**House Price Moments in Boom-Bust Cycles**

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ABSTRACT

This paper describes six stylized patterns among housing markets in the United States that potential explanations of the housing boom and bust should seek to explain. First, individual housing markets in the U.S. experienced considerable heterogeneity in the amplitudes of their cycles. Second, the areas with the biggest boom-bust cycles in the 2000s also had the largest boom-busts in the 1980s and 1990s, with a few telling exceptions. Third, the timing of the cycles differed across housing markets. Fourth, the largest booms and busts, and their timing, seem to be clustered geographically. Fifth, the cross sectional variance of annual house price changes rises in booms and declines in busts. Finally, these stylized facts are robust to controlling for housing demand fundamentals – namely, rents, incomes, or employment – although changes in fundamentals are correlated with changes in prices.

The United States experienced a remarkable boom and bust in house prices in the 2000s. According to the Fiserv Case-Shiller 10-city index, house prices grew by 125 percent in real terms from their trough in 1996 to their peak in 2006 and subsequently fell by 38 percent over the next five years. The impacts of this house price cycle have been wide-ranging and severe.

Explaining the causes of this episode of house price growth and decline and its effects on the rest of the banking sector and the real economy is the subject of much current research, some of which is collected in this volume. Potential explanations of the boom and bust in house prices include changing interest rates, subprime lending, irrational exuberance on the part of home buyers, a shift to speculative investment in housing, contagion and fads, and international capital flows.[1]

The goal of this paper is to describe a set of patterns among housing markets in the United States and to compile a set of empirical facts that potential explanations of the housing boom and bust should seek to explain. While some of the empirical relationships detailed here have been discussed to varying degrees in prior research, this paper seeks to assemble a broad collection of empirical facts. A unified theory of housing booms and busts would presumably be able to explain the entire set of facts. Of course, it is possible that there is no single channel that caused all the economic fluctuations that were experienced, and that a combination of mechanisms needs to be explored.

For this paper, I consider only house price dynamics. The many potentially important contributing factors to these housing market dynamics generally are outside the scope of this paper. However, demand fundamentals, such as rents, income, and employment, are lightly addressed. Other potentially important components of housing market dynamics are the purview of other authors in this volume, such as Haughwought *et al*'s chapter on the supply side of housing markets, Glaeser, Gottlieb, and Gyourko's chapter on interest rates, and Keys *et al*'s chapter on housing finance. In addition, I broadly define housing markets as metropolitan statistical areas

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[1] A complete set of references for the potential causes of the house price boom in the 2000s is beyond the scope of this article. However, an interested reader might find the following citations of use. For discussions of the explanatory potential of interest rates, see Glaeser, Gottlieb, and Gyourko (2010); Himmelberg, Mayer, and Sinai (2005); Mayer and Sinai (2007); and Campbell *et al* (2009). For subprime lending, see Pavlov and Wachter (2009); Mian and Sufi (2009); Wheaton and Nechayev (2008); and Lai and Van Order (2010). Arguments in favor of irrational bubbles can be found in Case and Shiller (2003) and Shiller (2005, 2006). Barlevy and Fisher (2011); Bayer, Geissler, and Roberts (2011); and Robinson and Todd (2010) examine the issue of speculative investment demand contributing to house price booms. Burnside, Eichenbaum, and Rebelo (2011) consider contagion ("social dynamics") and fads. Favilukis, Ludvigson, and Van Nieuwerburgh (2010) show that foreign capital flows into the U.S. could, in general equilibrium, lead to increases in the price-to-rent ratio for owner-occupied houses that match the aggregate U.S. time series.

(MSAs), intended to correspond to labor market areas that workers are willing to commute amongst. During the boom-bust, there were also important within-MSA house price dynamics. These dynamics are addressed by Genesove and Han in this volume as well as Ferreira and Gyourko (2011) and Bayer, Geissler, and Roberts (2011).[2]

I highlight six stylized facts. First, despite the sizeable boom-bust pattern in house prices at the national level, individual housing markets in the U.S. experienced considerable heterogeneity in the amplitudes of their cycles. The 75th percentile MSA experienced 111 percent trough-to-peak growth in real house prices in the 1990s and 2000s (using Federal Housing Finance Agency (FHFA) data), whereas the 25th percentile MSA had only 32 percent trough-to-peak real house price growth.

Second, the boom-bust of the 2000s bears remarkable similarities – as well as some differences – to the boom-bust of the 1980s. We observe two types of MSAs in the data. One set experienced house price cycles in both the 1980s and the 2000s whereas the other set experienced a boom-bust only in the 2000s. The MSA-level correlation in real house price growth from trough-to-peak and peak-to-trough around the late 1980s and late 2000s is quite high overall at 0.42. That correlation is attenuated by those MSAs that did not experience a 1980s cycle and thus have a very low correlation with the 2000s boom.

Third, housing markets also experienced differences in the timing of their cycles. Most MSAs in the 1990s saw their house prices bottom either between 1990 and 1993 or between 1996 and 1997, and house prices generally peaked in 2006 and 2007. In the 1980s, house prices peaked between 1986 and 1990. Potential explanations for housing booms, therefore, need to generate both differences in the amplitude and timing of price changes across MSAs.

Fourth, the largest booms and busts, and their timing, seem to be clustered geographically. The largest amplitude cycles in the boom/bust of the 1990s and 2000s occurred in coastal MSAs and in Florida. These geographic concentrations also had price peaks and troughs that started at similar times and at distinct times from the rest of the country.

Fifth, other interesting patterns emerge when one considers annual house price growth, rather than house price changes from trough to peak and back again. The cross sectional variance of annual house price changes increases in booms and decreases in busts. This appears to be a consequence of MSAs having booms of different amplitude.

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[2] I also limit my attention to U.S. housing markets. Burnside, Eichenbaum, and Rebelo (2011) document house price dynamics in 18 OECD countries.

Lastly, these five patterns remain even when house prices are conditioned on demand fundamentals such as rents, incomes, or employment. Although changes in fundamentals are correlated with changes in house prices, cycles in these fundamentals do not have the same amplitude as price cycles and the time pattern of the growth in fundamentals does not match the timing of the growth in house prices. In fact, controlling for demand fundamentals makes the remaining boom-bust patterns in house prices even starker. This result suggests that a significant portion of house price booms and busts were due to changes in the asset pricing of houses rather than changes in the underlying demand for housing itself.

The remainder of this paper proceeds as follows. I first describe the data used in the paper and the algorithm for identifying peaks and troughs in each MSA's time series. In section 2, I describe the aggregate national patterns in house price dynamics. Section 3 makes the point that MSAs can vary considerably from the national average and documents heterogeneity in the amplitude of the housing boom/bust of the 1990s and 2000s. It also shows that house price booms were typically followed by house price busts. The similarities and differences between the housing boom of the 1980s and the boom of the 2000s is discussed in Section 4. The next section documents the fact that MSA-level house prices hit their troughs and peaks in different years. Section 6 shows that MSAs with similar amplitudes and timing in their housing booms and busts are clustered near each other geographically. Section 7 moves from the trough-to-peak house price growth concept to consider annual growth in house prices and the distribution of that growth rate across MSAs. I briefly discuss housing demand fundamentals in Section 8, finding that house price cycles remain even conditional on cycles in housing fundamentals. Finally, Section 9 briefly concludes.

1.      Data

The primary source of data is the Federal Housing Finance Agency (FHFA)'s quarterly house price index from data on repeat sales of homes. By comparing repeat transactions on houses that sell multiple times, the index controls for the size or quality of the house to the degree that the house is not renovated. The most significant benefit of the data is that it is available over a very long time (it is reliable as early as 1980) and for a large number of MSAs. However, the index is estimated on a sample of houses that transact multiple times and which have conforming mortgages securitized by Fannie Mae or Freddie Mac. This sample of houses may not be

representative of the overall housing stock and may not reflect the full volatility of the underlying housing market.[3]  In addition, the FHFA indexes are normalized and thus cannot be used for cross-MSA house price comparisons.  The FHFA data contains 344 MSAs with data between 1990 and 2010 and 163 MSAs with data covering 1980 through 2010.  I annualize the data by averaging the index over the four quarters in a calendar year and convert the price indexes from nominal to real terms by deflating using the CPI (all urban consumers).

The FHFA repeat sales index is augmented with rent data from REIS, Inc.  REIS surveys "class A" apartment buildings, which are typically among the nicest in a given market, and adjusts the rents for concessions, such as months of free rent, to calculate a measure of effective rent.  This is the rent concept we use as a proxy for rental values of owner-occupied houses.  Because the REIS and FHFA indexes measure two different quantities of housing – the housing stock comprised by the apartment buildings in the REIS data can be quite different than the housing stock in the single family detached houses in the FHFA data – I will not try to interpret the level differences in house prices versus rents in a given MSA.  Instead, in section 8 I will compare the growth in FHFA prices to the growth in REIS rents, which merely requires that the growth in rents for apartments tracks the growth in (unobserved) rental value of houses.

As an alternative to using apartment rents as a proxy for housing demand, one could use demand fundamentals.  For that reason, I collect data on median per capita income by MSA and employment by MSA from the Bureau of Labor Statistics (BLS).  Income is converted into real dollars using the CPI.

Much of the analysis in this paper concerns the peaks and troughs of housing cycles.  The algorithm to determine those troughs and peaks starts by determining the peak of house prices in the 2000s.  For each MSA, that peak is defined by first finding all the local maxima – years where the average annual real house price exceeds that of the adjacent years – in the 1999 through 2010 period and then choosing the local maximum with the highest real house price.  After that, the algorithm works backward in time: It finds the local minimum – a year where house prices are lower than in the adjacent years – in the period prior to the 2000s peak year that is closest in time to the 2000s peak year and calls it the 1990s trough.  The next preceding local maximum is labeled the 1990s peak, and the local minimum that precedes it is called the 1980s trough.  Some MSAs

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[3] CoreLogic offers an alternative house price index that covers a comparable sample period and set of MSAs and that is not limited to houses with conforming mortgages.  The author is waiting to receive that data and will update the paper accordingly when the data arrives.

do not have cyclical enough house prices for there to be local maxima and minima for all possible peaks and troughs. In those cases, the algorithm defines only those peaks and troughs it can identify. In addition, the trough in house prices in the 2000s is defined as the lowest real house price subsequent to the 2000s peak. However, that so-called trough often occurs in 2010, the last year of the data, and thus may not reflect the actual bottom in house prices. The peak/trough algorithm is repeated for all the MSA-level economic variables in the data set – house prices, apartment rents, median incomes, and MSA employment – as well as the ratios of house prices to rents, incomes, and employment.[4]

## 2.      National patterns

The history of national average house prices in the U.S. is by now well-known. According to data from the FHFA, real house prices rose more than 55 percent between the mid-1990s and the end of 2006 and had declined by almost 17 percent by late 2010. A national boom-bust in house prices also was experienced in the 1980s, with real prices rising nearly 15 percent between the mid-1980s and late 1989 and subsequently falling by 8 percent. This data is plotted in Figure 1. The red line, labeled "HPI", corresponds to the FHFA national series, deflated by the CPI, and is normalized so that it equals one in 1990.[5]

Another index, Fiserv Case-Shiller, uses a similar repeat-sales methodology but, unlike the FHFA index, is not limited to housing transactions with conforming mortgages and does not exclude sales of foreclosed homes. The real Fiserv Case-Shiller index is plotted in Figure 1, in blue, for comparison with the FHFA index. The Fiserv Case-Shiller index demonstrates substantially more volatility than the national FHFA index, more than doubling between 1997 and 2007 and subsequently falling by about one-third. However, the Fiserv Case-Shiller index in this figure is a composite of just 10 cities, and it turns out that the differences in volatility between the FHFA index and the Case-Shiller index is more a function of the composition of cities that make up the index than of the composition of housing transactions within a city.[6] To show this, we plot

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[4] Burnside, Eichenbaum, and Rebelo (2011) apply a related algorithm to house price data for 18 countries. Two differences are that they smooth quarterly house price growth using a five-quarter moving average and they require the price change in a run-up to exceed a minimum bound before calling it a boom. Ferreira and Gyourko (2011) apply a more rigorous econometric procedure to identify house price troughs across U.S. metropolitan areas and Census tracts from structural breaks in house price growth.

[5] These sorts of aggregate house price dynamics were initially modeled in a stock-flow framework, such as DiPasquale and Wheaton (1994).

[6] The Fiserv Case-Shiller index is also publicly available as a 20-city composite index.

(in brown) a composite real FHFA index for the same 10 cities that are in the Fiserv Case-Shiller 10-city composite index. The two 10-city indexes are quite similar, with the Fiserv Case-Shiller index exhibiting slightly more volatility. This paper uses the FHFA series because the data covers a longer time span – for many MSAs, it starts (reliably) in 1980 rather than Fiserv Case-Shiller's 1987 – and because it covers more metropolitan areas. However, based on Figure 1, the results should be similar if other house price indexes were used.

3.      Heterogeneity in amplitude

The national pattern masks considerable heterogeneity within the United States. One way to see this heterogeneity is to consider the amplitude of the trough-to-peak and peak-to-trough cycles in house prices experienced across various housing markets. Appendix Table A reports these statistics for each MSA in the data. In the 1990s and 2000s, most MSAs did not experience nearly the price growth reflected in the national average. However, a number of MSAs experienced considerably more growth, skewing the national average. The dispersion in the cumulative price growth from each MSA's trough to peak is graphed in Figure 2. The solid line plots a kernel estimate of the distribution of total real price growth for the entire set of MSAs available in the FHFA data, weighting each MSA equally. Most MSAs, 57 percent, experienced real house price growth below the national average growth of 55 percent. Indeed, the mode of the distribution is below 50 percent. However, the right tail of the price growth distribution is skewed, with a number of MSAs experiencing a doubling or more in their real house prices over the period.

The skewness across MSAs in trough-to-peak real house price growth is accentuated when the MSA observations are weighted by their 1990 population of households. This result can be seen in the dashed line in Figure 2. The peak of the distribution is reduced, with the mass redistributed to the right. This change implies that the highest trough-to-peak house price growth in the 1990s and 200s was experienced by larger cities, so weighting by the number of households reduces the emphasis at the low-growth portion of the distribution and shifts out the right tail of the distribution.

Most of the skewness in house price growth in the 1990s and 2000s arises from exceeding the prior house price peak of the 1980s/1990s rather than from recovering to the prior high-price-level after the trough of the 1990s. Evidence can be found in the dashed-dotted line, which is a

kernel density estimate of the real house price growth between the real house price peak in the 2000s and the prior peak in house prices, which typically occurred in the late 1980s. That distribution, which is unweighted, looks very similar to the unweighted distribution of trough-to-peak real house price growth, but shifted a bit to the left.

Finally, the heterogeneity in trough-to-peak growth is not due to differences in the length of the boom. Even over a fixed time span there is considerable heterogeneity and skewness in real house price growth. This can be seen in the dotted line, which corresponds to house price growth over the fixed 2000 through 2005 period, rather than over the trough-to-peak period window that can vary in length. Although the mass of low-growth MSAs is greater under this fixed-time period measure, there is still considerable skewness. This pattern indicates that house prices in some MSAs grew at a higher average rate, not just for a longer period. Another potential fixed-duration measure of growth would be to compute house price growth over the five years subsequent to each MSA's trough of the 1990s, rather than using 2000 as a base year for all MSAs. The distribution generated by that approach looks very similar to the 2000-2005 distribution plotted in Figure 2.

That the skewness in the distribution of MSA house price growth during the 1990s/2000s boom is not due to differences in the length of the boom is especially evident in Figure 3, which plots the kernel density estimate of the geometric average trough-to-peak growth rate. Most of the MSAs averaged between 0 and 5 percent real house price growth during their run-ups. However, there is a sizeable tail of MSAs with annualized house price growth rates ranging between 5 and 15 percent. That tail is larger when we weight by each MSA's population of housing units, depicted by the dashed line, indicating that larger cities experienced higher average house price growth rates during the most recent boom.

