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House Price Dynamics: The Role of Tax Policy and Demography

HOUSE PRICES have recently attracted unusual attention because for the first time in decades large areas in the United States have experienced declining nominal house prices. Such house price declines are not unprecedented. Between 1929 and 1933, nominal house prices declined nearly 25 percent, although there was virtually no real decline.[1] And more recently, in the early 1980s, the prices of homes in oil-producing regions fell. In Canada, too, cities such as Vancouver have experienced sharp price declines following rapid increases. These episodes have not been widespread enough, however, to dislodge the view that housing is a solid long-term investment. This view is largely based on the experience of the 1970s, when house price inflation outpaced overall price increases by almost 30 percent.

Declining real houses prices are not so unusual. For the nation as a whole, real house prices have trended down since the fourth quarter of 1979. Just before the October 1987 stock market crash, real prices were 2.3 percent lower than their 1979 levels. By the second quarter of 1991, real prices had declined another 5.6 percent, with substantially greater real declines in the Northeast and some parts of California. In the New York City metropolitan area, for example, real prices have declined 24

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1. See Grebler, Blank, and Winnick (1956, p. 344).

percent since their 1987 peak, and San Francisco has experienced a 15 percent decline since mid-1989. These localized price declines have eroded household net worth and contributed to the stress on many financial institutions.

Recent events have inevitably led to speculation about the future course of house prices. A widely cited study by N. Gregory Mankiw and David Weil analyzes the historical link between house prices and demographic change and concludes that if past patterns persist, real house prices could decline significantly over the next two decades.[2] Although their conclusion has been challenged in the media and in professional journals, the ensuing debate has not yielded clear evidence on what determines house prices.

This paper presents new evidence on house price determination and the extent to which house prices are set in an efficient asset market. It begins by sketching three nonexclusive explanations for house price movements during the past three decades: changes in construction costs; changes in the real after-tax cost of homeownership; and changes in demographic factors. The paper develops three empirical tests to disentangle these possible determinants of house prices.

The first test exploits data on individual housing transactions to examine which types of houses gained value in the late 1970s and which lost value in the 1980s. The results suggest that larger homes appreciated the most in the early period and declined in value the most in recent years. This pattern supports the real user cost view.

The second empirical test analyzes data on the rates of house price appreciation in a large cross section of cities. Cities with more rapidly growing populations in the traditional home-buying years do not experience faster price growth than other cities. The patterns of house price appreciation across cities cast doubt on the role of demography in explaining price movements, although they do not lend support to the user cost view. User cost variation across cities is relatively limited, so it is more difficult to test the importance of real user costs using these data.

The third empirical test focuses on whether house prices are forward looking and can forecast changes in local economic conditions, such as the growth of per capita income. The results indicate that house prices do predict the future to some degree, but they also show that lagged

2. Mankiw and Weil (1989).

changes in a city's real per capita income, as well as the lagged change in its real house prices, can explain a substantial part of the variation in house price appreciation. These findings violate standard efficient-markets theory. A brief look at house price movements in other countries reveals several episodes of sharp increases *and decreases* in real house prices, suggesting that house prices can be subject to speculative bubbles.

The paper concludes that changing real user costs could be an important contributory factor in the house price rise of the late 1970s. They are less able to explain the data for the 1980s, when real interest rates increased and real user costs rose substantially but real house prices declined relatively little. The finding that house prices do not behave as efficient asset prices may be important for understanding the past decade, during which homeowners may have only slowly recognized that the rapid house price appreciation of the 1970s would not be repeated. Investor expectations of rapid house price appreciation through much of the 1980s can resolve the puzzle of why house prices did not fall further. This raises the possibility that investors may extrapolate the recent decline in real house prices and conclude that the real carrying costs of houses are particularly high, hence reducing the demand for housing and the level of house prices still further.

Theories of House Price Fluctuations

House prices are of more than conversational interest to economists. Owner-occupied housing accounts for a greater fraction of household net worth than corporate equity. In 1990, when household net worth equaled $17.1 trillion, the gross value of owner-occupied homes was $4.6 trillion, nearly double the $2.4 trillion worth of corporate equity owned by households.[3] Movements of real house prices have large effects on household wealth, and potentially on consumer spending.[4] High house prices relative to building costs also call forth increased construc-

3. Federal Reserve Board, *Balance Sheets of the U.S. Economy*, May 1991.

4. Skinner (1989), Manchester and Poterba (1989), and Bosworth, Burtless, and Sabelhaus (1991) explore the effect of housing wealth on household consumption. The latter two studies provide weak evidence that housing capital gains translate into increased spending.

tion activity and channel resources to the building sector. Only one-quarter of all new single-family homes are sold before construction starts (26.7 percent in 1990). The remaining three-quarters of new construction is started as a speculative venture by the builder; more than a third of new homes are not sold until after they are completed.[5] House prices play a role similar to that of the price of corporate stock in James Tobin's q-model of investment.

