Asset market hangovers and economic growth: US housing markets

Matthew Higgins and Carol Osler*

Asset market bubbles matter to policymakers. For example, in December 1996, Alan Greenspan, Chairman of the Board of Governors of the Federal Reserve System of the United States, asked publicly: "How do we know when irrational exuberance has unduly escalated asset values, which then become subject to unexpected and prolonged contractions ...?" Stock market participants interpreted this comment – correctly or not – as a warning that stock prices might be overvalued. The market suffered a brief reversal, but bounced back and was soon reaching new highs. In February 1997, Greenspan used his testimony to the US Senate Banking Committee to cite the possibility of "excessive optimism" in the stock market.

This paper addresses one reason for policymakers' concern about asset market bubbles: bubbles can adversely affect real activity as they collapse. We estimate models of house prices and investment for US state housing markets, and arrive at two main results. First, house prices may be subject to speculative bubbles. Second, housing investment responds noticeably to housing prices. Taken together, these results point to a potentially important role for house price bubbles in determining housing investment. We examine the economic significance of the connection between house prices and investment by focusing on events since the mid-1980s. We find noticeable, apparently bubble-induced swings in prices and investment in five of the nine US census regions.

Our results also shed light on the importance of credit availability for house prices and housing investment. Some observers have suggested that increased credit availability may have helped inflate house prices across the OECD during the mid-1980s (for example, Borio et al. (1994)). A separate literature suggests that changes in credit availability can affect investment, owing to informational asymmetries between borrowers and lenders (Hubbard (1996)). The evidence presented here does not point to any link between mortgage credit availability and either house prices or housing investment in the US.

The paper is organized as follows. Section 1 focuses on house prices in the 50 US states, developing evidence that both economic fundamentals and speculative bubbles played important roles over 1973-96. Section 2 focuses on housing investment, and estimates how this component of real activity is influenced by house prices; the section also considers the potential magnitude of bubble-induced swings in investment. Section 3 discusses the policy implications of our results.

1. Speculative bubbles and US house prices?

This section examines whether US house prices were subject to speculative bubbles over 1973-96. After reviewing what is known about bubbles in general, we provide some evidence supporting their existence in the house prices of many US states in the late 1980s. For convenience, we treat bubbles as sustained price rises above fundamentally-determined values, consistent with their common image; however, negative bubbles are certainly also conceivable. The section ends with caveats about the difficulty of verifying the presence of speculative bubbles.

Speculative bubbles: an overview

Since 1852, when Charles McKay documented some dramatic speculative bubbles in his *Extraordinary Popular Delusions and the Madness of Crowds*, most observers have attributed speculative bubbles to irrational investor behavior. To understand an irrational bubble, it is important to note, first, that prices sometimes rise for perfectly sensible reasons, such as strong economic growth. If such a rise lasts long enough, naive investors may gain confidence that prices will continue to rise. Based on this confidence, they may direct more funds to the market, propelling prices up farther and helping attract more investors. In this way, price rises come to depend on the expectation of further price rises, eroding the line between price levels and fundamentals. Over time, informed investors increasingly realize that prices are unreasonably high and begin pulling funds out. This slows the rise of prices, which in turn, discourages the less informed investors. Eventually, confidence and prices collapse together.

Based on an extensive historical survey, Kindleberger (1978) constructs a more detailed theory of the development of irrational speculative bubbles. Since Kindleberger's book, economists have learned a number of cautionary lessons about speculative bubbles. First, speculative bubbles need not be irrational (Blanchard (1981)). It is possible that speculators are aware of the misalignment between prices and fundamentals, but continue to invest quite rationally on the expectation that the bubble is unlikely to burst. Even so, the fact that irrational speculative bubbles are regularly generated in experimental asset markets (Smith et al. (1988)) does suggests that irrationality could be an important factor in real-world asset market bubbles.

Second, there can be extreme price cycles in which prices never depart from their fundamental values. A good example of extreme asset market behavior that might in fact have been consistent with fundamentals is found in the "Tulipmania" of 1634-37, when prices for rare tulip bulbs in the Netherlands skyrocketed and then crashed. Garber (1989) shows that the price behavior of rare bulbs appears consistent with the underlying fundamentals, and that such a precipitous rise and decline was not uncommon for new strains of bulbs. Since extreme price movements can be driven by fundamental factors, it is not possible to prove that a specific historical episode was truly a bubble (Hamilton and Whiteman (1985)). After all, some unrecorded but sensible consideration (an "unobserved fundamental") could have motivated investors at the time; and the absence of any such consideration can never be conclusively established. Nonetheless, it seems difficult to discover what fundamental consideration may have driven some apparent bubbles, such as the 1987 stock market crash (Shiller (1989)).

Speculative bubbles in US house prices: econometric tests

The hypothesis that US house prices have experience speculative bubbles is certainly not new: evidence suggesting the presence of bubbles in regional US housing markets is presented in Poterba (1991) and Abraham and Hendershott (1993, 1994). Muellbauer (1996) presents evidence that house-price bubbles have also been present in the United Kingdom, and Higgins and Osler (1997) for the presence of bubbles in many OECD housing markets during the late 1980s. We develop our own econometric evidence of this point in order to facilitate later analysis of the effects of price bubbles on housing investment.

Our house price variable represents median new house prices by state for 1973-96. We combine this with other state-level variables to form a panel of annual data for the 50 states covering 1973-96. We divide our independent variables into fundamental and non-fundamental house price determinants. Since we cannot directly measures the presence of speculative bubbles, our evidence concerning the importance of speculative bubbles is necessarily indirect in nature.

Fundamentals: One simple and robust model asserts that an asset's price should equal

the present discount value of the associated income stream:[1]

$$House\ price_t = rent_t^e + \frac{rent_{t+1}^e}{(1+r_t)} + \frac{rent_{t+2}^e}{(1+r_t)^2} + ...$$

Here, e indicates that the share price is based on the *expected* value of future rents, and r represents an appropriate discount rate. We derive an estimating equation consistent with this theory by restating it as follows:

$$House\ price_t = rent_{t+1}^e + \frac{House\ price_{t+1}^e}{(1+r_t)}$$

The expression states that the current price of a house should equal expected rents over the coming year plus its own value one year hence discounted to the present.

Table 1

Panel unit root tests

Panel unit root tests were implemented for a model containing state-specific dummy variables and rely on the critical values reported by Levin and Lin (1992). The null hypothesis is that the variable in question is I(1). For the variables included in our empirical analysis, we report below whether the unit root null is rejected and, if so, at the 1, 5, or 10% level. Level variables are measured in logs, except for the real mortgage interest rate and the user cost of housing.

