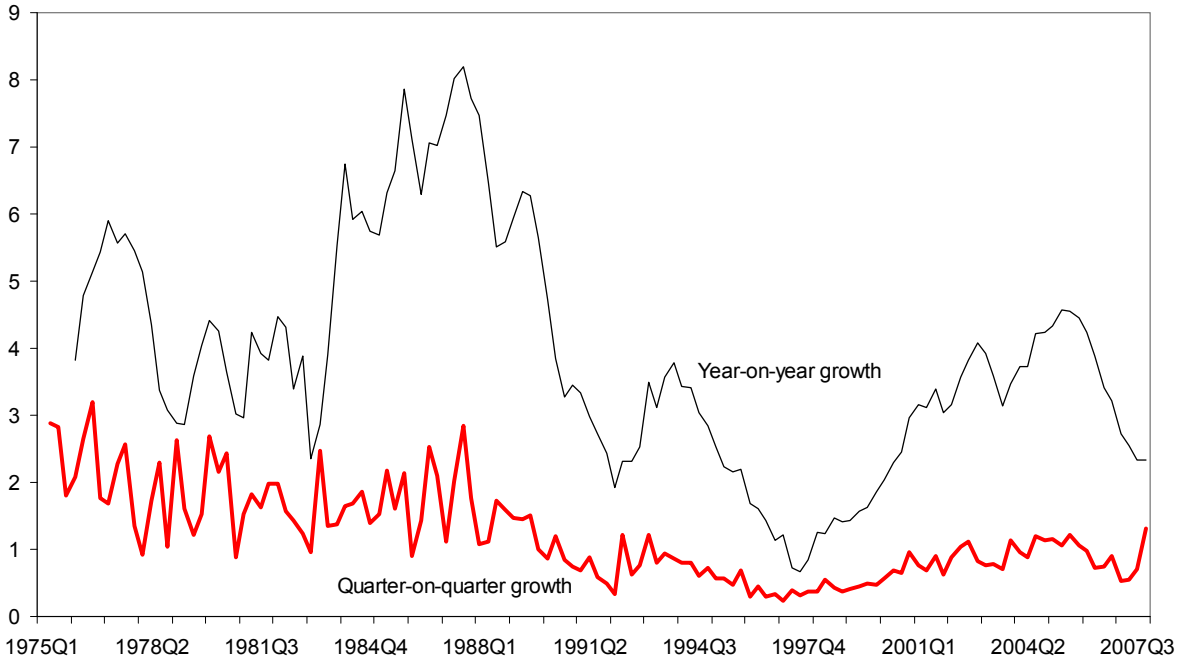
Sources: Haver Analytics; and staff calculations.

Figure 15. Quarter-on-quarter growth rates of home prices



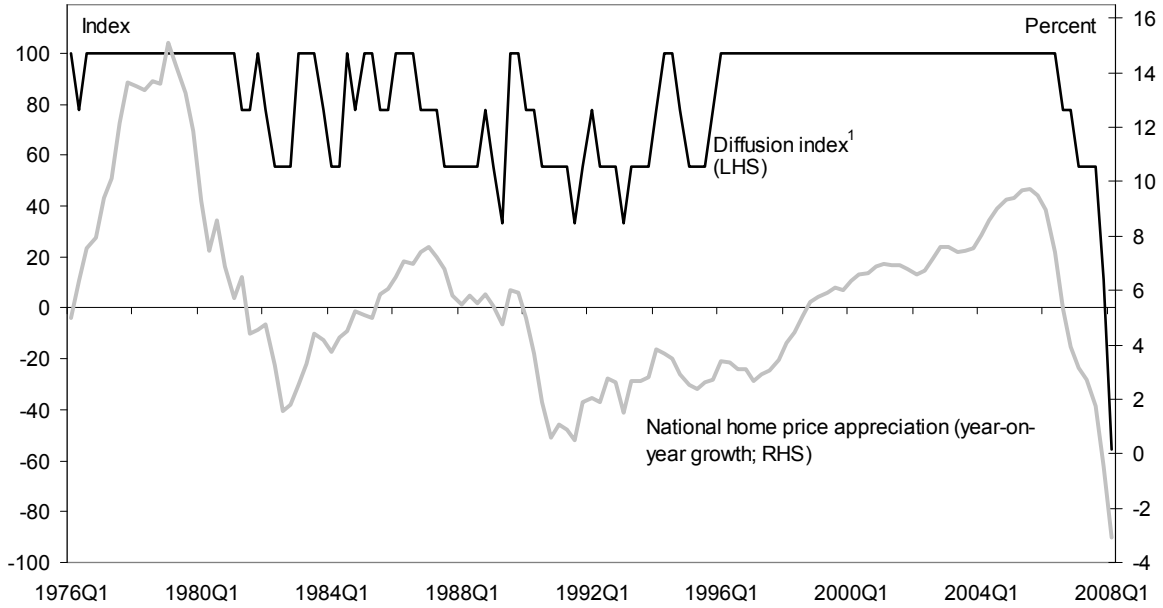
Sources: Haver Analytics; and staff calculations.