Relative to the GNP deflator, the quality-adjusted price of a new home in 1990 is more than 20 percent higher than in the early 1960s. Figure 1 plots the relative price of constant-quality new homes for the period since 1963, when the Census Bureau began reporting this series. Most of the appreciation in house prices took place during the 1970s, when real prices rose almost 30 percent. Since then, real house prices have declined.

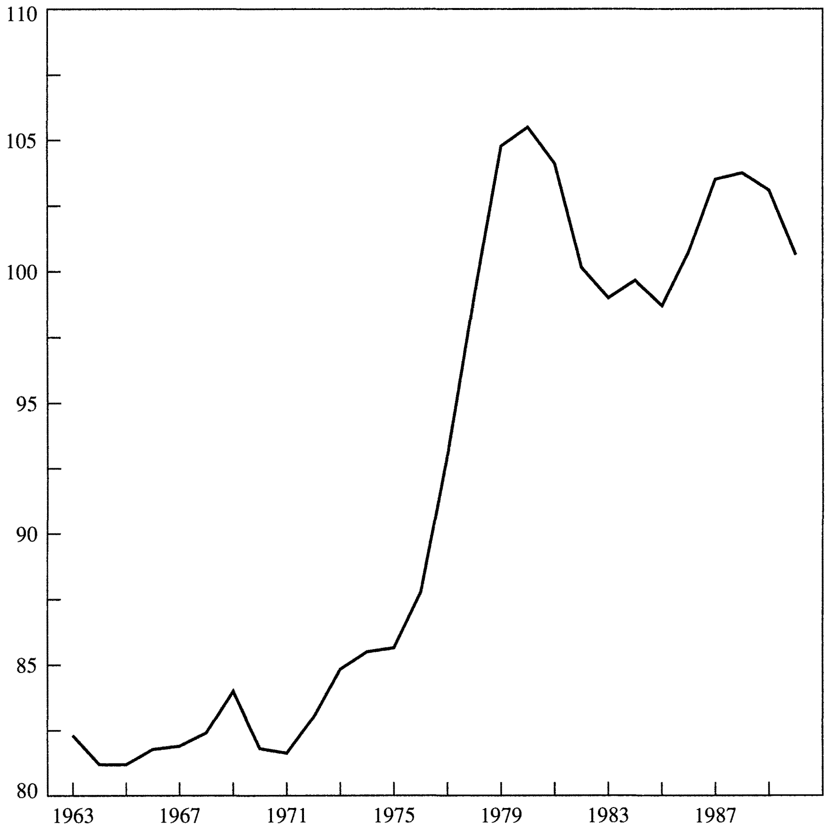
The national data presented in figure 1 mask heterogeneity across different regions. More disaggregated Census Bureau data reveal average annual house price appreciation of 1.1 percent in the West and 1.2 percent in the Northeast during the 1963–90 period, with real price *declines* of 0.1 percent a year in the South and Midwest. The timing of the real price changes also differs between regions. In the 1970s, real prices more than doubled in the West, while homes in the Northeast gained only 17 percent. During the late 1980s, real prices declined in all regions *except* the Northeast. Despite reductions at the end of the decade, real prices in the Northeast climbed 39 percent between 1980 and 1990. Homes in the West declined in value by nearly 10 percent, and those in the South and Midwest lost more than 20 percent of their real value.

Census regions may aggregate too much for studying housing prices, but they are the smallest jurisdictions that have relatively long time series of quality-adjusted house prices.[6] More disaggregate data are available from the National Association of Realtors (NAR), which reports quarterly median house prices for a set of 115 standard metropolitan statistical areas (SMSAs). However, for many SMSAs, the data do not go

5. Bureau of the Census, *Construction Reports C-27*.

6. There are some high-quality indexes for smaller jurisdictions and shorter time periods, such as Case and Shiller's (1989) indexes for four cities and Pollakowski's (1988) indexes for 22 cities between 1974 and 1983.

Figure 1. Average Real Price of New Single-Family Houses, 1963–90
Index, 1982 = 100



Source: Bureau of the Census. The figure shows an index of the average price of a constant-quality home relative to the GNP deflator, with 1982 = 100.

back very far. Only 39 SMSAs, with a 1990 population of 76 million people, provide data for the 1980–90 period.

Median prices suffer from a number of well-known limitations, principally their failure to control for quality variation over time. They nevertheless appear to capture broad price movements in housing markets. The Case-Shiller repeat-sale price indexes move in the same direction as the median sales prices in the cities where they can be compared, but inflation calculated from median prices can differ from that estimated with repeat-sale indexes by several percentage points.[7] Still, the NAR data are the best information currently available across cities.