Level variables	Significance level
Affordability	1%
Authorizations	5%
Consumer price index	not rejected
Construction costs (real)	not rejected
Employment	not rejected
House prices (real)	1%
Mortgage interest rate (real)	1%
Mortgage originations (real)	10%
Per capita income (real)	not rejected
User cost of housing	1%

Differenced variables	Significance level
Affordability	1%
Authorizations	1%
Consumer price index	1%
Construction costs (real)	1%
Employment	1%
House prices (real)	1%
Mortgate interest rate (real)	1%
Mortgage originations (real)	1%
Per capita income (real)	1%
User cost of housing	1%

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[1] See, for example, Copeland and Weston (1988), pp. 20-2, or Brealey and Myers (1987), pp. 44-5.

The formula suggests that our empirical model should include expected house rents, current mortgage interest costs, and expected future house prices. State-level data on actual house prices are readily available, and national information on the cost of mortgages can be adjusted to state-specific real values using state CPIs. However, data concerning expected rents and expected future house prices are not available. We estimate the influence of expected rents implicitly, using three factors likely to determine rents: per capita income, employment, and construction costs. Following convention, we approximate expected house prices as an autoregressive process; experiments indicate that two lags are relevant.[2]

To accommodate the stationarity properties of these data (described in Table 1), we take the growth rate of real house prices, rather than their level, as the dependent variable. Accordingly, the fundamental house-price determinants included in our panel are growth rates of the variables listed above. (The Appendix describes our data sources, and provides further details concerning variable measurement.) We include state dummies to capture persistent unmodeled or idiosyncratic factors that might vary by state. Aside from the dummy-variable coefficients (which amount to state-specific intercepts), the estimated coefficients are assumed to be the same for each state. Limiting our analysis to the fundamental determinants of house prices would lead to a regression specification such as the following:

$$\Delta HP_{it} = \alpha \Delta YD_{it} + \beta \Delta EM_{it} + \gamma \Delta CC_{it} + \mu \Delta r_{it} + \nu \Delta Hp^{e}_{it+1} + s_i + \varepsilon_{it}$$

where i indexes states and t time, while HP represents house prices, Y per capita disposable personal income, EM employment, CC construction costs, r real mortgage interest costs, s state-specific factors (constant over time), and ε is a residual.

Non-fundamentals: One of our central theses is that house prices are affected by speculative bubbles. The total contribution of non-fundamental forces which includes the contribution of speculative bubbles − could be assessed by examining the residuals from the above regression. However, since we are primarily interested in the contribution of speculative bubbles, our strategy is to estimate the influence of all potential non-fundamental forces individually, which implies regressions of the following form:

$$\Delta HP_{it} = \alpha \Delta YD_{it} + \beta \Delta EM_{it} + \gamma \Delta CC_{it} + \mu \Delta r_{it} + \nu \Delta HP^{e}_{it+1} + \sum_{j=1}^{k} \Psi_j NF_{ijt} + s_i + \varepsilon_{it}$$

where NF_j represents any non-fundamental force.

In addition to speculative bubbles, we focus on two other non-fundamental factors that may have influenced house prices in some states: credit availability and overbuilding. We discuss our measures of these two additional non-fundamental forces before returning to consider speculative bubbles.

A role for **credit availability** in determining house prices is suggested in Borio et al. (1994), who argue that the rapid rise of house prices around the OECD during the late 1980s was due in part to rapid contemporaneous growth in mortgage credit. Corresponding to the possibility that credit growth fueled the asset price spikes, the later price declines could be attributed to a "credit crunch" in the early 1990s. Such a credit crunch, if it occurred, might, among other factors, owe to BIS bank capital standards, imposed beginning in 1988 (Bernanke and Lown (1992)). The idea that credit dynamics could affect house price growth is closely related to the bubble hypothesis: a bubble occurs whenever asset prices experience a sustained rise beyond the levels justified by fundamentals, and this remains true even if the bubble is accompanied or fueled by rapid credit growth.

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[2] Note that there is an inherent difficulty in modeling expectations. We are not claiming that expectations are formed rationally. On the other hand, we model them as though they were formed rationally given lagged price information. This difficulty would not arise, of course, if survey data on house price expectations were available.

To assess the contribution of mortgage credit availability to house price growth, we would ideally include a measure of the growth in mortgage credit outstanding, by state, for our entire sample period. The available state-level data fall short of this ideal in two ways, however. First, they are only available from 1983 through 1993. Second, they cover mortgage originations, which include refinanced mortgages as well as new ones. To deal with this second problem, we measure state-level originations as deviations from the national average.

According to the overbuilding hypothesis, excessive investment during the 1980s could have left a substantial backlog of unoccupied new homes in some areas. This role for overbuilding in deflating asset prices is also compatible with the bubble hypothesis: just as excessive optimism leads investors to raise asset prices past the levels justified by fundamentals, builders might construct homes beyond levels justified by a sober analysis of potential demand growth. Overbuilding is considered "non-fundamental" because, in an efficient market, prices would adjust swiftly to supply, and any lagged supply variable would be uncorrelated with current price changes. Because our data are measured annually, the speed at which prices would be required to adjust to meet this criterion would not be great. In the absence of a natural measure of overbuilding, we experiment with two different proxies for it. The first is the ratio of cumulative housing authorizations to a state-specific trend. The second is the ratio of housing stock to population, where the housing stock is estimated using the perpetual inventory method, since state-level housing stock data apparently do not exist.

Unfortunately, there is no true "measure" of the forces behind a speculative bubble. However, there are two properties of speculative bubbles that we can use to evaluate whether they might have existed. First, the farther prices rise relative to fundamentals as a bubble takes hold, the farther they must fall relative to fundamentals later on. Second, during a bubble, the initial rise of prices above fundamentals, as well as the subsequent decline, should be fairly monotonic. We attempt to capture the first property directly, and the second property by examining regression residuals.

The first property of bubbles implies that, on average, a positive gap between prices and their fundamentally-determined values should be associated with subsequent price declines. Further, the larger the gap, the larger the later decline. One way to capture this property would be to include the lagged level of real house prices as an explanatory variable. Since our regression includes state dummies, this would in effect measure house prices as deviations from state-specific averages. If house prices are characterized by constant state-specific fundamental values, any speculative bubble component of prices should be captured by a negative coefficient on lagged prices. There is some empirical support for this crude view of house price determination. In particular, standard panel unit root tests indicate that state real house prices are I(0), narrowly rejecting the null hypothesis of a unit root at the one percent level (Levin and Lin (1992, 1993)). Hence, departures in real house prices from their state-specific averages tend to erode over time, suggesting the presence of constant state-specific fundamental values.