A similar degree of heterogeneity across MSAs can be observed in the house price declines from the peak of the 2000s through 2010, graphed in the solid line in Figure 4. In this chart, a larger positive number corresponds to a greater decline in real house prices after the peak in the mid-2000s. Most MSAs experienced price declines, as measured by the FHFA data, of well less than the 17 percent national average. The modal decline in house prices is less than 10 percent. However, many MSAs experienced 30, 40, or even 50 percent price declines. While these MSAs are atypical, they nonetheless constitute a sizeable tail. However, it is worth emphasizing that

while the sample period ends in 2010, the housing collapse did not. The data do not yet allow us to compute a complete peak-to-trough measure.[7]

Even within the truncated time period, the most populous MSAs, on average, experienced larger real house price declines after their peaks. This can be seen in the dashed line, which weights each MSA observation by its number of households. The density is shifted to the right.

The dotted line in Figure 4 graphs the distribution of house price declines between 2005 and 2010 for comparison to the 2000-2005 distribution in Figure 2. A positive number indicates that house prices fell between 2005 and 2010. Some MSAs had negative declines – which correspond to increases in house prices between 2005 and 2010 – because most MSAs' house prices peaked between 2006 and 2008 and so 2005-2010 spans a period of price growth and subsequent decline. In many MSAs, the growth in prices between 2005 and the peak was greater than the decline from the peak to 2010, which yields a point to the left of zero. Still other MSAs had a larger house price collapse than run-up.

It is typically the case that those MSAs that experienced the greatest run-up in house prices in the 1990s and 2000s also faced the largest subsequent house price declines, even recognizing that house prices still might continue to decline after 2010.[8] This pattern can be seen in Figure 5, which plots for 249 of the MSAs in the FHFA data the percent decline in real house prices after the peak of the 2000s on the vertical axis, and the percent growth in real house prices from the 1990s trough to the 2000s peak on the horizontal axis. The dashed line is the fitted bivariate regression line where each MSA is weighted equally. The upward slope (0.284 with a standard error of 0.013) indicates that the magnitudes of the price run-ups and run-downs are correlated. The dotted line weights the MSAs by the population of housing units and yields a slightly lower slope (0.226 with a standard error of 0.012). This indicates that larger MSAs had busts that were less correlated with their preceding booms.

The MSAs furthest away from the origin in Figure 5 experienced boom-bust cycles with the greatest amplitudes. These mainly include a number of MSAs in Florida, such as Naples with

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[7] Just as there are a host of possible explanations for the run-up in house prices, there are many possible contributors to the bust. One potentially exacerbating factor is foreclosures, discussed in Campbell, Giglio, and Pathak (forthcoming).

[8] Glaeser *et al* (2011) highlight a similar phenomenon over 1980-1990s time period, that U.S. housing markets exhibit long run mean reversion and short run serial correlation in house price growth. They use a fixed time window rather than MSA-specific peaks and troughs, but the idea is the same. This evidence is extended in Glaeser, Gyourko, and Saiz (2008). They, too, use the same endpoint dates for all MSAs when defining booms: 1982-1989, 1989-1996, and 1996-2006. We also observe a correlation in house price booms and subsequent busts in the 1980s-1990s period. It is not graphed, but the bivariate regression coefficient is reported in Table 1.

a 173 percent real price run-up, Miami (160 percent), and Fort Lauderdale (142 percent), and others in California, such as Salinas (165 percent), Santa Barbara (162 percent), Riverside/San Bernardino (158 percent), and Modesto (141 percent).

However, the decline in real house prices is not (yet) equal to the prior increase. The curved line in Figure 5 demarcates the percentage decline in house prices that would be necessary to undo all the price growth from the 1990s trough to the house price peak of the 2000s. (The curvature results because it takes a lower percentage point decline to offset a given percentage point increase in prices. For example, a 100 percent increase in house prices subsequently can be reversed with a 50 percent decline.) Nearly all of the MSAs lie below this curve, indicating that their real house prices at their lowest point after the peak of the 2000s were still above where they were in the prior trough of the 1990s. This is not surprising since, in most MSAs, the economic fundamentals that contribute to housing demand had not reverted to mid-1990s levels. Even so, some MSAs that have notably been suffering from a secular economic decline have real house prices in the late 2000s that were lower than what they were in the mid-1990s. These include many rust-belt MSAs, such as Detroit, Warren, and Flint, Michigan, Fort Wayne, Indiana, and parts of Ohio. Other MSAs whose real prices fell more than they rose in the latest boom include some "bubble" MSAs, such as Las Vegas, Nevada, and Merced, California. [9]

The heterogeneity across MSAs in the boom-bust cycle of house prices can be seen more clearly in Figure 6, which reports the same trough-peak-trough price cycle as Figure 5, but which restricts the sample of MSAs to those also covered by the REIS data. These 43 MSAs are among the largest in the U.S. The MSAs furthest from the origin – those with the largest price increases and decreases include most of California and South Florida, plus Phoenix, Arizona. Texas cities, such as Houston, Dallas, and Fort Worth had negligible price cycles and are close to the origin. Philadelphia, Baltimore, Seattle, New York, and Boston are in the middle. Only Cleveland and Detroit are above the curved line, where their post-boom real house prices are below the level of their prior trough.

Those MSAs that are below the straight fitted regression lines experienced a greater ratio of price increase to subsequent decrease than did the cities above the regression line. Some MSAs in close proximity experienced similar trough-to-peak price growth but dissimilar price declines. For example, as reported in Table 1, both Los Angeles and San Bernardino/Riverside experienced

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[9] Glaeser, Gyourko, and Saiz (2008) note that new house construction during booms could cause house prices to fall below their level in prior troughs because housing supply could increase more than demand fundamentals.

157 percent price growth between 1997 and 2006. However, prices in Los Angeles fell "just" 34 percent subsequently, compared to 48 percent in San Bernardino. In San Francisco, prices rose 129 percent from trough to peak and 124 percent in nearby Sacramento. But real prices have fallen by 44 percent from the peak in Sacramento and only 24 percent in San Francisco. However, it is worth re-emphasizing that none of these cities have necessarily yet reached their new price trough and so judgments about price declines should be tempered.

4.      Similarity with the 1980s

The same MSA-level heterogeneity in house price growth rates that characterized the boom-bust cycle that peaked in the 2000s also was present in the preceding house price cycle that peaked in the late 1980s. Figure 7 compares the unweighted distribution of real house price growth rates from the 1990s trough to the 2000s peak, as computed in Figure 2, to the distribution of real house price growth rates from the 1980s trough to the peak of the late 1980s/early 1990s. Both boom-bust cycles demonstrated considerable dispersion across MSAs in trough-to-peak house price growth. A large fraction of the distribution of MSA house price growth during the 1990s boom, which is described by the solid line, is less than 25 percent. However, the tail extends to growth of more than 100 percent. The dashed line, which corresponds to the boom that peaked in the 2000s, shows that the mass of the distribution of price growth in that run-up was shifted slightly more to the right than in the prior boom, up to about 50 percent increases in real house prices. The 2000 boom also had a thicker right tail, extending to more than 150 percent cumulative growth.

Both periods also exhibited dispersion in house price declines after their respective peaks. In Figure 8, the kernel density of the decline in real house price declines after the peak of the late 1980s (the solid line) is nearly the same as the density of real house price declines after the peak of the late 2000s (the dashed line). The more recent housing bust reveals a somewhat larger house price collapse across most MSAs as the distribution of house price declines is shifted to the right. On top of that, the extent of the house price declines in the most recent bust is not yet fully known whereas the 1990s bust is complete. That suggests that the most recent bust promises to be even more sizeable than the house price collapse of the 1990s.

In addition, the MSAs that boomed in the 2000s largely were the same MSAs that boomed in the 1980s, with a few notable exceptions. This relationship can be seen in Figure 9, which plots

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each MSA's trough-to-peak house price growth during the cycle that peaked in the 2000s against trough-to-peak house price growth during the 1980s cycle. Every MSA that had a 1980s cycle – even if it was small – is included in the sample, yielding 124 MSAs. On average, there is a positive relationship between house price growth in the two cycles, with higher trough-to-peak price growth in the 1980s predicting greater trough-to-peak price growth in the more recent cycle. This pattern can be seen in the dashed and dotted lines, which correspond to the unweighted and population-weighted bivariate regression lines, respectively. MSAs that experienced considerable volatility in the 2000s, such as Boston, New York, and San Francisco, also had large house price run-ups in the 1980s, and thus can be found away from the origin on the right side of the chart. Other MSAs, such as Nashville, Austin, and Minneapolis, had relatively low amounts of house price growth in both cycles and are close to the origin. Nearly all cities, however, experienced more house price growth in the 2000s cycle than in the 1990s. Rather, those that experienced *above-average* high price growth in the 1980s typically also had above-average house price growth in the 2000s. An exception to this rule is the group of declining MSAs, such as Rochester NY, Indianapolis IN, Lansing MI, and Reading PA, that had little house price growth in both the 1980s and the 2000s.

There is one significant group of outliers to this general pattern. A cohort of MSAs experienced outsized house price growth in the 2000s but relatively little price growth in the 1980s. This set of MSAs is located in the upper left of the graph, close to the Y-axis and far from the X-axis. This group includes many MSAs that were poster children for the recent housing bubble – Miami and much of South Florida, Phoenix AZ, Las Vegas NV, and Riverside/San Bernardino CA – as well as others that were less visible, such as Salt Lake City.

For legibility, Figure 10 graphs the same information for the smaller sample of MSAs that also have data available from REIS. The outliers in the upper left quadrant, such as south Florida and Phoenix, are more evident in this figure. The California MSAs of San Bernardino, Orange County, San Diego, and Oakland also lie above the regression line but, unlike the Florida MSAs, they did exhibit a cycle in the 1980s, albeit a muted one.

5.      Heterogeneity in timing

Popular discussion tends to refer to the start and end of the housing "bubble" as if there were a particular point in time in which price growth began in all MSAs and another date at which

the bubble ended. In practice, those dates varied widely across MSAs. Figure 11 charts the distribution of trough and peak dates for the house price peak of the 1980s (in gray), the trough of the 1990s (in black), and the peak of the 2000s (speckled). (Appendix Table A reports these dates for each MSA in the data.) Each distribution spans a number of years. For most MSAs, the 1980s peak in real house prices occurred between 1986 and 1990. However, some MSAs peaked in the early 1980s and others peaked well into the 1990s. The early dates typically correspond to MSAs whose house prices peaked in the early 1980s, declined through the early-1990s, and then rose until the mid-2000s. For example, Denver's real house price peaked in 1983, reached a trough in 1991, and peaked again in 2005. The MSAs with the latest peaks typically did not experience a 1980s cycle at all. Rather, their house prices fell until the late 1980s, then rose steadily until the late 2000s. However, Portland, Oregon, for example, experienced a slight house price dip after the tech boom of the late 1990s, and so the algorithm characterized that period as a local house price maximum. Leaving aside the extreme outliers in the dates of the peak, considerable heterogeneity remains over the five-year 1986 through 1990 span.

The dates of the subsequent trough in house prices are bimodal. One concentration occurs in the early 1990s, between 1990 and 1993, with a large number of MSAs hitting their troughs in 1991. The other concentration takes place around 1996 and 1997. About 30 MSAs have troughs in 2000 or 2001. These MSAs typically experienced a small dip in house prices after a run-up in the late 1990s, before their house prices continued their climb through the late 2000s. The algorithm counts the small hiccup in house price growth as a local minimum and identifies it as a trough even if, like in Scranton, PA, house prices reach a nadir again in the mid-1990s. Again, leaving aside the outliers, there is considerable dispersion across dates of the trough of house prices.[10]

By contrast, the peak of house prices in the 2000s was much more concentrated than either the previous trough or peak. MSA-level house prices topped out primarily in 2006 and 2007, with about 40 MSAs reaching their house price peaks in 2005. Despite this relatively high concentration, there is still considerable heterogeneity. House prices in 26 MSAs peaked before 2005 and a comparable number of MSAs had peaks in 2009.

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[10] Independently, Ferreira and Gyourko (2011) have estimated the starting date of the boom of the 2000s at the MSA level using a quarterly MSA-level house price index of their own construction and a more rigorous econometric procedure. They also find considerable dispersion in starting dates.

6.      Geographic clustering

Although MSAs are quite different in the timing and amplitude of their house price cycles, MSAs with similar house price cycles tend to be located near each other.  This pattern is especially evident in the trough-to-peak and peak-to-trough house price growth around the boom-bust of the 1990s/2000s.  Figure 12 maps the growth in real house prices between the 1990s trough and the 2000s peak, by MSA.  Lighter-shaded MSAs had less trough-to-peak house price growth and darker-shaded MSAs experienced more.  The darkest-shaded MSAs, those with 70 percent growth in house prices or more, were mainly located on the west coast of the U.S., the Northeast Corridor (Washington D.C./Philadelphia/New York/Boston), and in the state of Florida.  Most of the rest of the U.S. is shaded light grey, indicating relatively lower house price growth, with the exception of the areas around Denver, Salt Lake City, and Casper, Wyoming.  (House prices in the latter city more than doubled between 1989 and 2007.)  Even among the dark-shaded subset of MSAs, the coastal MSAs experienced more growth in prices than did the slightly more inland MSAs.  For example, central Florida had less trough-to-peak real house price growth than did coastal Florida.  In addition, major cities had greater house price growth during this period than did neighboring areas.  For example, the Portland, OR MSA had more price growth than the areas just to its south, and the Boston area experienced more house price growth than the areas to its west.

Since the MSAs that had house price booms also tended to have house price busts, it follows that the house price declines in the late 2000s are also spatially concentrated.  This pattern can be seen in Figure 13.  The west coast of the U.S., the northeast, and Florida experienced the largest concentrations of house price declines.  However, the pattern within those areas is partially reversed from the prior house price run-up.  The coastal MSAs and large cities experienced relatively less of a house price collapse by 2010 than did the more inland MSAs or the areas around the cities.  However, house prices in those coastal MSAs still fell by more than in the MSAs in the middle of the country, reflecting the fact that they also experienced a greater house price rise.

Similar geographic clustering can also be seen in the starting date of the boom of the 2000s.  This information is mapped in Figure 14, with a darker shade for MSAs that had a later start date for the boom.  The same areas that experienced the largest booms/busts appear to have

started their cycles later.  By contrast, in Figure 15, the dates of the peak of the 2000s house price boom are much more uniformly distributed across the country.[11]


7.      Annual house price growth

Up to this point, the paper has considered the distribution of trough-to-peak and peak-to-trough growth rates.  However, the distribution of annual growth rates in MSA-level house price indexes also reveals some interesting patterns.

First, the cross-sectional distribution of one-year MSA-level house price growth rates widens considerably during housing booms and contracts during housing busts.  That is, when house prices are highest, there is more dispersion across MSAs in the amount of growth.  This pattern can be seen in Figure 16, which plots the standard deviation of real house price growth over time.  The standard deviation is computed across MSAs at a point in time.  For example, the line in Figure 16 starts in 1981.  That year, the standard deviation across MSAs of their house price growth between 1980 and 1981 was just under 5 percent.  During the next decade, as average house prices rose, the standard deviation of house prices also grew.  By 1990, the peak of the boom, that standard deviation has grown to nearly 7 percent, indicating that the variation among MSAs in the amount of house price growth was greater at the top of the cycle.  In the mid-1990s, as house prices slumped, the cross-sectional variance also fell.  But, in the boom of the 2000s, the standard deviation rose steadily with house prices to a peak of more than 8 percent.

While the standard deviation of house price growth rose in both the 1980s and the 2000s, there was one interesting difference between the two booms: In the 1980s boom, some MSAs experienced house price growth whereas others saw house prices decline.  However, in the 2000s boom, almost all MSAs enjoyed house price increases.  Figure 17 plots the distribution of annual house price growth by year.  Within each year, there are 159 unweighted MSA-level observations on real house prices.  The horizontal white line in the middle of each vertical black bar corresponds to the median MSA-level house price growth between the prior year and the current one.  The median growth is positive between 1983 and 1989, reflecting the house price boom of that period.  The cross-section dispersion increases towards the peak of the boom, in 1987, 1988, and 1989.  As house prices fall through the late-1990s, the cross-sectional dispersion declines.