Figure 16. Standard deviation of home price growth rates across divisions



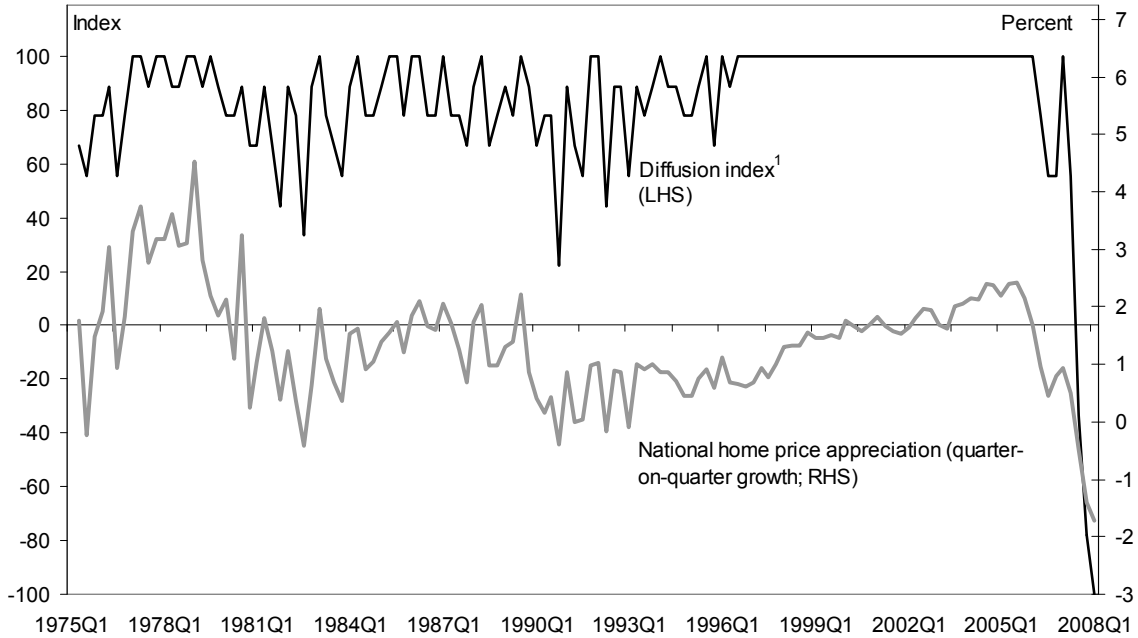
Sources: Haver Analytics; and staff calculations.

Figure 17. Diffusion index for year-on-year home price growth across Census divisions



1/ The index is the average indicator across divisions, with the indicator equal 100 if the price increased compared to a year earlier and -100 if it fell. The diffusion index equals 100 if prices go up in all divisions, and -100 if they drop in all divisions.
Sources: Haver Analytics; and staff calculations.

Figure 18. Diffusion index for quarter-on-quarter home price growth across Census divisions



1/ The index is the average indicator across divisions, with the indicator equal 100 if the price increased compared to a quarter earlier and -100 if it fell. The diffusion index equals 100 if prices go up in all divisions, and -100 if they drop in all divisions.
Sources: Haver Analytics; and staff calculations.