Even so, we are not fully convinced that the lagged house price level represents an appropriate measure of this first property of speculative bubbles. An important source of our skepticism is the fact that real house prices display a clear upward trend, rising by 26.7% at the national level from 1973 to 1996. Moreover, the literature on testing for unit roots in a panel setting remains in flux, with standard tests recently criticized for rejecting the unit-root null too frequently (O'Connell (1997)).

As an alternative, we use the lagged ratio of real house prices to real disposable income. This variable is also used by Muellbauer (1996), who labels it "affordability." Since the variable is lagged by a full year, it would not affect price growth in a fully efficient market. Further, its inclusion has a natural economic interpretation consistent with the presence of speculative bubbles: if houses become too unreasonably expensive, demand will dry up, forcing prices back down again. This variable is more unambiguously stationary than real house price levels: standard panel unit root tests reject the I(0) null at better than the 0.1% level. Moreover, the variable displays no trend, remaining virtually unchanged at the national level since 1973.

Relying on affordability to capture this first property of speculative bubbles is akin to treating house prices and disposable income as cointegrated. Affordability could then be seen as a quasi-error-correction term in the regression for house price growth. Though appealing, this interpretation of our regression equation is not econometrically reliable, for two reasons. First, affordability could not be an exact error correction term in our specification, since the cointegrating relationship implied by that specification includes several variables, not just per capita income. Second, little is known about estimating cointegration-ECM relationships in a panel setting. The literature on testing for cointegration in a panel setting is in its infancy and no clear consensus has emerged regarding appropriate test techniques or significance levels (Pedroni (1995, 1997)). Beyond this, there is apparently no work which estimates a panel error-correction model.

Table 2

Panel regressions of annual house price growth by US state, 1973-96

	Regression 1	Regression 2*	Regression 3	Regression 4
Fundamentals				
Per capita income growth	0.26 (2.62)	0.44 (3.17)	0.26 (2.72)	0.26 (2.65)
Employment growth	0.30 (2.98)	0.34 (2.80)	0.30 (2.97)	0.31 (3.04)
Growth in construction costs	0.76 (8.43)	0.27 (2.18)	0.77 (8.24)	0.77 (8.36)
Real mortgage interest growth	-1.04 (-9.07)	-0.90 (-3.68)	-1.05 (-9.11)	-1.04 (-9.07)
Expected house price appreciation	0.43 (4.41)	0.72 (3.70)	0.40 (3.46)	0.43 (4.46)
Non-fundamentals				
House "affordability", lagged (Ratio of price to per capita income)	-16.30 (-6.89)	-30.36 (-5.47)	-16.77 (-6.54)	-16.35 (-6.87)
Growth in mortgage originations, lagged		-0.00 (-0.20)		
Overbuilding 1 (Deviation of cumulative housing authorizations, from state trend)			0.40 (0.44)	
Overbuilding 2 (Housing stock/population ratio)				2.62 (1.22)
Number observations	1,071	561	1,020	1,020
R-bar squared	0.31	0.34	0.31	0.31
Durbin-Watson statistic	2.02	1.99	2.02	2.02

Note: t-statistics in parentheses.

* The sample size is smaller for this regression because mortgage origination data only span 1983-93.

Although affordability may help us capture the first property of speculative bubbles, it will not fully capture the second property of speculative bubbles listed above, that bubble-induced price movements should include a fairly monotonic rise above fundamentals followed by a fairly monotonic decline back towards fundamentals. We will use an analysis of the regression residuals to

capture this second property. There are other aspects of speculative bubbles that affordability may not capture at all. For example, bubbles may be based on irrational expectations of continuously rising prices, but there is no way to capture that irrationality in the absence of survey data on expectations.

Results: The results of our analysis are presented in Table 2, where we show a few different versions of our baseline regression. All the regressions display reasonably high explanatory power with low residual autocorrelation. The estimated coefficients for the fundamental variables all have the expected signs and have economically sensible magnitudes, and they are all statistically significant.

With regard to possible non-fundamental influences on house prices, the only non-fundamental variable with any apparent explanatory power is "affordability," which we interpret as capturing the fact that prices inflated by bubbles must eventually return to fundamental values. The coefficient on affordability is consistently negative as expected, and significant. Its magnitude, which varies only slightly across regressions, implies that a 10 percentage point deviation of the house-price/per capita-income ratio from its state-specific average is typically followed by a 2 percentage point decline in house prices the following year.

The coefficients on both mortgage credit availability and overbuilding are statistically insignificant and have unexpected signs. The statistical significance of the fundamental variables declines when mortgage credit is added to the model, but unreported results indicate that this is largely due to the constrained sample size. The exclusion of mortgage credit and overbuilding has little effect on the coefficients of the remaining variables or the other properties of the regressions. Regression 4, which is our preferred specification, includes only fundamentals and affordability.

Speculative bubbles in US house prices: 1982-93

The results so far support evidence from other studies that speculative bubbles could affect US housing markets. We have not yet examined, however, the second property of speculative bubbles listed above: that prices will tend to rise monotonically and then fall monotonically relative to fundamentals. Nor do the results tell us whether speculative bubbles have been important in economic terms. To address these issues, we now focus on 1984-93, and ask whether house prices in some regions overshot fundamental values for extended periods, and subsequently suffered sustained declines.

A quick review of the aggregate data suggests that US house prices movements were generally quite moderate during 1984-93: aggregate (population-weighted) real house prices rose 26% during 1982 to 1989, a period of rapid GDP growth (GDP itself grew over 30%), and fell just 4% during the slow-growth period from 1989 to 1993 (see Table 3). However, these moderate aggregate price movements mask dramatic regional swings. In New England, for example, real house prices rose 49% during 1982-89, and fell 17% during 1989-93. Large price movements were also observed in the Mid-Atlantic, Mountain and Pacific census regions.[3] For all four of these regions, price rises exceeded the national average over 1982-89 and price declines exceeded the national average over 1989-93. Since speculative bubbles tend to be identified with periods of extreme price movements, one might venture a preliminary guess that these four regions experienced such bubbles during 1984-1993.

The total amount of house price growth not determined by fundamentals can be estimated on the basis of Regression 4 of Table 2 as the regression residuals plus the contributions of deviations of affordability from its state-specific average. The cumulated value of these non-fundamental annual price movements, which are shown in Charts 1A through 1D for the nine US census regions, represents our measure of the total departure of prices from fundamental values.

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[3] Our regional definitions are taken from the US Census Bureau.