The 39 SMSAs with 10 years of NAR data display significantly different appreciation rates. The standard deviation of their 1980–90 appreciation rates is 24.1 percent. Four of the 39 cities averaged annual real appreciation rates of more than 4 percent, and 18 cities experienced real house price declines. This wide dispersion suggests the potential value of city-level data for analyzing house price determination.

The NAR median house prices reflect the combined cost of structures and land. The Census Bureau constant-quality price indexes, by contrast, attempt to value only structures. An important question in analyzing recent house price declines is whether they reflect only reduced land values or whether they include both lower land and structures prices. Because there are relatively few sales of buildable tracts in some established SMSAs, it is often difficult to disentangle land and structures prices.

One source of data on land costs is the Urban Land Institute's (ULI) semidecadal survey of land costs.[8] The survey asks developers to price a standard, improved, 10,000-square-foot lot in different cities. The ULI has surveyed 30 cities four times in the past 16 years, starting in 1975. The correlation across cities between the NAR median house price and the ULI land price for 1990 is 0.85. It is difficult to assign any causal interpretation to this result, since land prices and house prices are jointly determined.

A more important question is the share of the variation in *changes* in house prices that can be explained by movements in land prices. The aggregate pattern of house price movements is not coincident with that for real land prices. Averaging the land costs in the 30 ULI cities gives 19.5 percent real land price growth between 1975 and 1980, 3.0 percent between 1980 and 1985, and 13.5 percent between 1985 and 1990. Real house prices rose faster in the late 1970s and fell during the 1980s. The

7. See Case and Shiller (1987). I found additional support for the usefulness of median prices in a simple analysis of house sales in my hometown (Belmont, Massachusetts). Houses are re-assessed to current market value every three years, so within assessment cycles, assessed value provides an index of house quality. I analyzed the set of house sales during the 1987–89 period and found that the assessed value of the house with the median sales price in each of the three years varied relatively little. This suggests that the quality bias from analyzing median house prices would be small.

8. These data are reported in Black (1990).

ULI data may understate actual land price inflation in the early period. A comparison series of land costs, the U.S. Department of Agriculture (USDA) index of the average price of farmland in the United States, rose 39.4 percent (in real terms) between 1975 and 1980.

The ULI and NAR price data can be differenced for the small sample of cities with historical NAR price reports. Regressing the five-year percentage change in real median house prices, $\Delta \ln P_{it}$, on the percentage change in real land costs over the same period, $\Delta \ln L_{it}$, and using all available five-year intervals from the ULI data set yields:

$$\Delta \ln P_{it} = \underset{(0.025)}{-0.025} + \underset{(0.092)}{0.288}\, \Delta \ln L_{it} \qquad R^2 = 0.270; N = 29. \tag{1}$$

This suggests that a surprisingly small fraction of the variation in house prices may be explained by changing land costs.

A Framework for Explaining House Price Movements

The housing market actually consists of two markets: one for the stock of existing houses, which determines the price of houses, and another for the flow of new construction, which determines the level of new investment.[9] Shocks to either of these markets can affect house prices.

Equilibrium in the market for existing owner-occupied houses requires that homeowners, in their role as investors, earn the same return on housing investments as on other assets. This requires

$$R_H/P_H = [(1 - \theta)(i + \tau_p) + \delta + \alpha + m - \pi^e], \tag{2}$$

where R_H denotes the marginal value of the rental services per period on owner-occupied homes, P_H the price of existing houses, θ the investor's marginal tax rate, i the nominal interest rate, τ_p the property tax rate as a share of house value, δ the depreciation rate on housing capital, α the

9. This framework is developed in Kearl (1979), Poterba (1984), Topel and Rosen (1988), and many other papers. These studies ignore the fact that there are many types of houses, differentiated by location, quality, and other characteristics. In some of these many markets, gross investment may be zero. The potentially important nonnegativity constraints on gross housing investment are not considered when all housing is aggregated.

risk premium required on assets with the risk characteristics of housing, m the maintenance cost per unit value, and π^e the investor's expected rate of nominal house price appreciation. Both interest payments and property taxes can be deducted from federal income taxes.

The housing stock at the beginning of each period is determined by past investment. The housing stock in turn determines R_H. All but one of the other parameters in equation 2, the expected inflation rate, are exogenous to the housing market. Closing the model and determining the level of house prices therefore requires some choice of π^e.