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[11] Ferreira and Gyourko (2011) independently document similar MSA-level geographic clustering in the start of the boom.  Their research emphasizes the initial jump in house prices at the start of the house price boom.  Interestingly, they do not find geographic clustering at the MSA level in the magnitude of those initial price jumps.

However, during the entire 1983 to 1997 period, despite covering a significant aggregate house price boom and bust, the interquartile range (from the bottom to the top of the black bar) spanned zero. That is, some MSAs experienced price declines in the same year that other MSAs experienced price growth. By 1998, that pattern was over, and during every year of the house price boom of the 2000s, with the exception of the post-Internet boom year of 2000, at least 75 percent of the MSAs (and often more) in each year experienced positive house price growth. In 2007, this was no longer true. Then, in every year between 2008 and 2010, more than 75 percent of MSAs faced house price declines.

8.      House price cycles remain after controlling for demand fundamentals

Up to this point, the paper has focused on house prices alone. But, as is widely recognized, there are two components that determine house prices. The first is the fundamental value of the housing service flow, rent. The rental value of housing is determined by factors that affect the demand for living in a particular location – income, household demographics such as marital status, and local amenities or wage levels – as well as the elasticity of housing supply. The second component is an asset pricing relationship that capitalizes a stream of future rental value into a current price.[12]

If the rental value of owner-occupied housing could be measured directly, housing cycles could be decomposed into cycles in the value of housing services – rent – and cycles due to changes in asset pricing. Of course, owner-occupied houses are by definition not rented, and thus the econometrician does not observe the rental value of that set of houses. The prior literature takes three approaches to surmount that problem. One approach is to compare the rental value and prices for a set of matched rental and owner-occupied houses, as in Smith and Smith (2009). Another strategy is to assume that the growth rate in apartment rents, which are observed, is a good proxy for the growth rate in the unobserved rental value of owner-occupied housing, as in Himmelberg, Mayer, and Sinai (2005) or Campbell *et al* (2009). A third tactic is to use demand shifters, such as household income, to estimate rental value within the context of an economic model, as in Glaeser, Gottlieb, and Gyourko's chapter in this volume.

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[12] See, for example, Meese and Wallace (1994) for an early exposition of this present value relationship for housing. The intuition is robust in an even more complete house pricing model, such as Ortalo-Magne and Prat (2010).

In this section, I control for various measures of the underlying rental value of owner-occupied housing in each MSA to isolate the asset pricing component. Doing this makes the cyclical pattern of house prices, if anything, stronger.

One main reason for this outcome is that, while there are cycles in fundamentals, cycles in house prices are much larger. This can be seen clearly in Figure 18, which plots the distribution of trough-to-peak growth in the 2000 boom for four MSA-level variables: Real house prices, real rent, real income, and employment.[13] House price growth, the solid line, has considerably more dispersion than any of the three measures of fundamentals.[14] A sizeable fraction of MSAs experienced trough-to-peak real house price growth between 50 and 200 percent. However very few MSAs experienced more than 50 percent trough to peak growth in housing demand fundamentals, and none experienced more than 100 percent growth.[15] The distribution of rent growth, which is plotted using the dashed line, looks to be more evenly distributed than the income or employment growth distributions. However, that is due to the difference in the composition of MSAs that make up the REIS sample. If all four distributions are plotted using the same set of MSAs, the distribution of employment growth looks similar to the rent growth distribution, the income growth distribution remains relatively concentrated, and the house price growth distribution is still much more disperse than the others.

Not only are the run-ups in fundamental values muted relative to house prices, the relationship between trough-to-peak growth and the subsequent peak-to-trough decline is attenuated. Figure 19 plots a cycle in real apartment rents. We compute each MSA's troughs and peaks in real rent using the same algorithm we applied to house prices, then graph the peak-to-trough growth in real apartment rents in the 2000s against the trough-to-peak growth in the 1990s and 2000s for the subset of 43 MSAs for which we have rent data. Most MSAs experienced less than a 40 percent trough-to-peak growth in rent and less than a 20 percent decline from their rent peak through 2010. However, a handful of MSAs – including the San Francisco Bay area, Denver, and New York – experienced much larger rent cycles. Most MSAs lie below the dash-dot line, indicating that rents have not fallen as much as they rose during their booms. All the exceptions are rust-belt MSAs with very little rent growth, such as Detroit, Milwaukee, and

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[13] McCarthy and Peach (2004) show that the early stages of the house price boom of the 2000s may have been due to growth in demand fundamentals.

[14] Haughwout *et al* (2011) shows that house price growth is correlated with growth in the price of raw land.

[15] Figure 18 uses different trough and peak dates for each variable, thus the trough-to-peak growth is calculated over a different sample window. However, it makes little difference in this figure if we instead compute trough-to-peak growth for each demand fundamental using the trough and peak dates for the real house price index.

Pittsburgh. The dashed line corresponds to the unweighted bivariate regression and shows that, on average, MSAs that enjoyed more rent growth during their booms also experienced greater percentage rent declines through 2010. (The estimated coefficient on the trough-to-peak growth in real rent is 0.18 with a standard error of 0.05.) However, when each MSA is weighted by its number of housing units, displayed in the dotted line, we do not obtain a statistically significant correlation. (The estimated coefficient is 0.063 with a standard error of 0.045.)

In fact, all bivariate relationships discussed in this paper are stronger for house prices than for housing demand fundamentals. This fact can be seen in Table 1. The top panel of Table 1 uses the subsample of MSAs for which we have rent data from REIS. Each row corresponds to a different bivariate regression where the unit of observation is an MSA and each observation is weighted by the MSA's number of households. For a given variable, the first row regresses peak-to-trough declines after the peak in the 2000s on the preceding trough-to-peak growth. The second row repeats the strategy for the boom/bust of the 1980s and 1990s. The third row regresses trough-to-peak growth in the boom of the 2000s on trough-to-peak growth over the preceding boom. The bottom panel repeats the regressions using the full FHFA sample of MSAs.

Each column of Table 1 corresponds to a different variable of interest, and the estimated slope coefficient from the bivariate regression is reported in the cell. In the first row and column of Table 1, peak-to-trough real house price declines subsequent to the peak of the 2000s were 2 percentage points higher for every additional 10 percentage point increase in house price growth. (The estimated coefficient is 0.201 with a standard error of 0.028.) The analogous coefficient from the previous boom is just two-thirds of the magnitude, at 0.134 (0.060). But house price growth is highly correlated between the two booms. The estimated coefficient of 0.670 shows that an MSA with 10 percentage points more trough-to-peak house price growth in the 80s and 90s on average experienced nearly 7 percent more house price growth in the 2000s boom. The bottom panel, which uses the full sample, finds similar estimated coefficients.

The second column repeats the same analyses with MSA-level real rent, the third column with real income, and the fourth column with MSA employment. In none of these columns are the estimated coefficients as large as the corresponding ones for real house prices. In addition, in most cases in the top panel they are not statistically distinguishable from zero.

Another way to see the contribution of swings in asset prices net of fundamentals to housing booms and busts is to normalize by a measure of fundamentals. Figure 20 plots the

trough-to-peak distribution of growth between the trough of the 1990s and the peak of the 2000s in the price-to-rent, price-to-income, and price-to-employment ratios. The price-to-rent multiple should reflect the influence of factors that potentially affect housing asset pricing, such as interest rates, credit availability, expected future growth in the value of the housing service flow, adjustments for the relative riskiness of owning versus renting, and any mispricing in the housing market, while conditioning out differences across MSAs in current supply/demand fundamentals. The price-to-income and price-to-employment ratios are alternative measures that normalize by demand shifters in case rent growth for apartments does not parallel the growth in the implicit rental value of owner-occupied houses. Growth in the price-to-rent ratio exhibits nearly as much dispersion over the run-up as growth in prices alone, ranging from zero to 150 percent. Growth in the price-to-income and price-to-employment ratios are more concentrated below 50 percent, but this is due to differences in the composition of MSAs that make up the full sample and the MSAs for which we have rent data. The REIS MSAs simply had more house price growth during this boom. When we plot all three series using the same subset of MSAs that are in the REIS sample, all three distributions look quite similar. The price-to-income and price-to-employment growth distributions parallel the shape of the price-to-rent distribution, but are shifted to the left by about 10 percentage points of growth.

Even though there is not much evidence of cycles in underlying demand fundamentals in this simple analysis, after controlling for the influence of fundamentals the boom-bust relationships documented in this paper get stronger. This suggests that a significant contributor to housing cycles comes from factors that affect the asset pricing of houses. Figure 21 plots the peak-to-trough decline after the 2000s peak in the price-to-rent ratio against the trough-to-peak growth. There is a strong positive relationship – those MSAs that experienced the largest run-ups in their price-to-rent ratios also experienced the largest subsequent declines – and it is a tighter cyclical relationship than in the analogous chart for house prices alone (Figure 6, which uses the same sample of MSAs). The MSAs lie closer to the regression line – the adjusted R-squared that corresponds to the weighted bivariate regression line is 0.82 in Figure 20 and just 0.54 in Figure 6. In addition, the regression line is closer to the dot-dashed line that signifies the point where the price-to-rent ratio has reverted to its prior trough levels.

The last three columns of Table 1 report the estimated coefficients for the set of bivariate regressions on the price-to-rent, price-to-income, and price-to-employment ratios. There is a

stronger boom-bust pattern in price-to-rent ratios than in house prices alone in the booms of the 2000s and the 1980s/1990s (the first two rows). However the link between the run-up of the 1980s and the run-up in the 1990s/2000s was stronger in house prices than in price-to-rent ratios. The converse is true for our other two measures of fundamentals. The boom-bust cycles in price-to-income and price-to-employment are typically more muted than in house prices alone, but MSAs with high growth in price-to-income or price-to-employment in the 1990s/2000s were also likely to experience high growth in the same ratio in the 1980s boom.

Turning back to annual growth rates, the growth in housing demand fundamentals does not show the same increases in cross-sectional dispersion during booms as we saw in house prices. Figure 22 plots the standard deviation (across MSAs) in each year's growth in rents, income, and employment, between 1981 and 2010 for rent and between 1981 and 2008 for income and employment. The cross sectional dispersion in income and employment growth – the dashed and dotted lines, respectively – is relatively constant over the sample period. The standard deviation in rent growth, by contrast, is higher in the mid- to late-1980s and in the early 2000s, ahead of the house price peaks in the two booms in our sample period.

The variation in rent growth over the cycles is small relative to the variation in house prices and thus the standard deviation in house prices shown in Figure 16 must be largely due to changes in the asset pricing of houses across MSAs. In fact, because the increase in variation in rents leads the increase in variation in house prices, partialling rent growth out of house price growth reveals an even starker pattern of greater dispersion in the changes in asset pricing of houses during booms. To demonstrate this, we regressed real house price growth on real rent growth and graphed the standard deviation of the residual by year in the dashed line in Figure 23. The solid line repeats the standard deviation of real house price growth from Figure 16. The standard deviation of annual house price growth net of rent growth increases in house price booms, rises steadily to the house price peaks, and is low in the troughs. It is evident from Figure 23 that the volatility of house price growth outside of housing booms was due to growth in rents or correlated housing demand fundamentals, whereas the volatility of house price growth inside of housing booms can be attributed to asset pricing factors.

It is worth noting that these patterns cannot be due merely to some MSAs experiencing house price growth in booms and others not. Since the standard deviation increases through the

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booms, the house price growth would have to be accelerating for the appreciating MSAs.[16]
Figures 24 and 25 provide evidence that this explanation is correct. Figure 24 plots the
distribution of real rent growth by year. The largest dispersion can be found in the mid-1980s and
the late 1990s. In the 1983 through 1986 and the 1995 through 2000 periods, the top 75 percent of
MSAs nearly always had positive rent growth. But in the height of the booms of the late 1980s
and the mid 2000s, more than 75 percent of MSAs experienced real rent declines. Figure 25 plots
the distribution of the residuals from the regression of real house price growth on real rent growth.
Here, the dispersion was the largest during the booms of the late 1980s and mid-2000s. However,
during the peak of the 1980s boom, house price growth conditional on rent growth was much more
equally likely to be negative as positive. By contrast, in the run-up to the peak of the 2000s,
almost all MSAs in every year between 2001 and 2005 experienced positive house price growth
even conditional on rent growth. And, in the subsequent bust, between 2008 and 2010, almost all
MSAs experienced declines in the house price growth residual.


9.      Conclusion

        This paper has documented several empirical patterns in real house prices in the U.S. over
the last three decades. During that span, many housing markets experienced two boom-bust
periods in house prices. However, that pattern was far from universal. A large fraction of housing
markets had no booms or busts, or just one. Even among the cyclical housing markets, the
amplitude of house price increases or decreases varied greatly, and the start dates and end dates of
each boom were widely dispersed. In addition, during the house price boom-bust of the 1990s and
2000s, nearly all MSAs experienced house price growth during the boom and nearly all MSAs
faced house price declines in the bust. In the prior housing cycle, many MSAs faced real house
price declines even during the boom and many MSAs experienced real house price growth during
the bust.

        Despite these differences across metropolitan areas and between the two housing cycles,
there were also considerable similarities along these same dimensions. Housing markets that
enjoyed the largest house price booms also faced the largest subsequent price declines. Those
MSAs that had the largest boom/bust cycle in the 1980s also typically had the largest cycles in the

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[16] We obtain similar results if we plot the standard deviation of growth in the price-to-rent ratio rather than the
residual from the price vs. rent regression. The estimated coefficient on rent growth in the bivariate regression of real
house price growth on real rent growth is 0.750 with a standard error of 0.054.

most recent housing episode, though much of Florida and Phoenix, Arizona are exceptions to that pattern. Neighboring MSAs experienced similar timing and magnitudes of their cycles in the 1990s/2000s, but not so much in the 1980s.

In addition to these facts about trough-to-peak and peak-to-trough growth rates, I find that annual house price changes become more widely dispersed near the peak of a national house price cycle for both the 1980s and 2000s cycles.

Finally, these patterns persist even when demand fundamentals such as rents, median incomes, or MSA-level employment, are netted out of prices. Indeed, controlling for growth in apartment rents makes the boom-bust cycle in house price growth even clearer.

The paper has been agnostic about the possible causes of house price cycles. However, the accumulation of empirical facts limits the set of feasible explanations. Common national factors cannot easily generate differences in amplitude across MSAs unless they interact with MSA-specific characteristics and, even then, are hard to reconcile with the variation across MSAs in the start or end date of booms and busts.[17] Potential explanations that depend solely on differences across MSAs in the amount of new housing construction are at odds with the fact that cycles in price-to-rent ratios exhibit the same MSA-level heterogeneity as prices. Even if new construction attenuates house price growth in a given MSA, that new housing supply should also reduce the clearing rent, leaving price-to-rent ratios high.[18] Other models that emphasize how differences in initial conditions can yield variation in booms and busts across MSAs need to also explain how the magnitude of cycles in house prices or price-to-rent ratios can be persistent within MSAs over time and why MSAs with similar cycles are located in geographically concentrated clusters.[19] While much progress has been made on understanding the phenomena of house price booms and busts, it is clear that much work remains to be done.

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[17] Examples of this approach include Himmelberg, Mayer, and Sinai (2005) for interest rates and Brunnermeier and Julliard (2008) for money illusion.

[18] Glaeser, Gyourko, and Saiz's (2008) model sidesteps this issue by incorporating adaptive expectations, so differences across MSAs in the elasticity of supply lead to differences in short run growth expectations. Those expectations should be capitalized into the price-to-rent ratio, though their model does not make that explicit.

[19] This category of explanations includes "fads", such as Burnside, Eichenbaum, and Rebelo (2011) and subprime mortgages, such as Mian and Sufi (2009), since subprime mortgages were not prevalent in the 1980s. By contrast, Ferreira and Gyourko (2011) speculate that contagion could spread local housing booms to other areas.

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## Figure 1:

### National House Prices



Note: Indices are normalized to their 1990 price.

## Figure 2:

### Trough to Peak 2000 - Housing Price Index



*Note:* Figure plots the distribution of MSA cumulative real house price growth between (a) the house price trough of (typically) the 1990s and the house price peak of (typically) the mid-2000s; (b) 2000 and 2005; (c) the house price peak of the late 1980s/early 1990s and the peak of the mid-2000s. Data comes from FHFA, deflated by the CPI.