Table 3

Cumulative growth in real house prices and house authorizations, by region

	House prices		House authorizations	
	1982-89	**1989-93**	**1982-89**	**1989-93**
US	26.2	-4.2	41.4	10.9
New England	49.0	-17.1	56.2	-16.4
Mid-Atlantic	40.3	-12.7	80.7	-21.3
South Atlantic	19.2	1.9	46.0	6.0
E. N. Central	21.6	-1.7	113.4	21.2
E. S. Central	19.8	5.2	55.2	35.1
W. N. Central	18.9	1.8	41.4	30.1
W. S. Central	13.5	0.4	-89.9	53.1
Mountain	38.0	-7.6	-18.8	74.4
Pacific	27.7	-9.4	91.4	-43.3

Notes: Prices correspond to state median house price data deflated by state CPIs. Authorizations correspond to new single-family homes.

The five regions included in Chart 1A and 1B are those where the non-fundamental component of house prices is consistent with the second property of bubbles listed above: the component rises consistently and substantially during the late 1980s, and then falls consistently during the early 1990s. These five regions include the four mentioned above, in which average price changes were more extreme than the national average over 1984-93, plus the "East-South Central" region, which includes Louisiana and Texas, among other states. The modest size of the apparent speculative bubble, which peaked well before the national house price peak in 1989, suggests that most of the price dynamics in this region were driven by fundamental forces such as swings in oil prices. The remaining four regions are shown in Charts 1C and 1D, where it can be seen that the influence of non-fundamental forces was consistently small and did not conform to the up-down bubble profile.

In our introduction, we suggested that policymakers may be concerned about the "hangovers" associated with asset market bubbles. One such hangover would be the price declines associated with the collapse of such a bubble. These reduce homeowner wealth and they can also lead to increased defaults, if some homeowners find that their mortgages exceed the value of their house. The price declines can even impede the proper functioning of labor markets, to the extent that homeowners feel trapped in their existing home and unable to take advantage of new job opportunities elsewhere. Our results allow us to estimate crudely the extent to which the early 1990s' house price deflation is attributable to speculative excesses in the late 1980s.

Table 4 shows total house price declines over the four years following regional peaks, the amount of that decline attributable to affordability, and the amount attributable to non-fundamental forces more generally (affordability plus residuals). The measures associated with affordability correspond to the first property of speculative bubbles listed above: the fact that, the further prices initially rise, the further they ultimately must fall.

In the five regions where bubbles were apparently important, real house prices declined by almost 10% over the four years following their regional peaks. Affordability itself accounts for an average decline of 6.4% in these five regions. In the other four regions, where house prices declined only 2.1% on average in their four post-peak years, affordability accounts for virtually none of the price declines.

The total effect of non-fundamental forces, meanwhile, was to depress prices by almost 12% in the regions identified as most likely to have experienced bubbles, about 2 percentage points

Chart 1

Non-fundamentally determined house price growth, in percentages
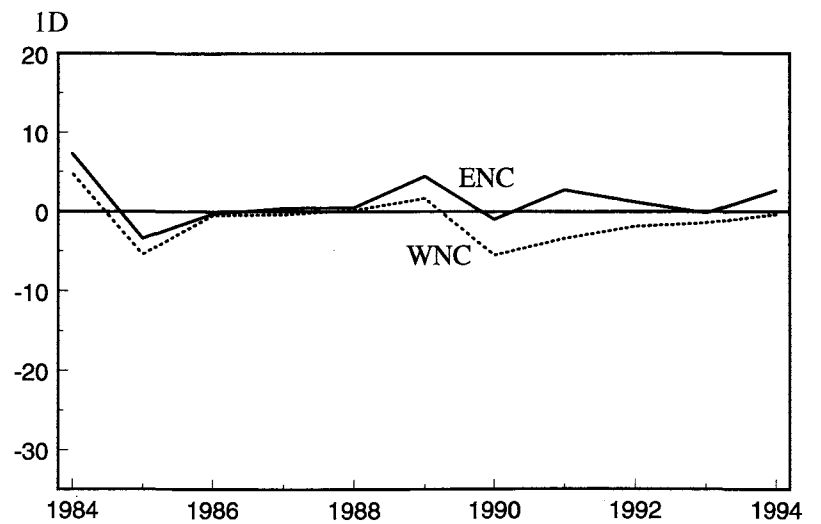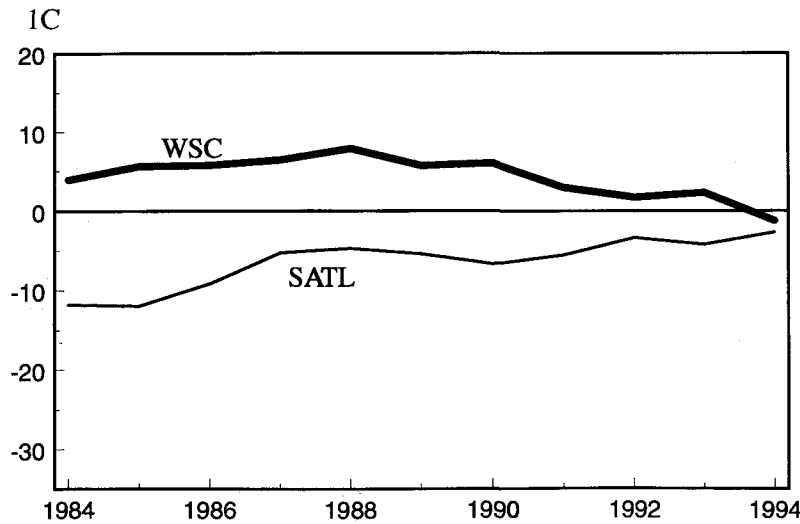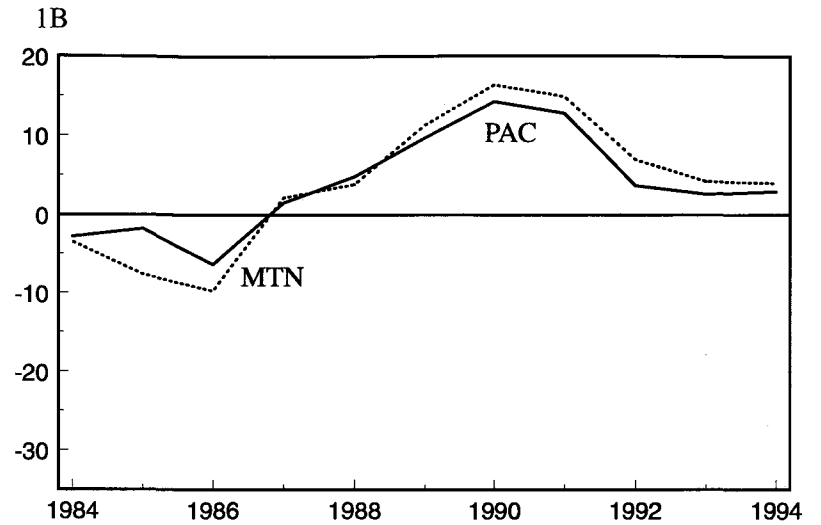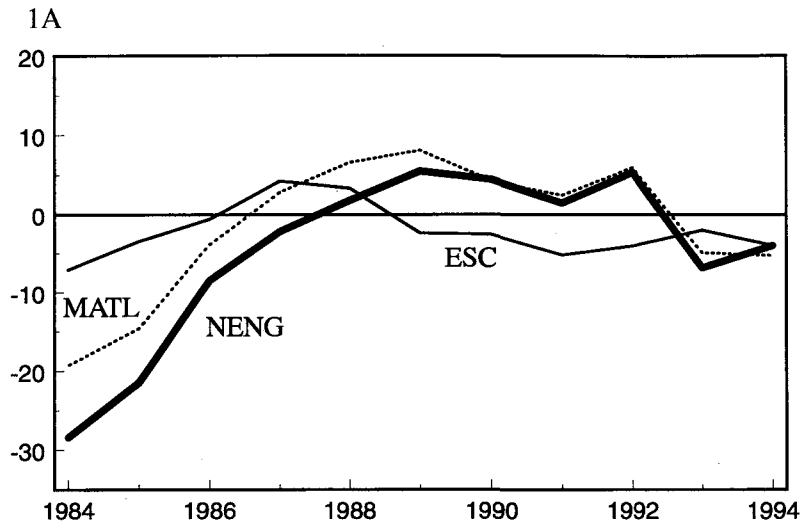
1A