The most theoretically appealing model of expected housing inflation imposes rational expectations on housing investors and recognizes the link between the current level of house prices and future housing investment. An investment supply equation relates the flow of net new construction, $H_t - H_{t-1}$, to the ratio of house prices to construction costs, P_H/C:

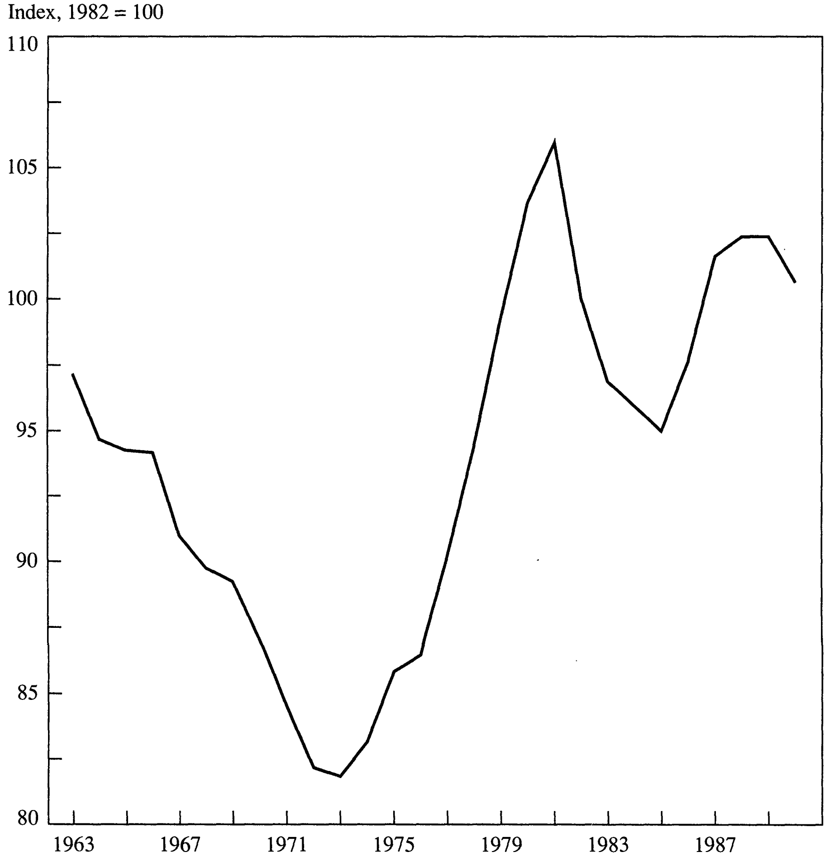
$$H_t - H_{t-1} = \phi(P_{Ht}/C_t) - \delta H_{t-1}. \tag{3}$$

Under the perfect foresight assumption that $\pi_t^e = (P_{H,t+1} - P_{Ht})/P_{Ht}$, equations 2 and 3 become a pair of difference equations in H_t and P_{Ht} that can be solved forward to determine the initial price of housing.[10] In this framework, an increase in the real price of houses could arise from supply shocks that raise current or future construction costs or from current or anticipated future demand shocks that raise the rental service value of the owner-occupied housing stock.

The model of house price determination can also be closed with assumptions other than rational expectations about house price changes. Recent survey research suggests that housing market participants form extrapolative expectations.[11] Such a backward-looking process for setting price expectations would permit periods of systematic overbuilding in the housing market and also would account for predictable patterns in the excess returns on houses. The claim that demographic changes during the 1970s affected house prices, even though these changes could be forecast two decades earlier, implicitly assumes that housing market participants do not form rational expectations about future price changes. How expectations of future house prices are set and whether

10. Poterba (1984) provides a more detailed solution.
11. Case and Shiller (1988).

Figure 2. House Prices Relative to Construction Costs, 1963–90



Source: Bureau of the Census. The figure shows the ratio of the Census Bureau's price index for a constant-quality new home to the Boeckh construction cost index. The ratio is indexed with 1982 = 100.

the asset market for houses can be viewed as efficient are therefore central questions for understanding the behavior of U.S. house prices during the past three decades.

There are three popular explanations for the rise in house prices during the 1970s. The first relies on shocks to construction costs.[12] Systematic changes in construction costs could raise house prices relative to the GNP deflator. Figure 2 plots the Census Bureau's price index for a con-

12. See Diamond (1984) for an exposition of this view.

stant-quality new home divided by the Boeckh construction cost index. The latter includes the cost of labor and materials for a residential structure but not the cost of land. The figure shows a 16 percent rise in the price-to-cost ratio during the 1970–80 period, approximately half the increase in house prices relative to the GNP deflator.[13]

A second explanation for rising house prices in the 1970s is a favorable and unexpected demand shock resulting from the interaction of inflation and the tax system. The U.S. tax code allows homeowners to deduct nominal interest payments in computing taxable income, as indicated in equation 2. If nominal interest rates rise only one for one with expected inflation, the after-tax cost of borrowing, $(1 - \theta)i - \pi^e$, declines as expected inflation rises. This effect is more pronounced for high–tax rate households and should therefore increase their demand for housing relative to that of low-income households.[14]