Figure 3:



**Trough to Peak 2000 - Housing Price Index**

*Note:* Figure plots the distribution of MSA <u>average</u> real house price growth between the house price trough of (typically) the 1990s and the house price peak of (typically) the mid-2000s. Data comes from FHFA, deflated by the CPI.

Figure 4:



**Peak to Trough 2000 - Housing Price Index**

*Note:* Figure plots the distribution of MSA cumulative real house price growth between (a) the house price peak of (typically) the mid-2000s and the subsequent house price trough, often 2010; (b) 2005 and 2010. Data comes from FHFA, deflated by the CPI.

Figure 5:

## FHFA Change in HPI



*Note:* Figure plots the MSA cumulative real house price growth between the house price trough of (typically) the 1990s and the house price peak of (typically) the mid-2000s against the subsequent house price decline. Data comes from FHFA, deflated by the CPI. The curved dot-dash line demarcates the percentage decline in house prices that would exactly undo the prior growth in prices. The straight lines are the fitted bivariate regression lines; the dashed one uses unweighted observations and the dotted one uses observations weighted by 1990 housing units.

Figure 6:

## FHFA Change in HPI
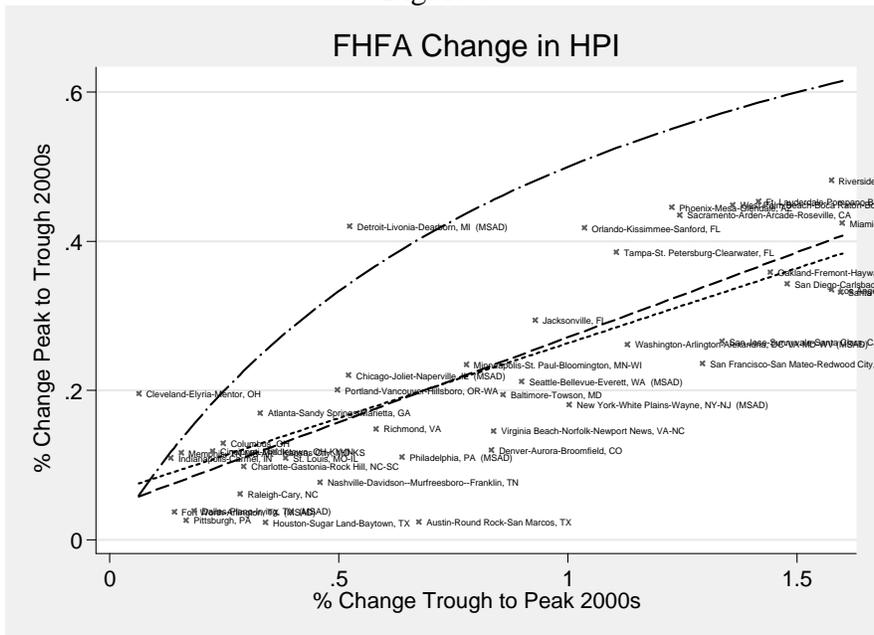


*Note:* See the notes to Figure 5. This Figure uses the subset of MSAs that also are in the REIS sample.

Figure 7:
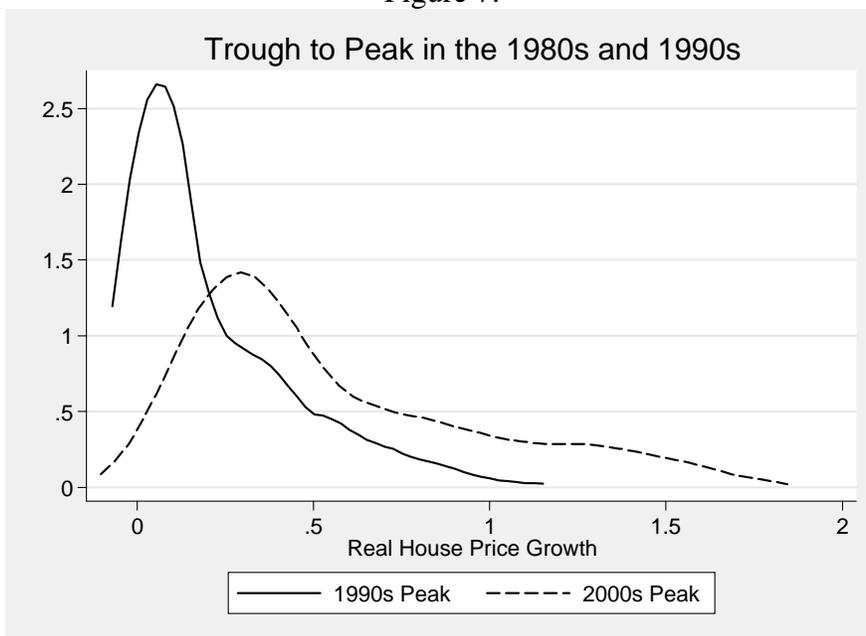


**Trough to Peak in the 1980s and 1990s**

*Note:* Figure plots the distribution of MSA cumulative real house price growth between the house price trough of (typically) the 1980s and the house price peak of (typically) the late 1980s to early-1990s. Data comes from FHFA, deflated by the CPI.
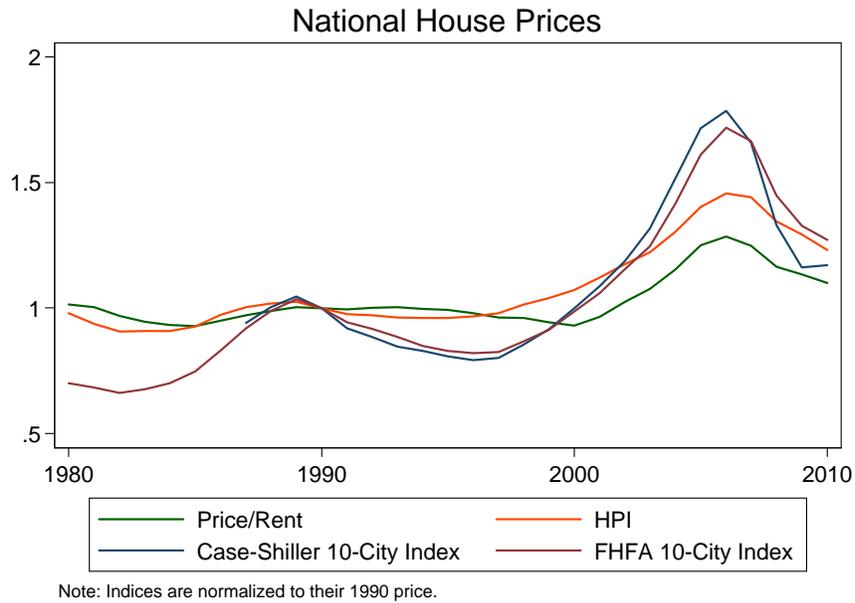
Figure 8:
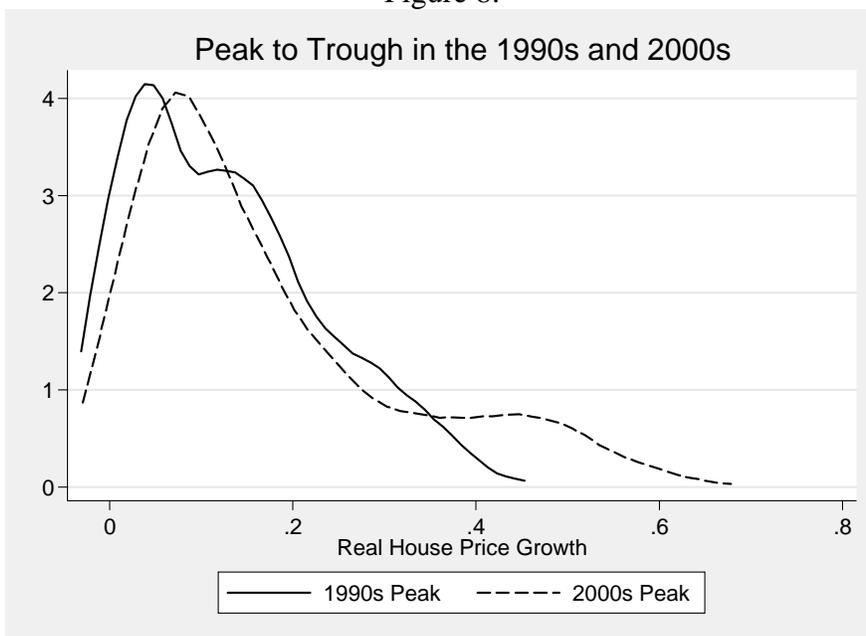


**Peak to Trough in the 1990s and 2000s**

*Note:* Figure plots the distribution of MSA cumulative real house price declines between the house price peak of (typically) the late 1980s to early-1990s and the house price trough of (typically) the mid-1990s. Data comes from FHFA, deflated by the CPI.

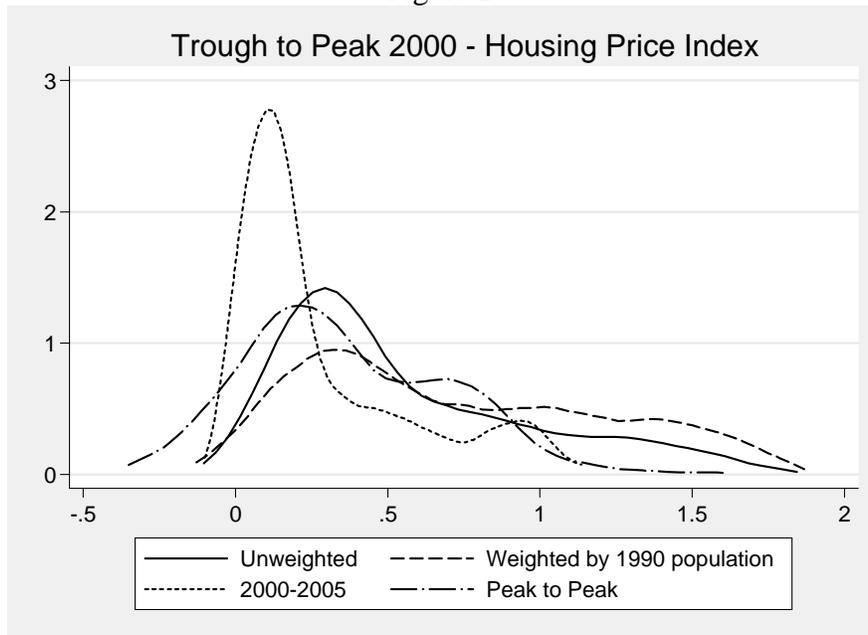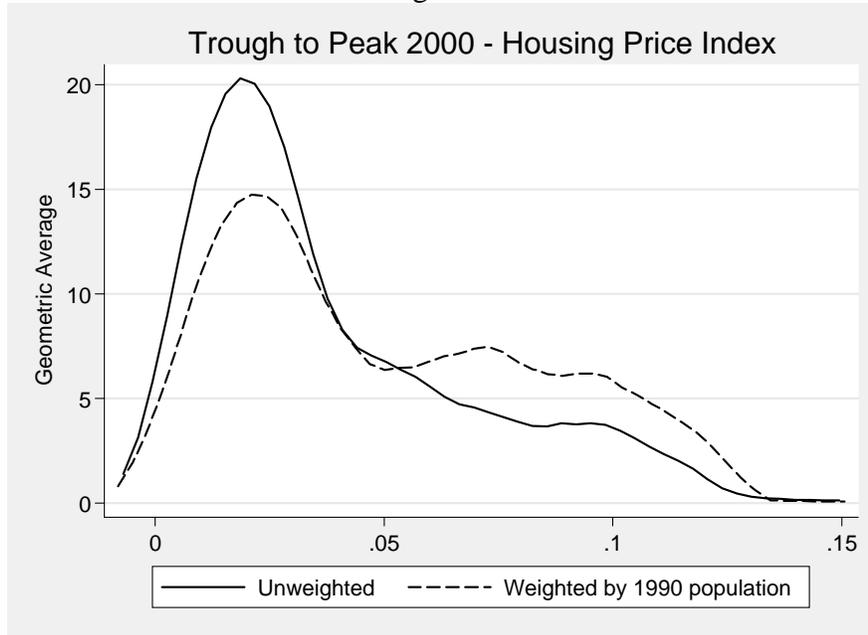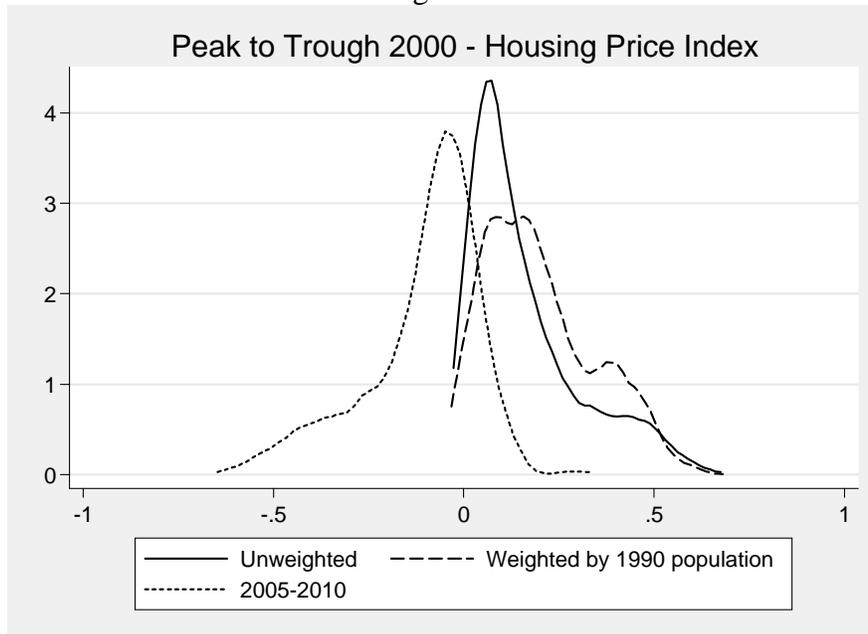Figure 9:



*Note:* Figure plots the MSA cumulative real house price growth between the house price trough of (typically) the 1990s and the house price peak of (typically) the mid-2000s against trought-to-peak house price growth in the boom of the 1990s. Data comes from FHFA, deflated by the CPI. The straight lines are the fitted bivariate regression lines; the dashed one uses unweighted observations and the dotted one uses observations weighted by 1990 housing units.

Figure 10:



*Note:* See the notes to Figure 9. This Figure uses the subset of MSAs that also are in the REIS sample.

Figure 11: Peak and Trough Years for Real House Prices
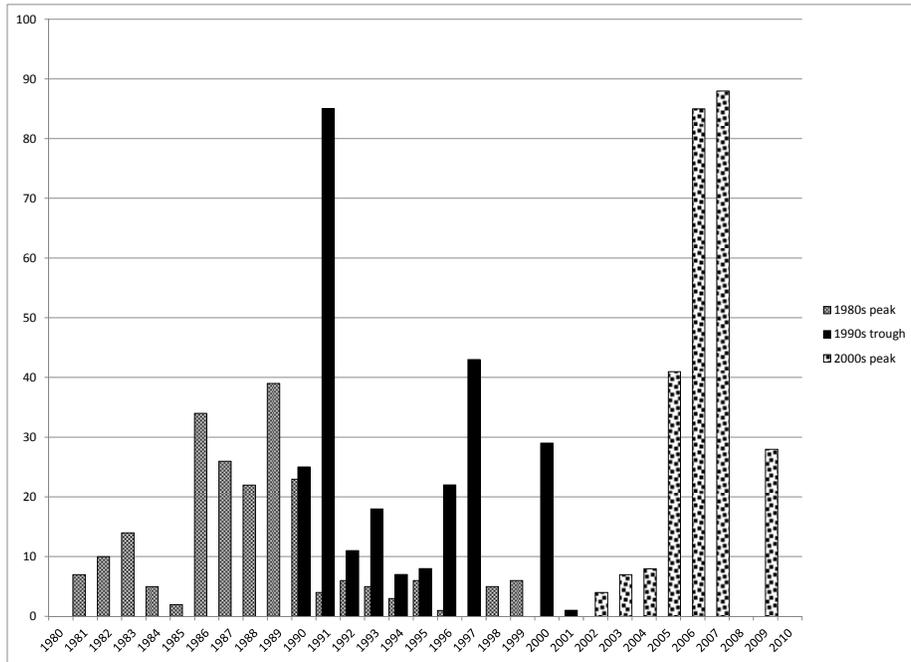


*Note:* Figure plots the histogram of peak and trough years for real house price cycles.  See Section 1 for details on the data construction.