1B

1C

1D

NENG: New England; MATL: Mid-Atlantic; ESC: East South Central; MTN: Mountain; PAC: Pacific; SATL: South Atlantic; ENC: East North Central; WNC: West North Central; WSC: West South Central.

Table 4

Real house price declines, four years from peak

Price declines	Bubbly ?					
	New England	Mid-Atlantic	Pacific	Mountain	E. S. Central	Average
Actual	-17.1	-12.7	-7.3	-6.9	-4.2	-9.7
Due to affordability	-7.9	-7.4	-5.9	-7.5	-3.1	-6.4
Due to non-fundamental factors	-12.3	-12.9	-11.6	-12.1	-9.8	-11.9

	Non-bubbly ?				
	E. N. Central	South Atlantic	W. N. Central	W. S. Central	Average
Actual	-1.7	-1.7	1.8	-5.0	-2.1
Due to affordability	-0.4	1.2	0.5	-1.7	-0.0
Due to non-fundamental factors	-5.1	1.0	-3.6	-6.2	-3.1

Notes: Prices represent median state house prices deflated by state CPIs. Estimated contributions of "affordability" and "non-fundamental factors" are based on regression 4 from Table 2.

more than the actual price decline.[4] Similarly, non-fundamental forces reduced house prices by about three percent in the other four regions, about one percentage point more than the actual decline. Although it is difficult to know how seriously to take differences of this magnitude, they do suggest that fundamental forces tended to support prices in these regions over these four years, and that price declines might have been more extreme had only the estimated non-fundamental forces been at work.

So far we have provided graphical and statistical evidence indicating that US house prices were susceptible to speculative bubbles over 1973-96. Further, we showed that speculative price bubbles may have arisen in the north-east, the far west, and the "East-South-Central" regions during the late 1980s, and that those bubbles may have been an important sources of local house price weakness in the early 1990s. The results do not *prove* that bubbles were important: as mentioned earlier, it is impossible to know for certain whether a given asset boom truly represents a speculative bubble, as some unobserved fundamental could always be driving prices. Nevertheless, the results do place the alternative, non-bubble hypothesis in sharper relief, by limiting the unobserved or unmeasured fundamentals consistent with observed house price behavior. In particular, if speculative bubbles do not explain the boom/bust cycles beginning in the mid-1980s, the unobserved or unmeasured fundamentals which do explain the cycles must have deteriorated most sharply in precisely those regions where they previously improved most sharply. For example, if state income taxes were a candidate unmeasured fundamental, this would require that such taxes rise the most in the early 1990s in those states where they declined the most in the late 1980s. The alternative, non-bubble hypothesis thus appears to require an unlikely confluence of events.

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[4] Qualitatively similar results are obtained if we look at price changes over the two years following the peak.

2. House prices and housing investment

In this section we turn our attention from house prices to house investment, and ask whether house price bubbles might be an important determinant of real activity. The section begins with a general discussion of the connections between house prices and housing investment, none of which imply irrationality among home builders. We then estimate this relationship empirically for the 50 US states. Finally, we evaluate the extent to which growth in housing investment may have been depressed in the early 1990s amid the hangover from earlier speculative excesses in the housing market.

House prices and housing investment: an overview

There are several possible connections between house prices and housing investment. First, expected house price appreciation affects the attractiveness of housing as an investment asset, with potential builders responding to the prospect of capital gains or losses. Second, the *level* of house prices might also discourage housing investment, even if potential investors do not expect house prices to change. Our focus in this paper is on the second of these connections.

House price levels can affect construction directly and through their effect on credit availability. The direct effect on construction works through the mechanism identified in Tobin's q theory of investment (1969): potential builders are unlikely to engage in speculative construction, and prospective homeowners will prefer to buy an existing home, if house prices are lower than the cost of construction.

The indirect effect of house prices, which works through credit availability, can affect housing investment in multiple ways. Declining house prices lower homeowners' net worth, and some homeowner will not have sufficient assets for a down payment on another house, if they are inclined to move or to trade up. Other homeowners may find themselves saddled with mortgage obligations greater than the value of their home, perhaps inducing default. Increased defaults reduce lenders' capital, possibly reducing the supply of mortgage credit.[5]

House prices and housing investment: empirical tests

To evaluate the strength of the connection between housing investment and house prices we develop an empirical model based primarily on the neoclassical model of business fixed investment, by Jorgenson (1971) and others. As modified to apply to housing investment, neoclassical theory suggests that investment in state i in year t should be positively related to expected future rents and the existing stock of housing (via depreciation), and negatively related to the user cost of capital. More recent theories which relate investment to asset prices via credit markets, described above, suggest that housing investment should be positively related to the level of house prices and to mortgage credit availability. Casual empiricism suggests that, in some regions, overbuilding may have been a determinant of housing investment during our period of interest.