The tax changes in the 1980s reduced marginal tax rates for many households, but especially for those with high incomes. Other things equal, these reforms should have raised the marginal cost of housing for high-income homeowners and depressed the prices of homes typically held by these households.[15] The Tax Reform Act of 1986 also raised standard deductions and reduced the fraction of the population who would itemize if they were not homeowners, reducing the demand for homeownership at lower incomes but not by as much as for high-income households.[16]

13. The most important component of the cost increase in the 1970s was the cost of materials. Real lumber prices rose 126 percent during the decade, and the wholesale price index for all construction materials rose 32 percent.

14. Feldstein (1980), Hendershott (1980), Summers (1981), and Poterba (1984) discuss this explanation for the 1970s experience in some detail. Van Order and Dougherty (1991) provide direct evidence supporting the importance of real user costs in housing demand. The sensitivity of nominal interest rates to expected inflation remains an unresolved empirical issue, as Mishkin (1991) explains, but during the 1970s a one-for-one increase seemed plausible.

15. The 1981 tax reform also reduced average tax burdens on high-income households. This increment to after-tax income could have partly offset the demand reduction from higher real user costs.

16. In general equilibrium, the tax treatment of rental and owner-occupied housing must be considered in determining tenure choice. The Tax Reform Act of 1986 significantly raised the cost of supplying rental housing. In the long run, as this reduces the supply of rental housing and drives up real rents, it could provide a countereffect to the changes in the standard deduction. See Berkovec and Fullerton (1989) for a more complete discussion.

Table 1. Real User Costs of Homeownership, by Household Income, 1970–90
Percent

Method of calculation and year	*Adjusted gross income of household (1990 dollars)* *$30,000*	*$50,000*	*$250,000*
Calculated with actual tax rates, actual mortgage interest rates, and expected inflation rates			
1970	11.09	10.76	7.47
1975	9.42	8.75	5.06
1980	10.57	9.68	4.48
1985	13.08	11.84	8.55
1990	13.24	11.67	11.67
Calculated with actual tax rates, constant mortgage interest rates, and constant expected inflation rates			
1970	11.15	10.86	8.01
1975	11.19	10.65	7.68
1980	11.28	10.74	7.59
1985	11.46	10.65	8.49
1990	11.55	10.38	10.38

Source: Author's calculations; see Poterba (1990) for further details. All cases assume a property tax of 2 percent of property value, a risk premium for real estate investment of 4 percent, annual maintenance costs of 2.5 percent of home value, and an annual real depreciation rate of 1.4 percent for residential structures. In the top panel, the mortgage interest rate is the annual average effective rate on all newly issued conventional mortgages, and the expected inflation rate is measured as the average CPI inflation rate over the previous five years. In the bottom panel, the mortgage interest rate is held constant at 7 percent and the expected inflation rate is held constant at 3 percent. The user cost of homeownership (c) is defined as

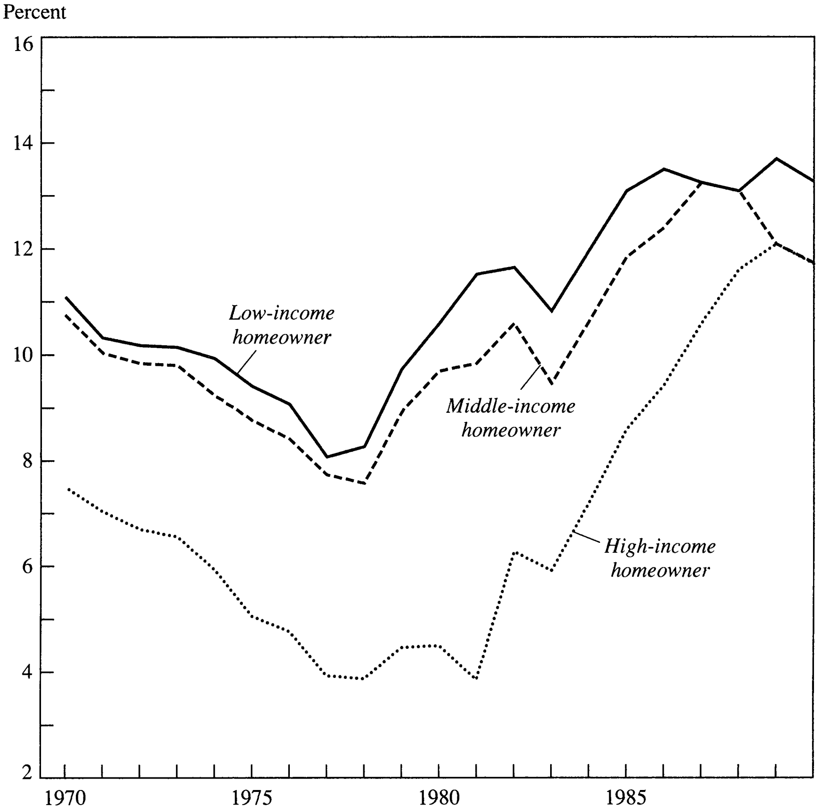
$$c = [(1 - \theta)(i + \tau_p) + \delta + \alpha + m - \pi^e],$$