Figure 12: Geography of Trough to Peak House Price Growth, 1990s to the 2000s
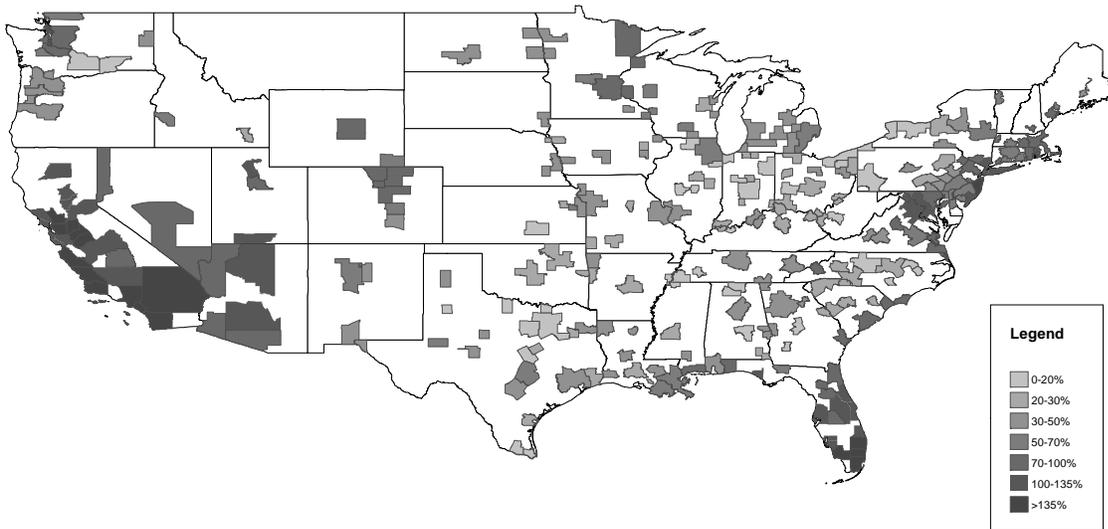


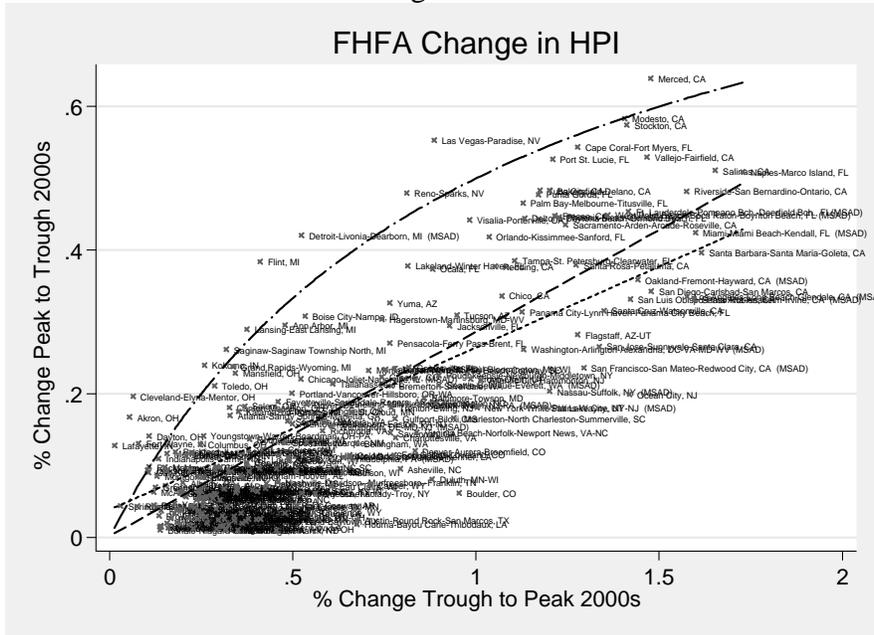*Note:* Figure maps the MSA cumulative real house price growth between the house price trough of (typically) the 1990s and the house price peak of (typically) the mid-2000s.  Data comes from FHFA, deflated by the CPI.

Figure 13: Geography of Peak to Trough House Price Growth, 2000s
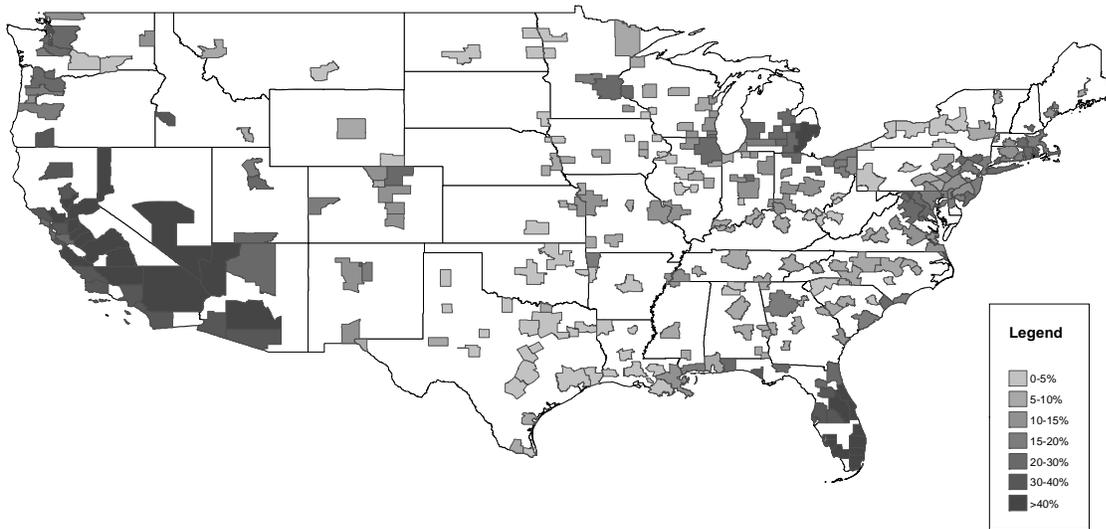


Legend
0-5%
5-10%
10-15%
15-20%
20-30%
30-40%
>40%

*Note:* Figure maps the MSA cumulative real house price declines between the house price peak of (typically) the mid-2000s and the subsequent trough. Data comes from FHFA, deflated by the CPI.

Figure 14: Starting date of the 1990s/2000s boom



Legend
1990
1991
1992
1993
1994
1995
1996
1997
1998 - 2001
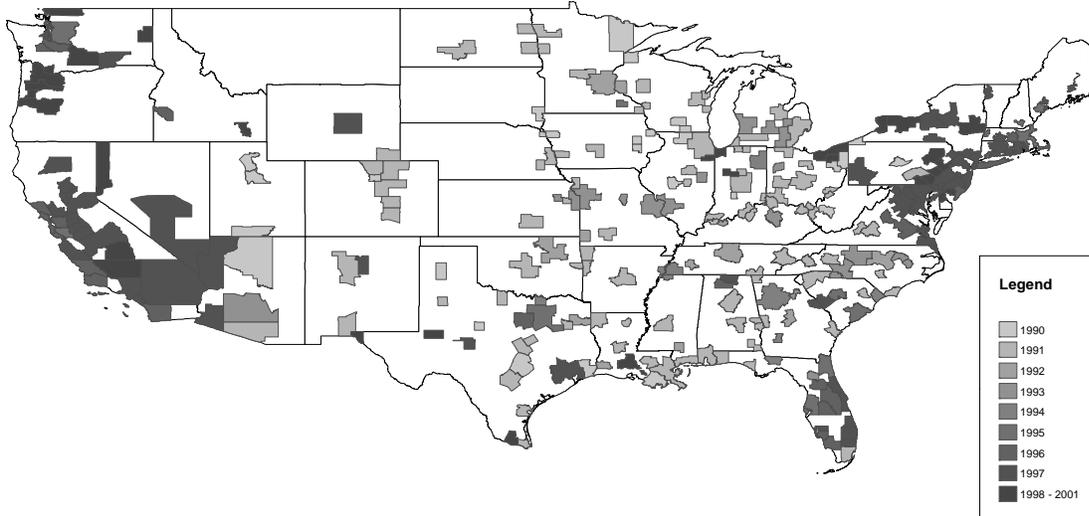
*Note:* Figure maps the date of the house price trough of (typically) the 1990s. Data comes from FHFA, deflated by the CPI.

Figure 15: Peak of the 1990s/2000s boom
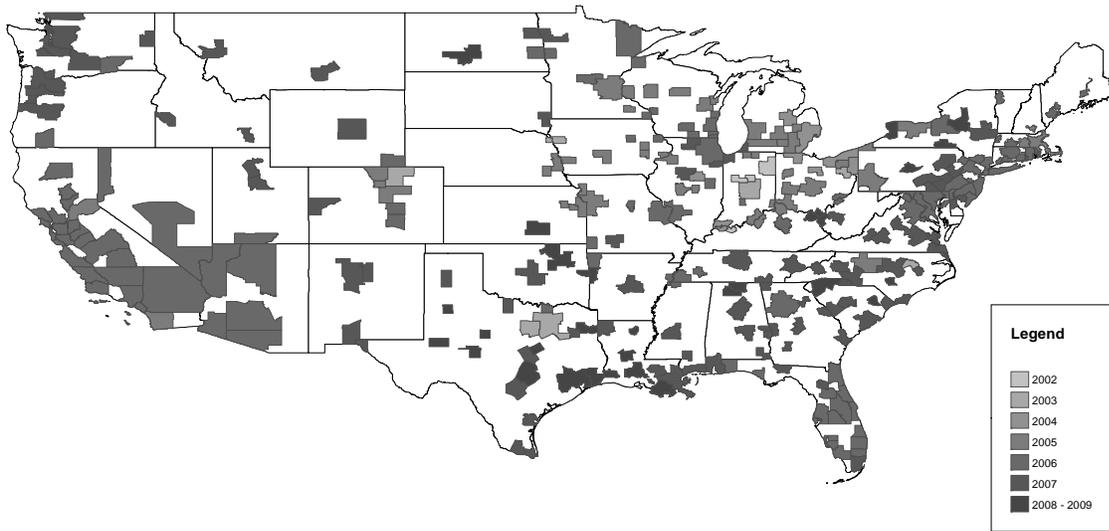


*Note:* Figure maps the date of the house price peak of the mid-2000s. Data comes from FHFA, deflated by the CPI.

Figure 16: The Standard Deviation of MSA-level Annual Real House Price Growth, 1981-2010
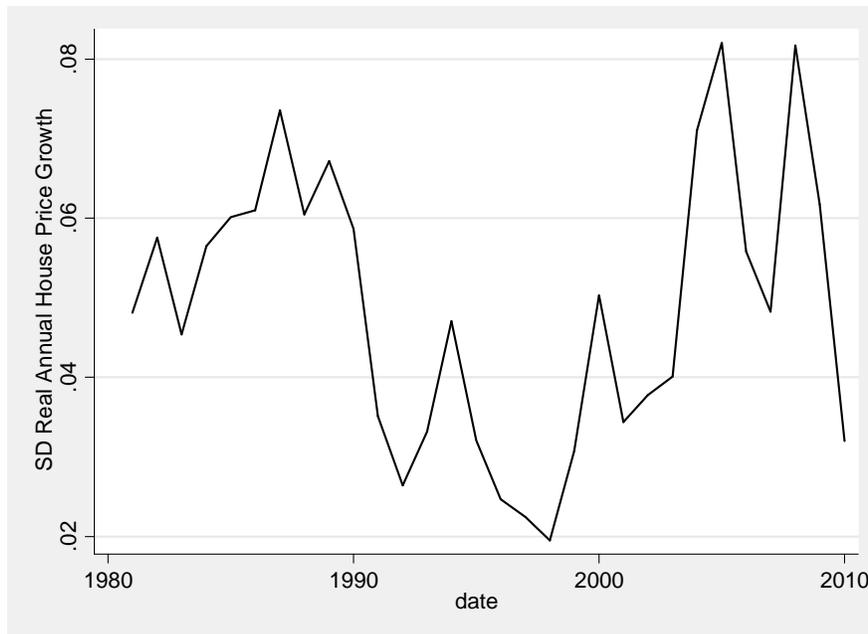


*Note:* Figure graphs the standard deviation of annual real house price growth across MSAs in each year. Data comes from FHFA, deflated by the CPI.

Figure 17: The Distribution of Annual Real House Price Growth, by Year
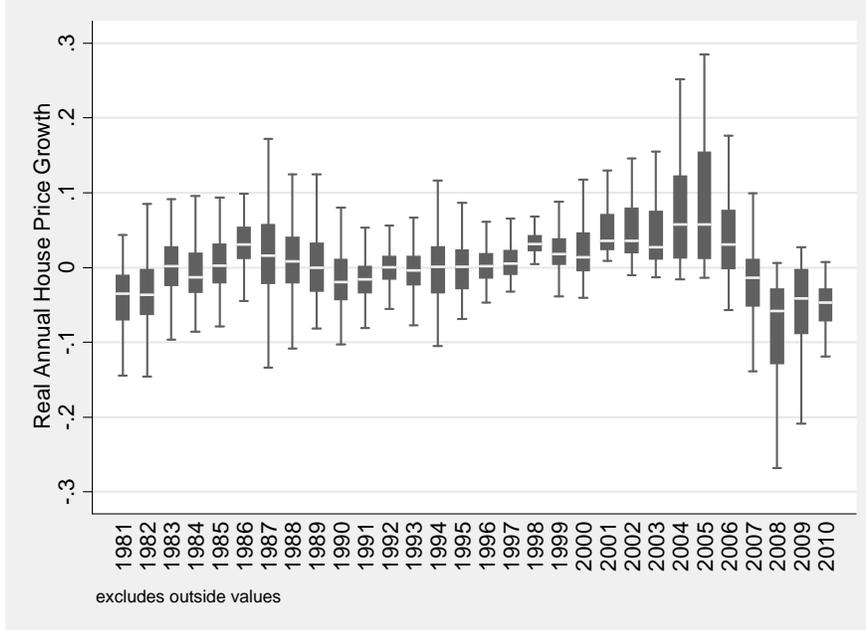


*Note:* Figure plots the distribution of annual real house price growth across MSAs in each year. The black bar runs from the 25th to the 75th percentiles. The horizontal white line corresponds to the median. Data comes from FHFA, deflated by the CPI.

Figure 18: Trough to Peak Growth in House Prices and Housing Demand Fundamentals, 1990s-2000s boom
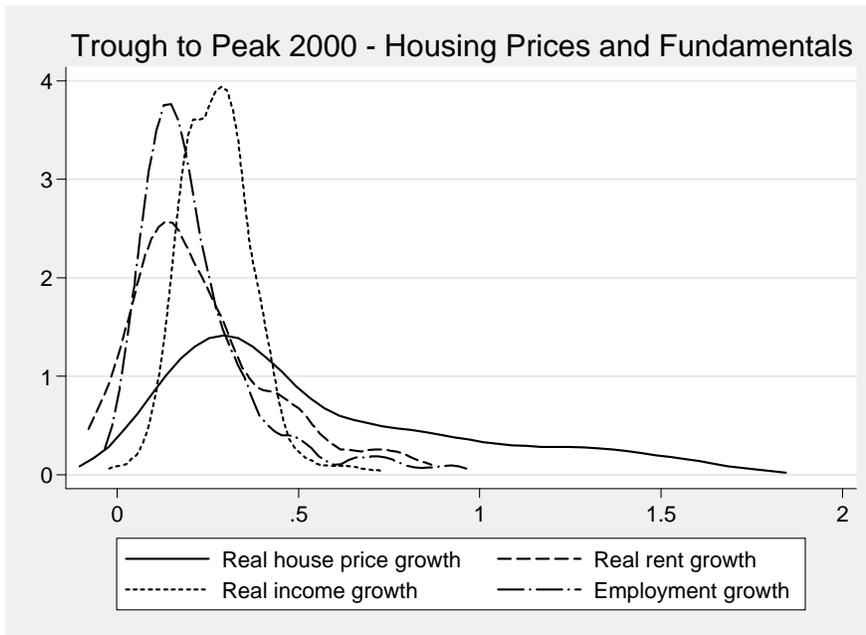


Note: Figure graphs the distribution of cumulative growth in real house prices, real rents, real MSA income, and MSA employment from each variable's trough in the 1990s to its peak in the 2000s. Data comes from FHFA, REIS, and BLS.