We use authorizations for the construction of new single-family houses as our measure of housing investment, a choice dictated by data availability.[6] As earlier, we allow for the influence of

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[5] This discussion condenses and, inevitably, simplifies an enormous literature on the subject of asymmetric information and the role of credit in business cycles. Surveys can be found in Hubbard (1996), Bernanke et al. (1996), Kashyap and Stein (1996), Bernanke (1993), and Gertler (1988).

[6] Our measure of housing authorizations differs somewhat from "residential construction," the measure of housing investment included in the national income and product accounts. First, our measure does not include any replacement investment. Second, our measure excludes multifamily homes, condominiums and apartments. We chose to focus on

expected rents implicitly, by including factors that should determine them, specifically per capita income and employment. We again use mortgage originations to proxy for mortgage credit availability. In the present context, the influence of overbuilding should be captured by a negative coefficient on the lagged capital stock.

The user cost of housing is determined by mortgage interest rates, expected depreciation, expected capital gains and the cost of construction.[7]

$$UC_t = CC_t \, [r_t - depreciation^e{}_t - capital \; gains^e{}_t]$$

where UC represents the user cost of capital. For construction costs (CC), we use a national measure deflated by state CPIs. State mortgage interest rates are estimated as the national mortgage rate minus state CPI inflation over the past year. Depreciation is taken to be 3.5% per year, following Summers and Heston (1995 a, b). Expected capital gains are represented by the estimate of expected house price appreciation discussed in the previous section.

In constructing our estimating equation, we take annual *growth* in (log) housing authorizations as our dependent variable; the independent variables described above thus also appear as changes or growth rates. We approximate the change in state housing stocks with authorizations themselves. State- and time-specific effects are also included, as is a lagged dependent variable, intended to capture the influence of unmodeled forces. We use changes in actual mortgage originations, rather than their deviations from national averages, because the effect of national refinancing trends should be captured by time dummies.

Our choice of functional form is informed by the fact that panel estimates which include a lagged dependent variable along with state-specific effects are biased, especially when the time dimension of the panel is small or moderate. Unbiased estimators have been developed by Anderson and Hsiao (1981) and Arellano (1989), who apply IV methods to differenced variables, using appropriate lags as instruments.[8] Our estimating equation is then given by:

$$\Delta HA_{it} = \alpha \Delta HA_{it-1} + \sum_{j=0}^{n} \beta_j \Delta YP_{it+j} + \sum_{j=0}^{n} \gamma_j \Delta EM_{it+j} + \sum_{j=0}^{n} \mu_j \Delta UC_{it-j} + \sum_{j=0}^{n} \eta_j MO_{it-j} + \sum_{j=0}^{n} \nu_j HA_{it-1} + s_i + \lambda_t + \varepsilon$$

Here, HA represents housing authorizations, MO mortgage originations, s a state dummy (constant across time), λ a time dummy (constant across states), and ε is the residual.

The regression results are presented in Table 5. Per capita income growth is excluded in all results since this variable was consistently statistically insignificant. We found that one lag of all variables was sufficient, which is not surprising since house construction generally takes less than a year to execute. Mortgage credit is excluded in the first column since this variable is available for only about half of our sample period. The second regression suggests that mortgage credit availability is not an important determinant of housing authorizations, once other fundamental factors are accounted for.

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single-family units to preserve compatibility with our measure of house prices. It is possible, of course, that our data include projects which were authorized but never carried out.

[7] Here, again, we allowed the effect of mortgage interest rates and expected house price appreciation to enter the regression separately, but the coefficients were extremely close and statistical tests indicated that they should be combined.

[8] Consistent estimation requires that the dependent variable be lagged twice before inclusion as an instrument. Differencing the original investment equation, as we do in moving from the expression for HA_{it} to that for ΔHA_{it}, produces a moving-average error term correlated with HA_{it-1}. For this reason, HA_{it-2} was the most recent lag of investment used as an instrument, and we used techniques described in Newey and West (1987) to control for the moving average component of the error term.

Table 5

Panel regression of annual growth in house authorizations by US State, 1973-96

	Regression 1	Regression 2*
Lagged growth in real house prices	0.34 (3.21)	0.24 (1.58)
Change in employment	1.54 (2.25)	1.08 (2.98)
Change in user cost of housing capital	-1.86 (-1.77)	-1.55 (-1.23)
Lagged authorizations	-17.32 (-4.78)	-18.49 (-4.74)
Lagged dependent variable	0.55 (5.09)	0.63 (19.24)
Lagged growth in mortgage originations (credit availability)		0.03 (0.99)
Number of observations	1,019	561
R-bar squared	0.57	0.30

Notes: Authorizations and prices correspond to single-family homes. The user cost of housing capital incorporates construction costs, mortgage interest rates, depreciation and expected house-price appreciation. t-statistics in parentheses.

* The sample size is smaller for this regression because mortgage origination data only span 1983-93.

In consequence, we concentrate on the first regression, which generally supports the theoretical predictions discussed above. Coefficients on all fundamental investment determinants have the expected sign and sensible magnitudes. All variables are significant at the 5% level, except the user cost of housing which has a marginal significance level of 8%. The significantly negative coefficient on lagged authorizations suggests a potentially important role for "overbuilding."