where the various terms are defined in the text.

Table 1 and figure 3 show the user cost of homeownership for three different income levels during the past two decades. The top part of table 1 shows the effect of the tax code at five-year intervals using interest rates and expected inflation rates prevailing at the time, thus indicating the net change in actual incentives for homeownership. The bottom part considers the user cost for a fixed pattern of interest rates and expected inflation rates, thereby isolating the effect of tax changes.

Real user costs for most households declined between 1970 and 1980 and then increased through the 1980s. These changes are most striking for high-income households. For a family of four with 1990 adjusted gross income of $250,000, the user cost in 1970 was 7.5 percent of house value; by 1980 it had declined to 4.5 percent. Rising real interest rates and falling marginal tax rates increased this user cost to 11.7 percent by

Figure 3. Real User Costs of Homeownership, by Household Income, 1970–90



Source: See table 1.

1990. Assuming a price elasticity of demand of − 1.0 for owner-occupied housing,[17] these changes in user costs could have large effects on both housing demand and house prices.

The user cost changes for a household with a 1990 adjusted gross income of $50,000 follow the same pattern but are less pronounced. During the 1970s, the real user cost was higher for this household than for its higher-income counterpart: 10.8 percent in 1970 and 9.7 percent in 1980. The changes for low-income homeowners, with 1990 adjusted gross income of $30,000, are smaller still and sensitive to whether the household itemizes deductions for tax purposes. For nonitemizing

17. See Rosen (1985).

households, the user cost declined as real interest rates fell in the mid-1970s but was roughly the same in 1970 and 1980.

Table 1 shows that most of the variation in user costs during the 1970s was due to rising nominal interest rates and falling real rates, not to changes in the tax system. During the 1980s, tax changes played a more important part in explaining changes in user costs, especially for high-income households.

Figure 3, when compared with figure 1, illustrates the difficulty of explaining house price movements on the basis of changing user costs. House prices rose during the late 1970s as user costs fell, but they did not fall as real user costs rose during the 1980s. Another factor is needed to explain the absence of a house price decline in the past decade.[18]

The third prominent explanation of the rise in house prices in the late 1970s, which focuses on demography, may provide the missing factor.[19] Most individuals increase their housing consumption substantially between the ages of 20 and 34, frequently as a result of starting a family and often in association with a switch from rental to owner-occupied housing. The fraction of the population in this age group is therefore an important determinant of the change in housing demand.

Mankiw and Weil argue that in an efficient market, demographic changes such as the entry of a large cohort into the 20–34 age bracket should be anticipated and therefore should not affect asset prices. The U.S. baby boom in the 1950s should have affected house prices *then*, as rational investors recognized that the "boomers" would boost housing demand two decades later. Despite this prediction of rational models, the entry of the baby-boom generation into its prime homebuying years coincided with a rapid increase in real house prices, and Mankiw and Weil find a strong correlation between demographic demand for owner-occupied housing and real house prices. This correlation underlies their forecast that the entry of much smaller "baby bust" cohorts into the housing market during the 1990s could result in falling real house prices.

This forecast has provoked many rebuttals, but the ensuing debate has obscured two central points of wide agreement. First, demographic

18. Hendershott (1988a) discusses the possible effects of slowing productivity growth in construction and rising real incomes as other factors explaining house price changes.

19. The role of demography has been emphasized by Mankiw and Weil (1989) but is implicit in a number of earlier analyses.

factors such as the number and characteristics of households *do* affect housing demand and should therefore affect prices; the critical point of disagreement is the timing of these effects.[20] Second, demographic factors are not the only force affecting house prices. The empirical issue is the fraction of the variation in house price movements that can be explained by demography.

Relative Appreciation of Different Sized Houses

The alternative explanations of real house price movements make different predictions concerning the relative appreciation of different types of houses. The construction cost view predicts that if housing inputs do not differ much, then different houses should experience roughly equal rates of appreciation. The user cost analysis implies an increase in the relative demand for the houses typically purchased by high-income households during the 1970s and a decline in the 1980s. This should have translated into lower appreciation rates for these, generally larger, houses than for smaller ones.