Figure 19:

## Change in REIS Rent Index
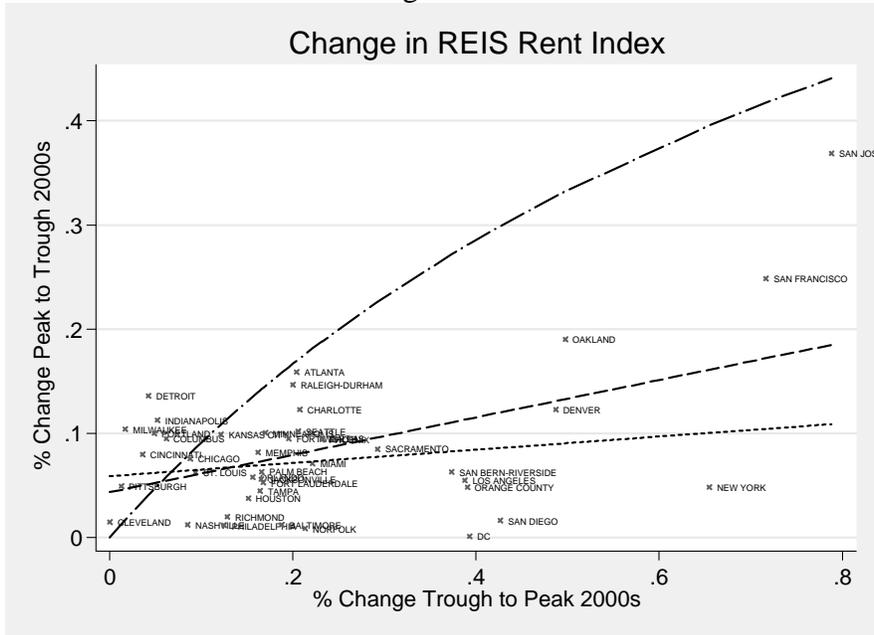


*Note:* Figure plots the MSA cumulative real rent growth between the rent trough of (typically) the 1990s and the rent peak of (typically) the mid-2000s against the subsequent rent decline. Data comes from REIS, deflated by the CPI. The curved dot-dash line demarcates the percentage decline in rents that would exactly undo the prior growth in rents. The straight lines are the fitted bivariate regression lines; the dashed one uses unweighted observations and the dotted one uses observations weighted by 1990 housing units.

Figure 20:
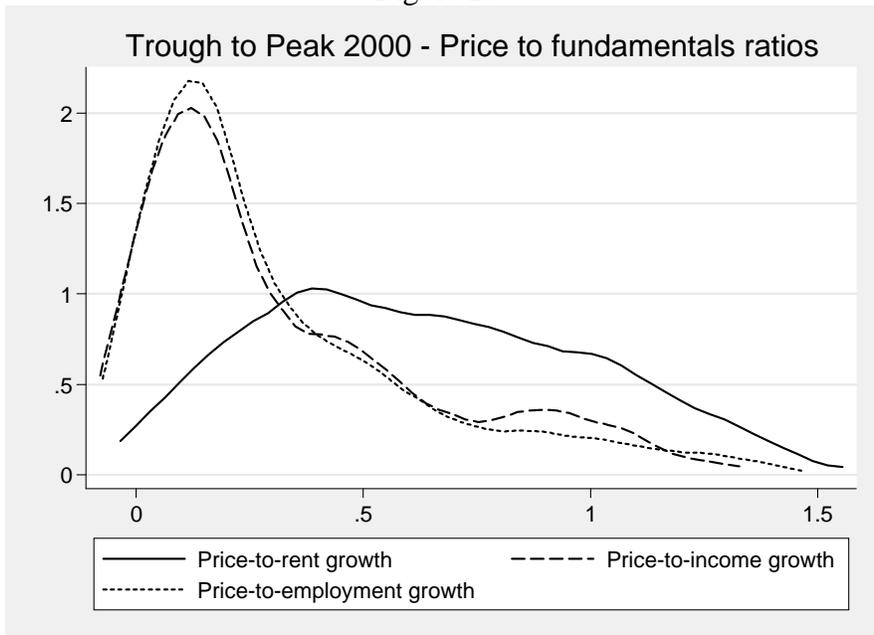
## Trough to Peak 2000 - Price to fundamentals ratios



Note: Figure graphs the distribution of cumulative growth in the price-to-rent, price-to-income, and price-to-employment ratios from each variable's trough in the 1990s to its peak in the 2000s. Data comes from FHFA, REIS, and BLS.

Figure 21:

## Change in Price-to-rent Ratio
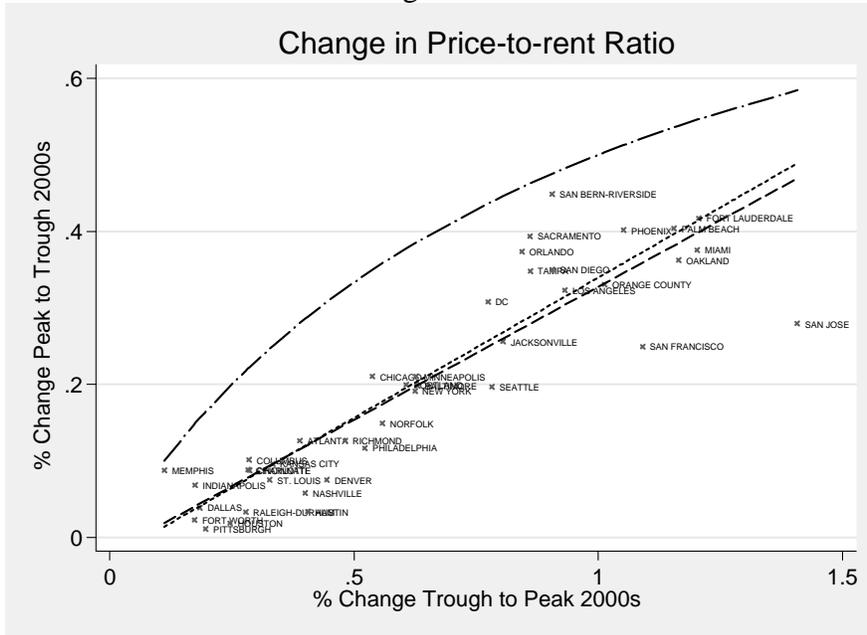


*Note:* Figure plots the MSA cumulative growth in the price-to-rent ratio between the R/P trough of (typically) the 1990s and the R/P peak of (typically) the mid-2000s against the subsequent R/P decline. Data comes from REIS and FHFA. The curved dot-dash line demarcates the percentage decline in R/P that would exactly undo the prior growth in R/P. The straight lines are the fitted bivariate regression lines; the dashed one uses unweighted observations and the dotted one uses observations weighted by 1990 housing units.

Figure 22: The Standard Deviation of MSA-level Annual Growth in Demand Fundamentals
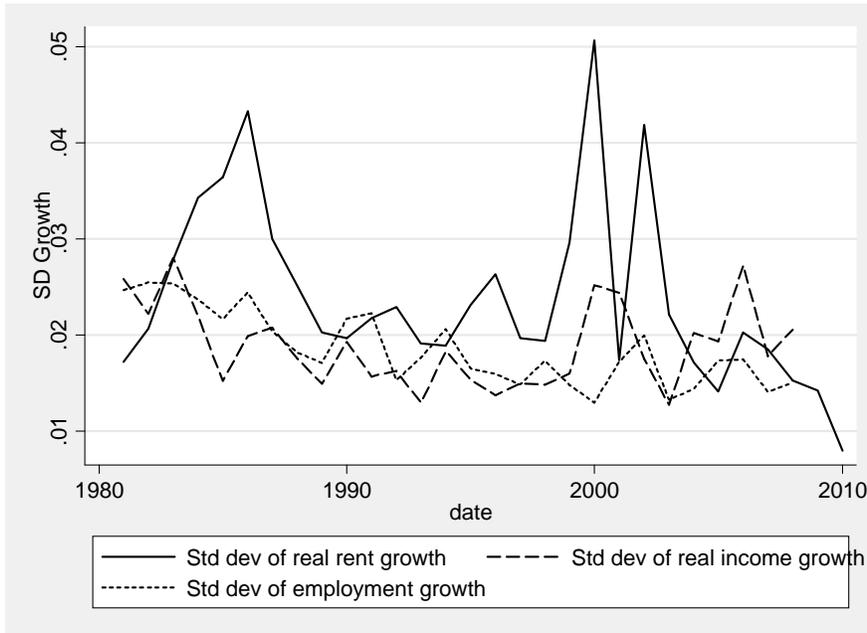


*Note:* Figure graphs the standard deviations of annual real rent, real income, and employment growth across MSAs in each year. Data comes from REIS and BLS, deflated by the CPI.

Figure 23: Standard Deviations of Conditional and Unconditional Annual House Price Growth
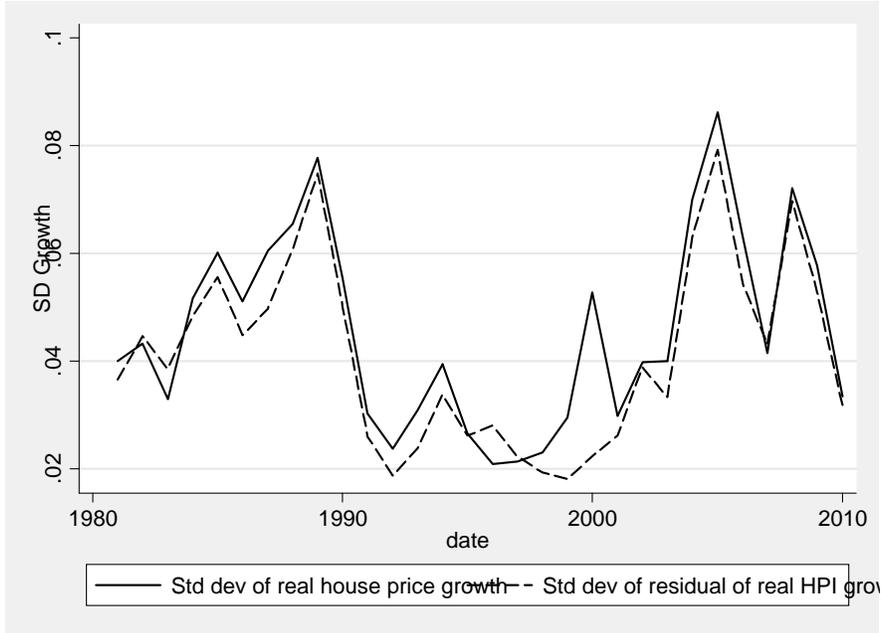


*Note:* Figure graphs the standard deviations of real house prices and the residuals from a MSA-level regression of real house price growth on real rent growth. Data comes from REIS and FHFA, deflated by the CPI.

Figure 24: The Distribution of Annual Real Rent Growth, by Year
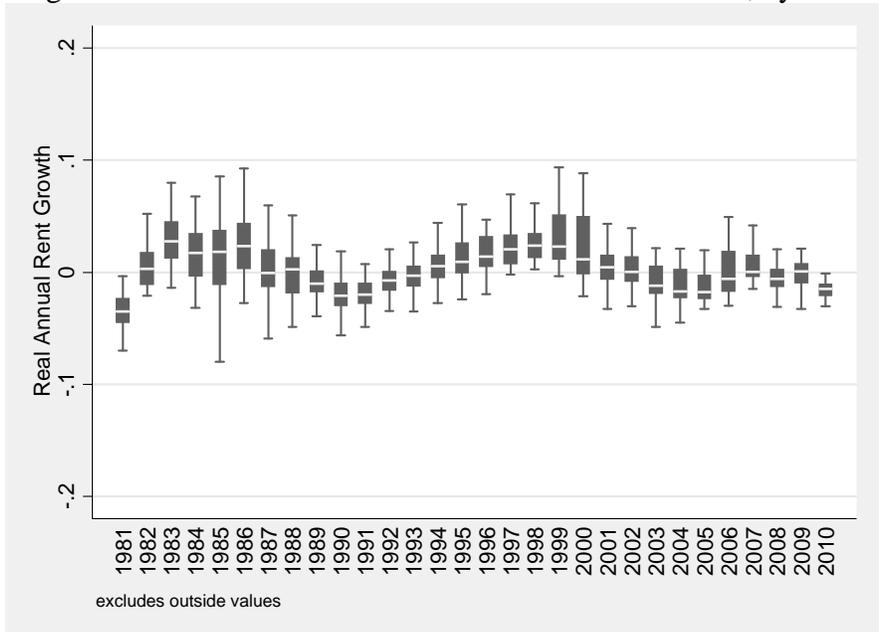


*Note:* Figure plots the distribution of annual rent growth across MSAs in each year. The black bar runs from the 25th to the 75th percentiles. The horizontal white line corresponds to the median. Data comes from REIS, deflated by the CPI.

Figure 25: The Distribution of Conditional Annual Real House Price Growth, by Year
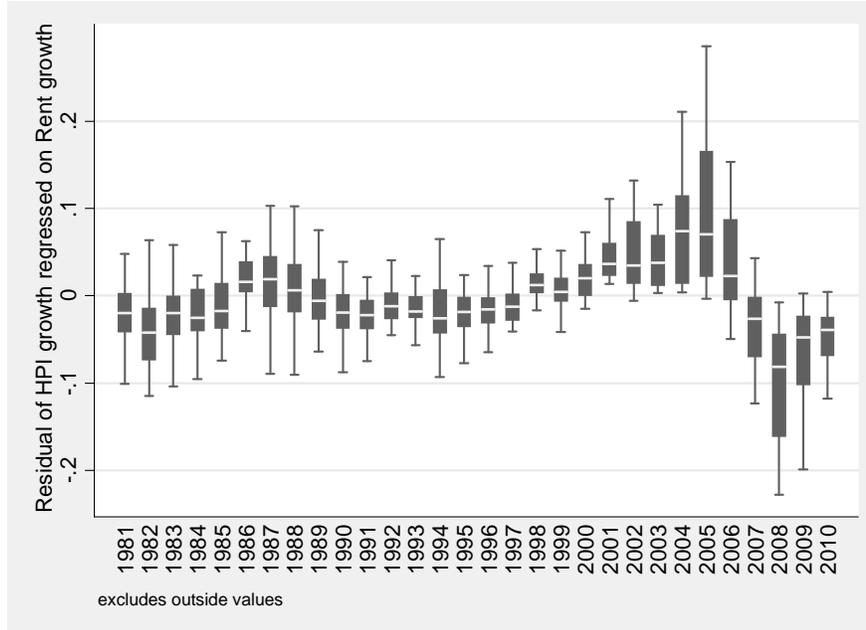


*Note:* Figure graphs the distributions of the residuals from a MSA-level regression of real house price growth on real rent growth. The black bar runs from the 25th to the 75th percentiles. The horizontal white line corresponds to the median. Data comes from REIS and FHFA, deflated by the CPI.