Table 1. Estimated supply and demand system for real home prices

	Coefficient	Standard error	z-statistic	Probability
Supply equation				
Number of homes sold	0.306	0.048	6.39	0.00
Real construction cost	-0.087	0.132	-0.66	0.51
Average household size	-0.840	0.256	-3.28	0.00
Midwest region	-0.134	0.026	-5.07	0.00
Northeast region	-0.135	0.026	-5.19	0.00
West region	-0.142	0.025	-5.57	0.00
Constant	4.525	0.723	6.26	0.00
Demand equation				
Number of homes sold	0.128	0.089	1.44	0.15
Real disposable income per capita	0.411	0.138	2.98	0.00
Real mortgage rate	-0.002	0.002	-0.76	0.45
Unemployment rate	-0.037	0.032	-1.18	0.24
Midwest region	-0.116	0.028	-4.16	0.00
Northeast region	-0.114	0.028	-4.10	0.00
West region	-0.162	0.027	-5.95	0.00
Constant	2.294	0.415	5.53	0.00

Dependent variable: OFHEO purchase-only price index for existing single-family homes deflated with CPI.
All variables except the real mortgage rate are in logs.
The system is estimated by three-stage least squares on annual regional data for 1976-2002.

Table 2. Estimated equations for real home prices as a function of fundamentals

Real construction cost	0.769 **	--
	(0.300)	--
Average household size	-0.804	-0.651
	(0.587)	(0.600)
Real disposable income per capita	0.471 **	0.266
	(0.22)	(0.205)
Real mortgage rate	-0.009 *	-0.009 *
	(0.005)	(0.005)
Unemployment rate	-0.093	-0.139 **
	(0.065)	(0.064)
Midwest region	-0.101 ***	-0.098 ***
	(0.026)	(0.027)
Northeast region	-0.100 ***	-0.100 ***
	(0.026)	(0.027)
West region	-0.161 ***	-0.145 ***
	(0.031)	(0.031)
Constant	-0.032	4.356 ***
	(2.241)	(1.487)

Dependent variable: OFHEO purchase-only price index for existing single-family homes deflated with CPI.
All variables except the real mortgage rate are in logs.
The system is estimated by ordinary least squares on annual regional data for 1976-2002.
Standard errors are in parentheses.
One, two, or three stars indicate statistical significance at the 10, 5, and 1 percent level, respectively.

Table 3. Home price as a function of fundamentals with land-constraint dummy.

	Coefficient	Standard error	t-statistic	Probability
Constant	4.737	1.968	2.41	0.02
Land-constraint dummy	1.262	2.358	0.54	0.59
Average household size	0.412	0.721	0.57	0.57
interacted with land dummy	-2.890	0.956	-3.02	0.00
Real disposable income per capita	-0.075	0.276	-0.27	0.79
interacted with land dummy	0.379	0.324	1.17	0.25
Real mortgage rate	-0.007	0.006	-1.17	0.24
interacted with land dummy	-0.006	0.008	-0.68	0.50
Unemployment rate	-0.138	0.085	-1.62	0.11
interacted with land dummy	-0.041	0.106	-0.38	0.70

Dependent variable - OFHEO purchase-only price index for existing single-family homes deflated with CPI.
All variables except the real mortgage rate are in logs.
Land-constraint dummy equals one for Northeast and West, zero for Midwest and South.
The equation is estimated by ordinary least squares on annual regional data for 1976-2002.

The F-statistic for the test that all interaction coefficients equal zero is 21.8 (significant at 1 percent level).

Table 4. Cointegrating relationship between real house prices, rents, and interest rates

	1	2	3	4
Dependent variable	Real price	Real price	Price-rent ratio	Price-rent ratio
Estimation period	72Q1:02Q4	72Q1:08Q1	72Q1:02Q4	72Q1:08Q1
Regressors				
Constant	1.269	-1.0621	0.1154	0.1518
	(0.496)	(0.903)	(0.018)	(0.024)
Log of real rent	0.736	1.2734	- -	- -
	(0.113)	(0.208)		
Real interest rate	-0.024	-0.0403	-0.0281	-0.0321
	(0.004)	(0.008)	(0.004)	(0.004)

Dynamic OLS estimation. The equations included four leads and lages of changes in the regressors.
Newey-West standard errors in parentheses.

Table 5. Home price appreciation and price gap.