For our purposes, the relationship of greatest interest is between house prices and investment. The regression results point to a reasonably strong link between the two variables, with a point-in-time elasticity of 0.34 and a long-run elasticity of 0.77.[9] If our finding that mortgage origination growth is not economically important for housing investment is correct, one can infer that house prices primarily influence housing investment through the direct effect (analogous Tobin's q theory), rather than through their influence on credit.
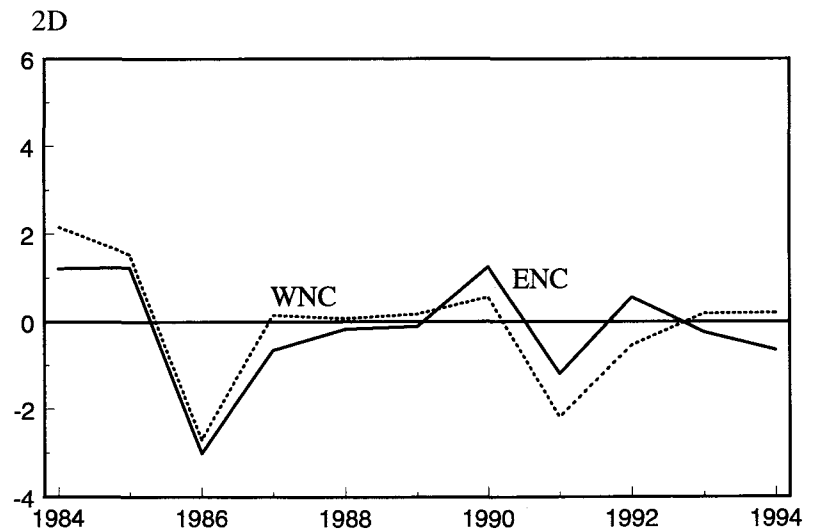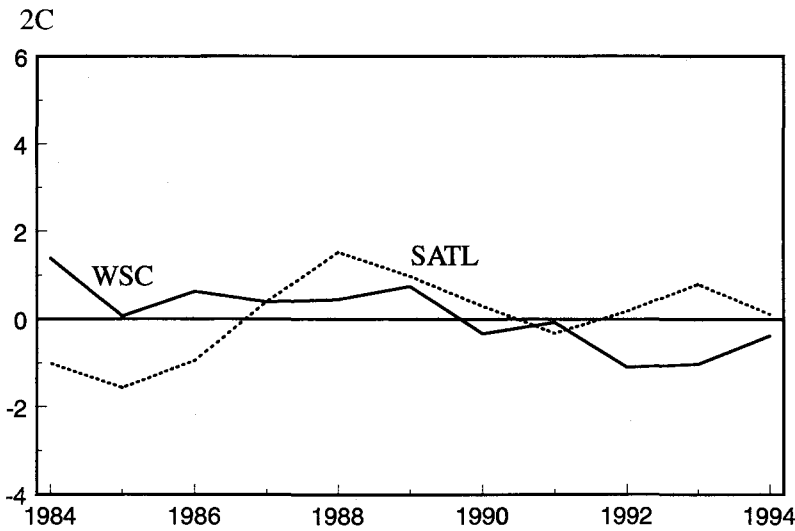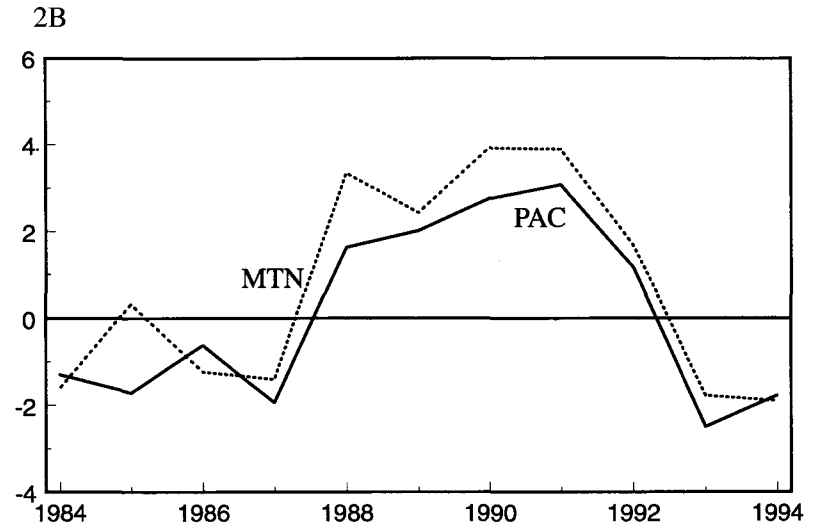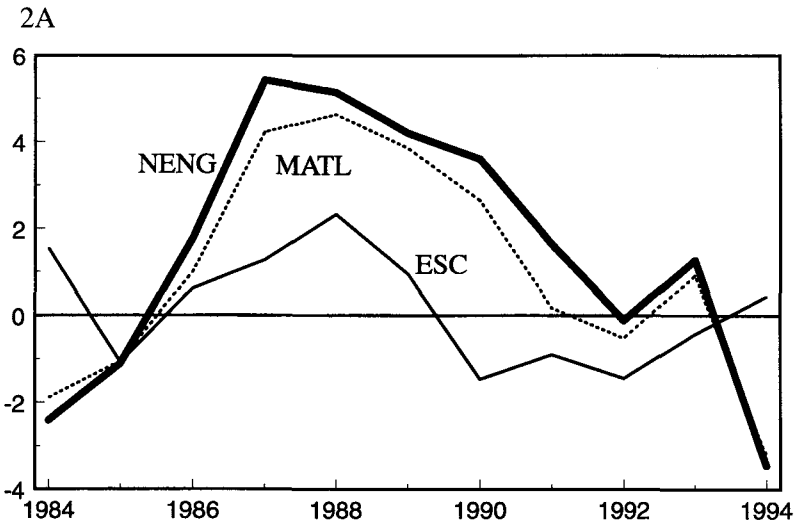
House prices and housing investment

To examine whether house prices have indeed been important determinants of housing investment, we focus once again on the period from the mid-1980s to the mid-1990s. At the national level, housing investment growth peaked in 1986 at 9%.[10] Following that peak, housing investment growth turned negative, and remained so through 1991. House prices, however, would only have been a drag on investment growth following their own peak in 1989. Our estimates suggest that, amid

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[9] The short and long-run effects of house price growth differ because price growth also influences current investment indirectly through lagged investment.

[10] Note that the peak of housing investment precedes the peak in house prices by a few years. This is typical, and it highlights the important fact that house prices are just one determinant of housing investment.

Chart 2

Housing authorization growth attributable to non-fundamentally determined house price growth, in percentages

2A

2B

2C

2D

NENG: New England; MATL: Mid-Atlantic; ESC: East South Central; MTN: Mountain; PAC: Pacific; SATL: South Atlantic; ENC: East North Central; WNC: West North Central; WSC: West South Central.

the recession of 1990-91, house price movements reduced housing investment growth by 0.8 percentage points in 1990 and by a further 1.8 percentage points in 1991. By 1992, when the economy confronted mysterious "headwinds" as it tried to recover, house price movements may have reduced housing investment growth relative to its 1989 level by a full 3.9 percentage points. In short, the estimates suggest that house prices declines may have noticeably reduced housing investment growth during the early 1990s.

Our central thesis is that speculative bubbles in house prices can affect housing investment. To evaluate this thesis, we combine the measure of non-fundamental house price movements developed in Section 1 with the regression estimates of the effect of house prices on housing investment. This allows us to calculate the contribution of non-fundamental price movements to housing investment growth.

Charts 2A through 2D show the estimated influence of non-fundamental house price movements on housing investment over 1983-93, broken down by region. In the regions identified previously as possibly experiencing speculative bubbles, these movements boosted housing investment on the price upswing and depressed housing investment on the downswing. This "hangover" effect on housing investment was apparently quite substantial. For example, during the five years following the regional house price peak in 1989, cumulative housing investment growth in New England was slowed by more than seven percentage points. In the Mid-Atlantic states, the corresponding figure is 5.9%. Across these five regions, investment growth was reduced by 5.0 percentage points on average due to non-fundamental price movements following price peaks. For the remaining four regions, the corresponding figure is 1.1 percentage points.