Table 1: Bivariate Regression Results

| | (1) Real house prices | (2) Real rent | (3) Real income | (4) Employ-ment | (5) P/R | (6) P/Income | (7) P/Emp |
|---|---|---|---|---|---|---|---|
| **REIS sample** | | | | | | | |
| Regress peak-to-trough growth in the 2000s on trough-to-peak growth in the 1990s/2000s (N=43/43/41/44/44/33/44) | 0.201 (0.028) | 0.063 (0.045) | 0.094 (0.042) | -0.008 (0.024) | 0.366 (0.027) | 0.176 (0.024) | 0.122 (0.024) |
| Regress peak-to-trough growth in the 1990s on trough-to-peak growth in the 1980s/1990s (N=42/41/32/30/43/27/38) | 0.134 (0.060) | -0.108 (0.117) | -0.128 (0.065) | -0.060 (0.028) | 0.351 (0.068) | 0.197 (0.082) | -0.017 (0.093) |
| Regress trough-to-peak growth in the 2000s on trough-to-peak growth in the 1980s/1990s (N=42/41/32/30/43/25/38) | 0.670 (0.232) | 0.357 (0.350) | -0.299 (0.234) | 0.201 (0.167) | 0.430 (0.217) | 1.014 (0.204) | 0.691 (0.216) |
| **Full FHFA sample** | | | | | | | |
| Regress peak-to-trough growth in the 2000s on trough-to-peak growth in the 1990s/2000s (N=249/./.243/262/183/260) | 0.226 (0.012) | | 0.064 (0.018) | -0.008 (0.011) | | 0.179 (0.010) | 0.152 (0.011) |
| Regress peak-to-trough growth in the 1990s on trough-to-peak growth in the 1980s/1990s (N=165/./.147/203/92/189) | 0.144 (0.030) | | -0.059 (0.025) | -0.063 (0.016) | | 0.241 (0.040) | 0.019 (0.045) |
| Regress trough-to-peak growth in the 2000s on trough-to-peak growth in the 1980s/1990s (N=165/./.137/203/189) | 0.693 (0.117) | | -0.123 (0.100) | 0.176 (0.093) | | 1.125 (0.098) | 0.815 (0.103) |

Appendix Table A: Real House Price Trough and Peak Dates and Cumulative Growth Rates, by MSA

| MSA | 1980s Trough | 1990s Peak | 1990s Trough | 2000s Peak | 1980s Trough to 1990s Peak | 1990s Peak to 1990s Trough | 1990s Trough to 2000s Peak | 2000s Peak to 2010 |
|---|---|---|---|---|---|---|---|---|
| Abilene, TX | | | 1990 | 2009 | | | 30% | 2% |
| Akron, OH | 1984 | 1999 | 2000 | 2005 | 34% | 1% | 5% | 17% |
| Albany, GA | 1992 | 1993 | 1994 | 2007 | 0% | 1% | 20% | 8% |
| Albany-Schenectady-Troy, NY | 1982 | 1989 | 2000 | 2007 | 81% | 25% | 52% | 6% |
| Albuquerque, NM | 1982 | 1986 | 1991 | 2007 | 7% | 15% | 54% | 13% |
| Alexandria, LA | | | 1991 | 2009 | | | 41% | 3% |
| Allentown-Bethlehem-Easton, PA-NJ | 1983 | 1989 | 2000 | 2007 | 56% | 24% | 50% | 16% |
| Amarillo, TX | 1982 | 1984 | 1990 | 2007 | 3% | 31% | 36% | 2% |
| Ann Arbor, MI | 1985 | 1989 | 1993 | 2005 | 29% | 3% | 48% | 30% |
| Appleton, WI | | 1986 | 1991 | 2005 | | 5% | 29% | 10% |
| Asheville, NC | | 1987 | 1991 | 2007 | | 3% | 79% | 10% |
| Athens-Clarke County, GA | | 1986 | 1993 | 2007 | | 8% | 38% | 9% |
| Atlanta-Sandy Springs-Marietta, GA | 1982 | 1987 | 1994 | 2006 | 13% | 12% | 33% | 17% |
| Atlantic City-Hammonton, NJ | 1984 | 1989 | 1996 | 2006 | 34% | 22% | 101% | 22% |
| Auburn-Opelika, AL | 1989 | 1990 | 1991 | 2007 | 1% | 3% | 41% | 10% |
| Augusta-Richmond County, GA-SC | 1983 | 1987 | 1997 | 2007 | 9% | 13% | 24% | 6% |
| Austin-Round Rock-San Marcos, TX | 1981 | 1985 | 1990 | 2009 | 22% | 38% | 67% | 2% |
| Bakersfield-Delano, CA | 1985 | 1986 | 2000 | 2006 | 1% | 24% | 120% | 48% |
| Baltimore-Towson, MD | 1982 | 1989 | 1997 | 2006 | 30% | 11% | 86% | 19% |
| Baton Rouge, LA | 1981 | 1982 | 1991 | 2007 | 0% | 34% | 48% | 3% |
| Beaumont-Port Arthur, TX | 1982 | 1983 | 1990 | 2009 | 1% | 30% | 24% | 3% |
| Bellingham, WA | 1987 | 1995 | 2000 | 2007 | 60% | 2% | 67% | 13% |
| Billings, MT | | | | 2007 | | | | 3% |
| Binghamton, NY | | 1987 | 1997 | 2009 | | 35% | 37% | 2% |
| Birmingham-Hoover, AL | 1982 | 1987 | 1991 | 2007 | 10% | 7% | 36% | 9% |
| Bismarck, ND | | 1987 | 1991 | 2009 | | 13% | 45% | 1% |

| Area | | | | | | | | |
|------|------|------|------|------|------|------|------|------|
| Bloomington, IN | | 1989 | 1990 | 2006 | | 3% | 27% | 2% |
| Bloomington-Normal, IL | | 1987 | 1991 | 2004 | | 8% | 21% | 6% |
| Boise City-Nampa, ID | | 1981 | 1996 | 2007 | | 7% | 53% | 31% |
| Boulder, CO | 1981 | 1982 | 1990 | 2005 | 8% | 15% | 95% | 6% |
| Bremerton-Silverdale, WA | 1988 | 1994 | 1997 | 2007 | 33% | 2% | 77% | 21% |
| Brownsville-Harlingen, TX | | | 1991 | 2007 | | | 13% | 3% |
| Buffalo-Niagara Falls, NY | 1983 | 1992 | 2000 | 2009 | 35% | 15% | 14% | 1% |
| Canton-Massillon, OH | 1985 | 1989 | 1990 | 2003 | 3% | 0% | 33% | 18% |
| Cape Coral-Fort Myers, FL | 1985 | 1989 | 1996 | 2006 | 7% | 11% | 128% | 54% |
| Casper, WY | 1989 | 1996 | 1997 | 2007 | 34% | 0% | 71% | 7% |
| Cedar Rapids, IA | 1985 | 1989 | 1990 | 2005 | 4% | 1% | 24% | 6% |
| Champaign-Urbana, IL | | 1987 | 1993 | 2006 | | 10% | 26% | 6% |
| Charleston, WV | | | 1990 | 2007 | | | 19% | 2% |
| Charleston-North Charleston-Summerville, | | 1982 | 1995 | 2007 | | 17% | 94% | 17% |
| Charlotte-Gastonia-Rock Hill, NC-SC | 1983 | 1989 | 1993 | 2007 | 18% | 7% | 29% | 10% |
| Charlottesville, VA | 1985 | 1989 | 1996 | 2007 | 16% | 5% | 78% | 14% |
| Chattanooga, TN-GA | 1984 | 1988 | 1991 | 2007 | 11% | 9% | 34% | 6% |
| Cheyenne, WY | 1982 | 1983 | 1991 | 2006 | 8% | 22% | 56% | 3% |
| Chicago-Joliet-Naperville, IL (MSAD) | 1982 | 1990 | 1991 | 2006 | 31% | 1% | 52% | 22% |
| Chico, CA | | 1981 | 1997 | 2006 | | 13% | 107% | 34% |
| Cincinnati-Middletown, OH-KY-IN | 1985 | 1989 | 1991 | 2005 | 10% | 2% | 22% | 12% |
| Cleveland-Elyria-Mentor, OH | 1985 | 1999 | 2000 | 2004 | 27% | 0% | 6% | 20% |
| College Station-Bryan, TX | | | | | | | | |
| Colorado Springs, CO | 1981 | 1986 | 1991 | 2006 | 9% | 20% | 65% | 11% |
| Columbia, MO | | | 1993 | 2006 | | | 29% | 6% |
| Columbia, SC | 1984 | 1987 | 1995 | 2007 | 7% | 7% | 24% | 5% |
| Columbus, GA-AL | | 1987 | 1991 | 2007 | | 12% | 32% | 9% |
| Columbus, OH | 1985 | 1988 | 1991 | 2005 | 10% | 2% | 25% | 13% |
| Corpus Christi, TX | 1981 | 1982 | 1991 | 2007 | 9% | 35% | 28% | 6% |
| Corvallis, OR | 1988 | 1998 | 2000 | 2007 | 77% | 4% | 37% | 10% |
| Dallas-Plano-Irving, TX (MSAD) | 1982 | 1986 | 1995 | 2003 | 7% | 32% | 18% | 4% |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Davenport-Moline-Rock Island, IA-IL | | | | 2005 | | | | 4% |
| Dayton, OH | 1982 | 1988 | 1991 | 2005 | 19% | 2% | 11% | 14% |
| Decatur, AL | 1991 | 1993 | 1996 | 2009 | 2% | 4% | 14% | 2% |
| Decatur, IL | 1988 | 1989 | 1991 | 2005 | 2% | 2% | 12% | 4% |
| Deltona-Daytona Beach-Ormond Beach, FL | 1981 | 1987 | 1997 | 2006 | 22% | 13% | 113% | 44% |
| Denver-Aurora-Broomfield, CO | 1981 | 1983 | 1991 | 2005 | 4% | 25% | 83% | 12% |
| Des Moines-West Des Moines, IA | 1982 | 1983 | 1991 | 2005 | 4% | 7% | 33% | 9% |
| Detroit-Livonia-Dearborn, MI  (MSAD) | 1984 | 1990 | 1991 | 2004 | 26% | 0% | 52% | 42% |
| Dothan, AL | | | 1991 | 2007 | | | 25% | 7% |
| Dover, DE | | 1990 | 2000 | 2007 | | 10% | 54% | 19% |
| Dubuque, IA | 1987 | 1989 | 1990 | 2006 | 2% | 2% | 38% | 3% |
| Duluth, MN-WI | 1987 | 1989 | 1990 | 2006 | 5% | 0% | 88% | 8% |
| Eau Claire, WI | 1987 | 1988 | 1991 | 2005 | 2% | 5% | 61% | 7% |
| El Paso, TX | | 1983 | 2000 | 2007 | | 28% | 35% | 7% |
| Elkhart-Goshen, IN | | 1986 | 1991 | 2005 | | 10% | 21% | 11% |
| Erie, PA | 1985 | 1989 | 1990 | 2005 | 7% | 1% | 19% | 4% |
| Eugene-Springfield, OR | 1986 | 1999 | 2000 | 2007 | 70% | 2% | 47% | 18% |
| Evansville, IN-KY | 1985 | 1986 | 1991 | 2004 | 2% | 14% | 26% | 8% |
| Fargo, ND-MN | | | 1991 | 2006 | | | 31% | 3% |
| Fayetteville, NC | | | 1991 | 2009 | | | 14% | 1% |
| Fayetteville-Springdale-Rogers, AR-MO | 1981 | 1982 | 1991 | 2006 | 5% | 12% | 46% | 19% |
| Flagstaff, AZ-UT | | 1987 | 1990 | 2006 | | 7% | 128% | 28% |
| Flint, MI | 1984 | 1992 | 1993 | 2005 | 7% | 0% | 41% | 38% |
| Florence, SC | 1987 | 1988 | 1991 | 2009 | 1% | 3% | 23% | 4% |
| Fort Collins-Loveland, CO | 1982 | 1983 | 1991 | 2005 | 8% | 15% | 78% | 11% |
| Fort Smith, AR-OK | | | 1991 | 2009 | | | 22% | 4% |
| Fort Wayne, IN | 1984 | 1987 | 1994 | 2002 | 13% | 11% | 8% | 13% |
| Fort Worth-Arlington, TX  (MSAD) | 1982 | 1986 | 1996 | 2003 | 4% | 30% | 14% | 4% |
| Fresno, CA | 1988 | 1992 | 1997 | 2006 | 11% | 16% | 121% | 45% |
| Ft. Lauderdale-Pompano Bch.-Deerfield Bc | | 1981 | 1997 | 2006 | | 15% | 142% | 45% |
| Gainesville, FL | | 1986 | 1993 | 2007 | | 14% | 82% | 24% |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Gary, IN  (MSAD) | 1987 | 1998 | 2000 | 2007 | 28% | 2% | 11% | 9% |
| Grand Forks, ND-MN | | | 1991 | 2007 | | | 40% | 3% |
| Grand Junction, CO | | | | 2007 | | | | 15% |
| Grand Rapids-Wyoming, MI | 1984 | 1989 | 1993 | 2005 | 16% | 3% | 34% | 24% |
| Greeley, CO | | 1986 | 1991 | 2003 | | 19% | 74% | 22% |
| Green Bay, WI | | 1986 | 1991 | 2005 | | 5% | 42% | 13% |
| Greensboro-High Point, NC | 1983 | 1988 | 1993 | 2005 | 17% | 9% | 12% | 7% |
| Greenville, NC | | 1987 | 1993 | 2007 | | 10% | 15% | 7% |
| Greenville-Mouldin-Easley, SC | | 1981 | 1991 | 2009 | | 8% | 24% | 4% |
| Gulfport-Biloxi, MS | | 1988 | 1991 | 2007 | | 16% | 78% | 17% |
| Hagerstown-Martinsburg, MD-WV | | 1990 | 1996 | 2006 | | 6% | 74% | 30% |
| Harrisburg-Carlisle, PA | 1984 | 1989 | 1991 | 2007 | 14% | 2% | 26% | 6% |
| Hattiesburg, MS | | | 1992 | 2007 | | | 43% | 8% |
| Hickory-Lenoir-Morganton, NC | 1987 | 1989 | 1991 | 2007 | 3% | 1% | 25% | 5% |
| Houma-Bayou Cane-Thibodaux, LA | | | 1990 | 2009 | | | 68% | 2% |
| Houston-Sugar Land-Baytown, TX | 1981 | 1982 | 1997 | 2009 | 5% | 40% | 34% | 2% |
| Huntington-Ashland, WV-KY-OH | 1989 | 1990 | 1991 | 2009 | 0% | 4% | 29% | 1% |
| Huntsville, AL | | 1987 | 1997 | 2009 | | 15% | 18% | 2% |
| Indianapolis-Carmel, IN | 1985 | 1988 | 1991 | 2003 | 9% | 2% | 13% | 11% |
| Iowa City, IA | 1988 | 1989 | 1990 | 2005 | 5% | 1% | 30% | 5% |
| Jackson, MI | | | | 2005 | | | | 29% |
| Jackson, MS | 1982 | 1986 | 1991 | 2007 | 4% | 20% | 20% | 6% |
| Jackson, TN | | | 1992 | 2006 | | | 10% | 9% |
| Jacksonville, FL | 1981 | 1986 | 1995 | 2006 | 11% | 15% | 93% | 29% |
| Janesville, WI | 1988 | 1989 | 1990 | 2006 | 2% | 0% | 47% | 14% |
| Joplin, MO | | | 1992 | 2006 | | | 24% | 7% |
| Kalamazoo-Portage, MI | 1985 | 1988 | 1991 | 2005 | 6% | 1% | 35% | 17% |
| Kankakee-Bradley, IL | | 1998 | 2000 | 2007 | | 2% | 16% | 9% |
| Kansas City, MO-KS | 1984 | 1987 | 1993 | 2005 | 4% | 14% | 36% | 12% |
| Kennewick-Pasco-Richland, WA | 1988 | 1994 | 1997 | 2006 | 48% | 11% | 14% | 1% |
| Killeen-Temple-Fort Hood, TX | | | 1991 | 2007 | | | 18% | 3% |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Knoxville, TN | 1985 | 1987 | 1991 | 2007 | 5% | 6% | 35% | 7% |
| Kokomo, IN | | | 1991 | 2002 | | | 26% | 24% |
| La Crosse, WI-MN | | 1986 | 1991 | 2006 | | 11% | 51% | 4% |
| Lafayette, IN | | 1999 | 2000 | 2002 | | 1% | 1% | 13% |
| Lafayette, LA | | 1982 | 2000 | 2009 | | 36% | 25% | 3% |
| Lake Charles, LA | | | 1992 | 2009 | | | 34% | 3% |
| Lake County-Kenosha County, IL-WI (MSAD | | | | 2006 | | | | 21% |
| Lakeland-Winter Haven, FL | 1985 | 1986 | 1996 | 2006 | 0% | 14% | 81% | 38% |
| Lancaster, PA | 1984 | 1990 | 2000 | 2007 | 25% | 8% | 31% | 7% |
| Lansing-East Lansing, MI | | 1981 | 1993 | 2005 | | 14% | 37% | 29% |
| Las Cruces, NM | | 1986 | 1991 | 2007 | | 14% | 42% | 12% |
| Las Vegas-Paradise, NV | | 1982 | 1997 | 2006 | | 19% | 89% | 55% |
| Lawrence, KS | 1988 | 1989 | 1991 | 2005 | 1% | 6% | 51% | 9% |
| Lexington-Fayette, KY | 1982 | 1983 | 1993 | 2006 | 7% | 13% | 28% | 5% |
| Lima, OH | 1985 | 1988 | 1993 | 2005 | 4% | 4% | 22% | 12% |
| Lincoln, NE | 1985 | 1986 | 1991 | 2005 | 1% | 6% | 30% | 10% |
| Little Rock-North Little Rock-Conway, AR | 1982 | 1986 | 1991 | 2007 | 7% | 19% | 25% | 4% |
| Longview, TX | 1985 | 1986 | 1992 | 2009 | 1% | 20% | 32% | 1% |
| Los Angeles-Long Beach-Glendale, CA  (MS | 1984 | 1990 | 1997 | 2006 | 61% | 34% | 158% | 34% |
| Louisville-Jefferson County, KY-IN | 1984 | 1989 | 1991 | 2005 | 9% | 2% | 35% | 7% |
| Lubbock, TX | | 1981 | 1991 | 2009 | | 28% | 16% | 1% |
| Lynchburg, VA | | 1988 | 1991 | 2007 | | 2% | 40% | 6% |
| Macon, GA | 1984 | 1987 | 1992 | 2007 | 8% | 10% | 15% | 10% |
| Madison, WI | 1981 | 1982 | 1990 | 2006 | 0% | 4% | 64% | 9% |
| Mansfield, OH | 1987 | 1988 | 1991 | 2004 | 3% | 4% | 34% | 23% |
| McAllen-Edinburg-Mission, TX | 1990 | 1994 | 2000 | 2007 | 4% | 6% | 12% | 6% |
| Medford, OR | | | | 2006 | | | | 35% |
| Memphis, TN-MS-AR | 1984 | 1987 | 1994 | 2006 | 16% | 12% | 16% | 12% |
| Merced, CA | 1985 | 1991 | 1997 | 2006 | 24% | 20% | 148% | 64% |
| Miami-Miami Beach-Kendall, FL  (MSAD) | 1981 | 1982 | 1991 | 2007 | 2% | 13% | 160% | 42% |
| Milwaukee-Waukesha-West Allis, WI | | | | 2006 | | | | 13% |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Minneapolis-St. Paul-Bloomington, MN-WI | 1985 | 1987 | 1992 | 2005 | 4% | 7% | 78% | 23% |
| Missoula, MT | | | | 2007 | | | | 8% |
| Mobile, AL | 1985 | 1986 | 1991 | 2007 | 4% | 17% | 45% | 10% |
| Modesto, CA | 1984 | 1990 | 1997 | 2006 | 43% | 27% | 141% | 58% |
| Monroe, LA | | | 1991 | 2009 | | | 35% | 1% |
| Montgomery, AL | | | 1991 | 2007 | | | 13% | 9% |
| Myrtle Beach-North Myrtle Beach-Conway, | | | 1994 | 2007 | | | 71% | 23% |
| Naples-Marco Island, FL | 1985 | 1990 | 1996 | 2006 | 12% | 8% | 173% | 51% |
| Nashville-Davidson--Murfreesboro--Frankl | 1982 | 1987 | 1992 | 2007 | 18% | 15% | 46% | 8% |
| Nassau-Suffolk, NY  (MSAD) | | 1988 | 1996 | 2006 | | 28% | 120% | 20% |
| New Orleans-Metairie-Kenner, LA | | | 1991 | 2007 | | | 65% | 11% |
| New York-White Plains-Wayne, NY-NJ  (MSA | 1982 | 1988 | 1997 | 2006 | 108% | 28% | 100% | 18% |
| Newark-Union, NJ-PA  (MSAD) | 1982 | 1988 | 1997 | 2006 | 93% | 28% | 85% | 19% |
| Niles-Benton Harbor, MI | 1985 | 1990 | 1991 | 2007 | 23% | 1% | 46% | 11% |
| Oakland-Fremont-Hayward, CA  (MSAD) | 1984 | 1990 | 1996 | 2006 | 50% | 24% | 144% | 36% |
| Ocala, FL | | | 1996 | 2006 | | | 88% | 37% |
| Ocean City, NJ | | 1989 | 1997 | 2006 | | 18% | 142% | 20% |
| Odessa, TX | 1991 | 1992 | 2001 | 2009 | 3% | 8% | 56% | 6% |
| Oklahoma City, OK | 1981 | 1983 | 1991 | 2007 | 8% | 42% | 30% | 2% |
| Olympia, WA | 1988 | 1995 | 1996 | 2007 | 39% | 1% | 59% | 16% |
| Omaha-Council Bluffs, NE-IA | 1982 | 1983 | 1991 | 2005 | 0% | 13% | 33% | 9% |
| Orlando-Kissimmee-Sanford, FL | 1981 | 1986 | 1996 | 2006 | 8% | 15% | 104% | 42% |
| Owensboro, KY | 1988 | 1989 | 1992 | 2002 | 0% | 8% | 19% | 6% |
| Palm Bay-Melbourne-Titusville, FL | | 1981 | 1997 | 2006 | | 25% | 113% | 47% |
| Panama City-Lynn Haven-Panama City Beach | | | 1991 | 2006 | | | 113% | 31% |
| Parkersburg-Marietta-Vienna, WV-OH | | | 1991 | 2006 | | | 26% | 3% |
| Pensacola-Ferry Pass-Brent, FL | | 1986 | 1991 | 2006 | | 16% | 76% | 27% |
| Peoria, IL | | | | 2007 | | | | 3% |
| Philadelphia, PA  (MSAD) | 1982 | 1989 | 1997 | 2006 | 60% | 19% | 64% | 11% |
| Phoenix-Mesa-Glendale, AZ | 1982 | 1986 | 1993 | 2006 | 8% | 23% | 123% | 45% |
| Pittsburgh, PA | 1982 | 1993 | 1997 | 2005 | 14% | 2% | 17% | 3% |