	1	2	3	4	5
Estimation period	72Q1:08Q1	72Q1:02Q4	82Q3:08Q1	82Q3:08Q1	72Q1:07Q4
Gap measure[1]	C-R 2002	C-R 2002	C-R 2002	C-R 2002	C-P 2007
Constant	0.0014 *	0.0016 *	0.0014 *	-0.0021	0.0015 *
	(0.0008)	(0.0009)	(0.0008)	(0.0021)	(0.0008)
Lagged dependent variable	0.5389 ***	0.4147 ***	0.6433 ***	0.5257 ***	0.4985 ***
	(0.0984)	(0.0786)	(0.1292)	(0.1601)	(0.0857)
Gap	-0.0037	0.0162	-0.0108	-0.0089	0.0021
	(0.0136)	(0.0152)	(0.0116)	(0.0121)	(0.0116)
Lagged log of inventory-sales ratio				-0.0067 **	
				(0.0033)	
	6	7	8	9	
Estimation period	82Q3:08Q1	72Q1:02Q4	72Q1:07Q4	82Q3:02Q4	
Gap measure[1]	C-P 2007	S-D 2002	S-D 2002	S-D 2002	
Constant	-0.0022	0.0012	0.0017 **	-0.0008	
	(0.0023)	(0.0009)	(0.0008)	(0.0021)	
Lagged dependent variable	0.4546 ***	0.4221 ***	0.5089 ***	0.4167 ***	
	(0.1640)	(0.0862)	(0.0762)	(0.1405)	
Gap	-0.0017	-0.0434 **	-0.0175	-0.0094	
	(0.0128)	(0.0193)	(0.0128)	(0.0289)	
Lagged log of inventory-sales ratio	-0.0071 *			-0.0046	
	(0.0038)			(0.0040)	

Dependent variable - quarterly change in the log of real home price. Newey-West standard errors in parentheses.
One, two, or three stars indicate statistical significance at the 10, 5, and 1 percent level, respectively.

[1]Gap measure mnemonics identify the technique (C-R for cointegration on price-rent ratio,
C-P for cointegration on price level, S-D for supply-demand model) and the end-year of sample used to estimate gap.

Table 6. Short-run determinants of real home price appreciation

	1	2	3	4
Estimation period	82Q3:08Q1	82Q3:02Q4	82Q3:00Q4	82Q3:08Q1
Estimation technique	OLS	OLS	OLS	SUR
Standard errors	Newey-West	Newey-West	Newey-West	SUR
Constant	0.0049	0.0006	0.0092	0.0053 **
	(0.0031)	(0.0059)	(0.0078)	(0.0026)
Lagged dependent variable	0.4288 ***	0.4087 ***	0.3407 ***	0.3925 ***
	(0.1242)	(0.1314)	(0.1270)	(0.0899)
Lagged log (inventory-sales ratio)	-0.0126 ***	-0.0065	-0.0101 **	-0.0134 ***
	(0.0037)	(0.0042)	(0.0045)	(0.0030)
Second lag of foreclosure starts	-0.0304 ***	-0.0068	-0.0427	-0.0327 ***
	(0.0087)	(0.0223)	(0.0296)	(0.0089)
R-squared	0.46	0.26	0.21	0.45
Durbin-Watson statistic	1.98	1.90	1.91	1.92

Dependent variable - change in the log of real home price on previous quarter.
Foreclosure starts enter as a percentage of total mortgages outstanding at quarter-end.

Table 7. Evolution of inventory-to-sales ratio

	1	2	3	4
Estimation period	82Q3:08Q1	82Q3:02Q4	82Q3:00Q4	82Q3:08Q1
Estimation technique	OLS	OLS	OLS	SUR
Standard errors	Newey-West	Newey-West	Newey-West	SUR
Constant	-0.0592 ***	-0.0673 ***	-0.0799 ***	-0.0598 **
	(0.0175)	(0.0175)	(0.0242)	(0.0249)
Lagged dependent variable	0.9152 ***	0.8960 ***	0.8566 ***	0.9152 ***
	(0.0264)	(0.0310)	(0.0552)	(0.0363)
Lagged price gap	0.2132 **	0.1983	0.4355	0.2348 *
	(0.0998)	(0.1980)	(0.2919)	(0.1320)
R-squared	0.86	0.84	0.82	0.86
Durbin-Watson statistic	2.44	2.49	2.47	2.44

Dependent variable - change in the log of real home price on previous quarter.
Foreclosure starts enter as a percentage of total mortgages outstanding at quarter-end.