The demographic explanation for price changes suggests just the opposite. The entry of baby boomers into the housing market should have boosted the demand for starter houses relative to larger trade-up homes in the late 1970s and 1980s. The 1989 Chicago Title and Trust survey of homebuyers, for example, shows that the average price of homes purchased by repeat buyers is 1.34 times greater than the price of homes purchased by first-time buyers.[21] If housing supply adjusts slowly, the demographic shifts of the 1970s should have raised the prices of both new and existing small houses relative to those of larger ones.

This section presents two types of evidence on the relative appreciation of different types of houses. The first uses data from the Census Bureau's quarterly survey of new-home sales to compare the relative appreciation rates of houses with different structural characteristics between 1974 and 1989.[22] The second exploits data on repeat sales of a

20. If the elasticity of new construction with respect to prices is high, as McFadden (1990) argues, then even large changes in housing demand should result in relatively brief deviations of house prices from their underlying replacement costs.

21. Chicago Title and Trust (1990).

22. The Bureau of the Census publishes the Housing Sales Survey.

smaller group of houses to analyze whether more expensive houses appreciated by more, or less, than smaller houses during the 1970s.

The Census Bureau collects data on a large random sample of new-home sales each quarter. The data contain information on the sale price and on some basic features of each house. These data are then used to construct a hedonic index of real house prices.[23] This involves estimating regressions for each quarter (t) of the form

$$\ln(P_{it}) = \mathbf{X}_{it}\boldsymbol{\beta}_t + \epsilon_{it}, \tag{4}$$

where P_{it} is the sale price of the new house, $\mathbf{X}_{it}$ is a vector of house characteristics, and ϵ_{it} is the residual. The time subscript on the coefficient vector $\boldsymbol{\beta}_t$ recognizes that a different parameter vector is estimated each quarter.

The predicted purchase price in quarter t of a constant-quality house with attributes $\overline{\mathbf{X}}$ is then $\hat{P}_t = \exp[\overline{\mathbf{X}}\hat{\boldsymbol{\beta}}_t]$. The house price index is

$$I_t = \hat{P}_t/\hat{P}_0 = \exp[\overline{\mathbf{X}}(\hat{\boldsymbol{\beta}}_t - \hat{\boldsymbol{\beta}}_0)], \tag{5}$$

where $\overline{\mathbf{X}}$ denotes the characteristic vector for the average house sold in the base year, 1987. The estimated hedonic coefficients can be used to estimate the price changes for houses with many different characteristics, not just for the average 1987 house. To compare large and small houses, I defined a starter home (with characteristics $\overline{\mathbf{X}}_S$) and a trade-up, or upper-income, home ($\overline{\mathbf{X}}_T$). The starter home contains 1,200 square feet of living space, and the trade-up home contains 3,000 square feet.[24]

The Census Bureau hedonic algorithm relates the logarithm of the house price to housing characteristics.[25] Estimates of $\hat{\boldsymbol{\beta}}_t$ for this model are available for 1977–89. These coefficients can be used to estimate appreciation rates over various three-year subperiods for the starter and trade-up houses. For starter houses, the three-year appreciation rate is defined in the following equation:

23. Follain, Ozanne, and Alburger (1979) discuss alternative approaches to measuring change in real house prices, noting both the advantages and limitations of the hedonic approach.

24. The other characteristics of the starter home include no fireplace, fewer than two bathrooms, no garage, two or fewer bedrooms, and no air conditioning. The other characteristics of the trade-up home include two or more fireplaces, three or more bathrooms, four or more bedrooms, and air conditioning.

25. The Census Bureau has published a constant-quality house price index since 1963, but directly comparable estimates of the hedonic coefficients are only available since 1977.

Table 2. Appreciation of Trade-up Homes Relative to Starter Homes, by Region, 1977–89
Percent

Time period	Region: Northeast	Midwest	South	West	Entire United States
1977–80	29.5	29.7	1.2	8.9	11.7
	(7.3)	(5.0)	(4.3)	(3.4)	(4.5)
1980–83	−9.1	20.9	7.2	7.2	7.7
	(8.1)	(5.6)	(4.4)	(4.3)	(5.0)
1983–86	−21.1	−24.9	−5.3	−16.7	−13.2
	(7.9)	(5.9)	(4.3)	(4.6)	(5.1)
1986–89	−18.5	−5.0	17.8	1.3	5.6
	(9.1)	(6.9)	(5.1)	(7.0)	(6.4)