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|---|---|---|---|---|---|---|---|---|
| Pocatello, ID | 1989 | 1998 | 2000 | 2007 | 26% | 4% | 25% | 7% |
| Port St. Lucie, FL | 1983 | 1984 | 1997 | 2006 | 2% | 18% | 121% | 53% |
| Portland-Vancouver-Hillsboro, OR-WA | 1988 | 1999 | 2000 | 2007 | 70% | 1% | 50% | 20% |
| Poughkeepsie-Newburgh-Middletown, NY | 1983 | 1988 | 1997 | 2006 | 86% | 32% | 90% | 23% |
| Provo-Orem, UT | 1985 | 1986 | 1990 | 2007 | 1% | 12% | 98% | 22% |
| Pueblo, CO | 1982 | 1983 | 1991 | 2006 | 2% | 15% | 49% | 11% |
| Punta Gorda, FL | | 1989 | 1997 | 2006 | | 17% | 117% | 48% |
| Racine, WI | | | | 2006 | | | | 16% |
| Raleigh-Cary, NC | 1982 | 1986 | 1992 | 2007 | 21% | 12% | 28% | 6% |
| Reading, PA | 1982 | 1989 | 2000 | 2007 | 33% | 18% | 37% | 10% |
| Redding, CA | 1987 | 1991 | 1997 | 2006 | 25% | 15% | 105% | 38% |
| Reno-Sparks, NV | 1982 | 1983 | 2000 | 2006 | 0% | 5% | 81% | 48% |
| Richmond, VA | 1982 | 1989 | 1996 | 2007 | 14% | 8% | 58% | 15% |
| Riverside-San Bernardino-Ontario, CA | 1984 | 1990 | 1997 | 2006 | 33% | 33% | 157% | 48% |
| Roanoke, VA | 1982 | 1988 | 1991 | 2007 | 31% | 3% | 42% | 7% |
| Rochester, MN | | 1985 | 1995 | 2005 | | 8% | 38% | 14% |
| Rochester, NY | 1982 | 1988 | 2000 | 2005 | 33% | 22% | 8% | 4% |
| Rockford, IL | 1985 | 1987 | 1990 | 2007 | 2% | 0% | 18% | 12% |
| Rocky Mount, NC | | 1986 | 1993 | 2003 | | 11% | 11% | 10% |
| Sacramento-Arden-Arcade-Roseville, CA | 1984 | 1991 | 1997 | 2005 | 43% | 26% | 124% | 44% |
| Saginaw-Saginaw Township North, MI | 1983 | 1984 | 1991 | 2004 | 1% | 1% | 32% | 26% |
| Salem, OR | 1987 | 1999 | 2000 | 2007 | 59% | 1% | 37% | 18% |
| Salinas, CA | 1982 | 1990 | 1997 | 2006 | 53% | 17% | 165% | 51% |
| Salt Lake City, UT | 1985 | 1986 | 1990 | 2007 | 1% | 17% | 118% | 18% |
| San Angelo, TX | 1991 | 1993 | 1997 | 2009 | 2% | 3% | 31% | 3% |
| San Antonio-New Braunfels, TX | | 1984 | 1991 | 2007 | | 36% | 32% | 4% |
| San Diego-Carlsbad-San Marcos, CA | 1983 | 1990 | 1996 | 2005 | 43% | 25% | 148% | 34% |
| San Francisco-San Mateo-Redwood City, CA | 1982 | 1989 | 1996 | 2006 | 79% | 24% | 129% | 24% |
| San Jose-Sunnyvale-Santa Clara, CA | 1983 | 1989 | 1995 | 2006 | 66% | 23% | 134% | 27% |
| San Luis Obispo-Paso Robles, CA | 1981 | 1990 | 1996 | 2006 | 65% | 30% | 142% | 33% |
| Santa Ana-Anaheim-Irvine, CA  (MSAD) | 1985 | 1989 | 1997 | 2006 | 49% | 31% | 160% | 33% |

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| Santa Barbara-Santa Maria-Goleta, CA | 1983 | 1990 | 1996 | 2006 | 50% | 25% | 162% | 40% |
| Santa Cruz-Watsonville, CA | 1984 | 1990 | 1996 | 2006 | 63% | 20% | 135% | 32% |
| Santa Fe, NM | 1988 | 1995 | 1997 | 2007 | 32% | 4% | 49% | 16% |
| Santa Rosa-Petaluma, CA | 1984 | 1990 | 1996 | 2006 | 53% | 19% | 127% | 38% |
| Savannah, GA | | 1986 | 1991 | 2007 | | 13% | 77% | 15% |
| Scranton-Wilkes-Barre, PA | | 1993 | 2000 | 2007 | | 6% | 26% | 5% |
| Seattle-Bellevue-Everett, WA (MSAD) | 1985 | 1990 | 1995 | 2007 | 41% | 3% | 90% | 21% |
| Sheboygan, WI | 1989 | 1990 | 1991 | 2006 | 0% | 0% | 49% | 11% |
| Sherman-Denison, TX | 1991 | 1992 | 1994 | 2006 | 0% | 1% | 20% | 6% |
| Shreveport-Bossier City, LA | 1985 | 1986 | 1991 | 2007 | 1% | 29% | 31% | 2% |
| Sioux City, IA-NE-SD | | | 1990 | 2003 | | | 29% | 4% |
| Sioux Falls, SD | | | 1990 | 2007 | | | 36% | 3% |
| South Bend-Mishawaka, IN-MI | 1984 | 1988 | 1991 | 2005 | 10% | 5% | 22% | 9% |
| Spokane, WA | 1988 | 1995 | 2000 | 2007 | 34% | 6% | 48% | 13% |
| Springfield, IL | | 1987 | 1990 | 2005 | | 2% | 3% | 4% |
| Springfield, MO | | 1986 | 1991 | 2007 | | 14% | 24% | 8% |
| St. Cloud, MN | | | 1991 | 2006 | | | 66% | 17% |
| St. Joseph, MO-KS | | 1987 | 1991 | 2005 | | 2% | 39% | 7% |
| St. Louis, MO-IL | 1982 | 1987 | 1993 | 2006 | 17% | 12% | 38% | 11% |
| State College, PA | | | 1990 | 2009 | | | 32% | 1% |
| Stockton, CA | 1984 | 1990 | 1997 | 2006 | 40% | 26% | 141% | 57% |
| Syracuse, NY | 1982 | 1988 | 1997 | 2006 | 35% | 25% | 22% | 3% |
| Tacoma, WA (MSAD) | 1988 | 1995 | 1996 | 2007 | 31% | 1% | 75% | 23% |
| Tallahassee, FL | | 1983 | 1994 | 2007 | | 13% | 61% | 21% |
| Tampa-St. Petersburg-Clearwater, FL | 1981 | 1986 | 1995 | 2006 | 10% | 15% | 111% | 39% |
| Toledo, OH | 1985 | 1989 | 1991 | 2004 | 5% | 3% | 29% | 21% |
| Topeka, KS | 1982 | 1984 | 1993 | 2005 | 2% | 17% | 21% | 6% |
| Trenton-Ewing, NJ | 1982 | 1988 | 1997 | 2006 | 86% | 31% | 77% | 18% |
| Tucson, AZ | 1982 | 1986 | 1991 | 2006 | 9% | 13% | 95% | 31% |
| Tulsa, OK | 1981 | 1983 | 1992 | 2009 | 5% | 35% | 23% | 1% |
| Tyler, TX | | | 1991 | 2007 | | | 25% | 3% |

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|---|---|---|---|---|---|---|---|---|
| Utica-Rome, NY | | 1989 | 1997 | 2009 | | 25% | 33% | 2% |
| Vallejo-Fairfield, CA | 1984 | 1990 | 1997 | 2006 | 33% | 24% | 147% | 53% |
| Vineland-Millville-Bridgeton, NJ | | 1989 | 2000 | 2007 | | 16% | 63% | 19% |
| Virginia Beach-Norfolk-Newport News, VA- | 1982 | 1988 | 1997 | 2007 | 23% | 13% | 84% | 15% |
| Visalia-Porterville, CA | 1988 | 1992 | 2000 | 2006 | 13% | 16% | 98% | 44% |
| Waco, TX | | | 1991 | 2009 | | | 22% | 2% |
| Washington-Arlington-Alexandria, DC-VA-M | 1982 | 1989 | 1997 | 2006 | 44% | 20% | 113% | 26% |
| Waterloo-Cedar Falls, IA | | | | 2006 | | | | 3% |
| Wausau, WI | | | | 2005 | | | | 8% |
| West Palm Beach-Boca Raton-Boynton Beach | 1982 | 1983 | 1997 | 2006 | 1% | 17% | 136% | 45% |
| Wichita Falls, TX | | | 1991 | 2007 | | | 19% | 4% |
| Wichita, KS | 1985 | 1986 | 1991 | 2009 | 2% | 19% | 16% | 2% |
| Wilmington, DE-MD-NJ  (MSAD) | 1981 | 1989 | 1997 | 2006 | 49% | 16% | 61% | 15% |
| Wilmington, NC | | 1987 | 1991 | 2007 | | 4% | 89% | 19% |
| Yakima, WA | 1989 | 1998 | 2000 | 2007 | 46% | 3% | 18% | 5% |
| York-Hanover, PA | | 1989 | 2000 | 2007 | | 7% | 38% | 12% |
| Youngstown-Warren-Boardman, OH-PA | 1987 | 1989 | 1990 | 2004 | 3% | 3% | 26% | 14% |
| Yuba City, CA | | 1991 | 1997 | 2006 | | 19% | 117% | 48% |
| Yuma, AZ | 1994 | 1995 | 1997 | 2006 | 2% | 2% | 76% | 33% |