At the national level, diversity across the US states mutes the effect of non-fundamental forces on housing investment. The estimates suggest that non-fundamental price movements reduced cumulative growth in national housing investment by 2.7 percentage points over the five years following the national house price peak in 1989. Of this, a full 1.1 percentage point took place in the recession year of 1991 and an additional 1/4% the following year. While these effects are moderate in scale, they do suggest that a slowdown in housing construction associated with non-fundamental house price movements could have contributed to the early 1990s recession, and to the "headwinds" that slowed the ensuing recovery.

Conclusion

Our paper presents evidence that speculative bubbles in US house prices can effect housing investment. Based on annual data covering the 50 US states, we derive evidence from two separate panel regressions suggesting, first, that non-fundamental forces have had a significant influence on house prices; and second, that these in turn have had a significant influence on investment. Taking these results together, non-fundamental movements in house prices appear to have had a noticeable impact on housing investment. We use the econometric results to show that the tumbling house prices and anemic investment observed in many regions during the early 1990s could have represented, in part, the "hangover" from speculative house price bubbles in the late 1980s.

The idea that asset market behavior could have substantial effects on real economic activity is not new: as early as 1933, Irving Fisher claimed that debt deflation contributed importantly to the great depression. More recently, economists have fleshed out our theoretical understanding of these real-financial linkages, and much evidence has accumulated suggesting the importance of such linkages in earlier historical episodes.[11] Our results support the idea that asset price developments continue to affect real activity.

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[11] For recent reviews on this topic, see Bernanke and Gertler (1995) or Bernanke et al. (1996). For additional empirical evidence, see Hubbard (1994).

Beyond this, our evidence suggests that asset price movements not based on fundamentals can have important implications for economic stability, which raises an important policy question: Should governments try to contain or to prevent speculative asset price bubbles? We introduce this issue here without taking a stand on its resolution. In considering this question, governments could choose among policy alternatives including monetary policy, tax policies, or regulation.

Monetary policy could be tightened in response to excessive speculative activity: higher interest rates should directly reduce equilibrium asset prices. Further, the associated decline in the value of assets used as collateral would discourage the heavy borrowing typically associated with speculation. Though this policy is fairly certain to have the desired effect on asset prices if pursued with sufficient vigor, it has the fundamental problem that, if the bubbles are regionally concentrated, as they seem to have been in US housing markets, monetary policies intended to deflate bubbles in some regions would also affect the other regions.

A monetary attack on speculative bubbles would have other problems, as well. Identifying when to intervene would be difficult: for example, though it is by now widely accepted that Japan's stock and property markets were inflated by speculative bubbles in the late 1980s, there was no such agreement at the time. In fact, our best statistical methodologies even have difficulty identifying bubbles in *past* episodes. (One possible solution to this difficulty would be to focus on rapid asset price rises only when they are accompanied by rapid credit growth, as suggested in Schinasi and Hargraves (1993).) Finally, adding speculative asset price movements to the list of intermediate targets for monetary policy could make policy shifts less transparent to the public. One alternative would be for monetary authorities to alert markets to the possibility that asset prices exceed their fundamental values, without actually changing interest rates, a practice commonly referred to as "jawboning."

Tax policies or regulation could attack speculative bubbles in a manner more carefully targeted across the type of market – that is, tax policies could be focused on the housing market or the stock market. However, if applied at the federal level such policies are not likely to be any better targeted regionally than monetary policy. As an example of tax policies, note that capital gains taxes in some countries already attempt to discourage speculative turnover by promoting long-term ownership of investment assets. Requiring hefty minimum down payments on mortgages could also discourage speculative activity. Other regulations could actually prohibit speculative activity, as in some countries where banks have historically been barred from financing commercial building construction until future occupancy is fully committed. Tax policies and regulation could be applied permanently or only when the danger from bubbles appears imminent, much as the Japanese government limited banks' real estate lending during 1990. This, of course, brings back into focus the difficulty of identifying bubbles as they arise.

In short, in deciding whether to attempt to contain or to prevent bubbles, a government must first decide whether there is sufficient information on which to base any policy change. If intervention appears appropriate, it must choose whether the policies should be implemented by the monetary, tax, or regulatory authorities; it must choose the level of government authority most appropriate, and it must choose between permanent measures and those adopted as speculative pressures appear to build.

Our results have direct implications for the connection between monetary policy and asset market bubbles. Some observers have suggested that, as a general principle, easy monetary policy can be an important force behind excessive asset price inflation (Allen and Gale (1997) and Grant (1991)). Others have specified that easy money was in fact an important force behind the asset market booms of the late 1980s (Hoffmaister and Schinasi (1994) and Schinasi (1994)). Monetary policy was, of course, the same for all 50 US states in our panel. Since we find that speculative bubbles were strong in only about half of US states, one might infer that easy monetary policy is not a sufficient condition, and may not even be a necessary condition, for the development of price bubbles.

Data Appendix

Construction costs at the national level are reported in the *Engineering News-Record*, published by McGraw-Hill, Inc., and were taken from the DRI data base. State-level measures of real construction costs were derived by dividing this variable by state-level CPIs.

Consumer price indexes for the 50 US states are reported by the US Department of Labor, Bureau of Labor Statistics, and were taken from the DRI data base.

Disposable income data for the 50 US states are reported the *Survey of Current Business*, published by the US Department of Commerce, and were taken from the DRI data base. Total disposable income was divided by state population to derive per capita disposable income; this in turn was divided by state-level CPIs to derive real per capita disposable income.

Employment data for the US states is reported in *Employment and Earnings*, published by the US Department of Labor, Bureau of Labor Statistics, and were taken from the DRI data base. The data pertain to non-agricultural employment.

Housing authorizations data for the 50 US states are reported by the US Department of Commerce, Bureau of the Census, and were taken from the DRI data base. The data refer to the number of construction permits issued for new single-family homes.

House prices refer to DRI calculations of the median price of new, single-family homes based on national, regional and state-level information on median and mean house prices.

Mortgage interest rates at the national level are reported by the Federal Housing Finance Board, and were taken from the DRI data base. We subtracted state-level CPI inflation during the current year to derive state-level measures of real mortgage interest rates.

Mortgage originations data for the 50 US states were provided by the US Department of Housing and Urban Development. These data are in current dollar terms, and are available for 1983-94. We measure real mortgage originations by dividing the current dollar data by state-level CPIs.

Population data for the US states comes from the US Department of Commerce, Bureau of the Census, and were taken from the DRI data base.

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