Source: Author's calculations using Census Bureau data. Entries correspond to the differential appreciation rates of trade-up (T) and starter (S) homes computed as

$$\ln P_{Tt}/P_{T,t-3} - \ln P_{St}/P_{S,t-3} = (\bar{\mathbf{X}}_T - \bar{\mathbf{X}}_S)\,(\hat{\boldsymbol{\beta}}_t - \hat{\boldsymbol{\beta}}_{t-3}),$$

where $\bar{\mathbf{X}}_T$ and $\bar{\mathbf{X}}_S$ are vectors of characteristics for the two types of homes and $\hat{\boldsymbol{\beta}}$ is the vector of hedonic coefficients used in the Census Bureau's house price index algorithm. The standard error of this expression, shown in parentheses, is $[(\bar{\mathbf{X}}_T - \bar{\mathbf{X}}_S)'\,[\mathrm{Var}\,(\hat{\boldsymbol{\beta}}_t) + \mathrm{Var}\,(\hat{\boldsymbol{\beta}}_{t-3})]\,(\bar{\mathbf{X}}_T - \bar{\mathbf{X}}_S)]^{1/2}$ since the two sets of parameter estimates are based on different data sets and are therefore independent. Statistics for the United States are a weighted average of the regional values, with weights proportional to the sample size in each regional regression.

$$\ln (P_{St}/P_{S,t-3}) = \overline{\mathbf{X}}_S(\hat{\boldsymbol{\beta}}_t - \hat{\boldsymbol{\beta}}_{t-3}). \tag{6}$$

An analogous definition yields the appreciation rate for trade-up homes.

Table 2 reports estimates of the relative appreciation rates for the starter and trade-up houses in each of the four census regions, as well as for the United States as a whole. The results suggest that different types of houses appreciated at significantly different rates during the 1977–89 period; they also display important subsample variation in these relative appreciation rates. The finding of differential appreciation rates is difficult to reconcile with supply shocks to the construction sector, since these presumably affect high- and low-value houses similarly.

The broad patterns of relative house price movements are consistent with the importance of changing real user costs. During the 1977–80 period, when rising inflationary expectations combined with high marginal tax rates to reduce user costs for high-income households, trade-up houses appreciated more than starter homes. During the 1980–83 and 1986–89 periods, the hypothesis of equal appreciation rates cannot be rejected at standard confidence levels for the pooled national data. Between 1983 and 1986, when falling inflation rates and the passage of the

Tax Reform Act of 1986 combined to raise real user costs more for high-income than for low-income households, the appreciation rate of large homes was substantially *lower* than that of smaller houses. The national estimate suggests that the appreciation of trade-up homes was 13 percent lower than that of starter homes, with the largest effects observed in the Northeast and Midwest.

Although more than half of the appreciation in real house prices during the 1970s occurred after 1977, the absence of comparable pre-1977 hedonic coefficients is an unfortunate limitation. For this earlier period, the Census Bureau used a linear rather than a logarithmic hedonic specification, and the set of explanatory variables differed from that in the current index. Calculations similar to those reported in table 2, but based on the earlier hedonic models, show that trade-up houses appreciated by 2.1 percent more than starter houses for the 1974–77 period, with the largest gains in the Northeast (4.3 percent) and the Midwest (5.7 percent).[26] Since expected inflation was rising during these years, these findings provide further support for the real user cost model.

The hedonic approach, which provides the basis for the foregoing analysis, is subject to a number of well-known deficiencies. A better house price index involves analyzing *repeat sales* of a sample of houses. Karl Case and Robert Shiller use this method to construct house price indexes for Atlanta, Chicago, Dallas, and Oakland.[27] Their data can also be used to investigate the relative appreciation of starter and trade-up houses. Since their data set does not include information on house characteristics, houses must be stratified as large or small solely on the basis of their transaction prices.

To illustrate the procedure, consider the sample of all houses sold in Atlanta in 1974. Since expensive houses will typically be purchased by high-income (and high–tax rate) households, the real user cost analysis suggests that houses that were relatively expensive in 1974 should appreciate more in the second half of the 1970s than their less expensive counterparts. The demographic explanation suggests the opposite.

This proposition can be tested as follows. Consider all houses that

26. Parameter covariance matrices for the pre-1977 hedonic models are not available, so it is not possible to assess the statistical significance of this difference.

27. See Case and Shiller (1987). Shiller (1991) discusses a number of issues associated with repeat-sales indexes and references much of the previous work in this area.

sold in 1974 and again k years later. Define R_i as the average annual appreciation rate for house i over the k subsequent years: $R_i = (1/k) \ln (P_{i,t+k}/P_{it})$. Since the strongest predictions from the real user cost model contrast houses at the top and bottom of the house price distribution, I compute the difference in actual appreciation rates between houses in the first and fourth quartiles of the 1974 house price distribution. I also estimate the difference in appreciation rates for houses between the top octile and the lower quartile of the house price distribution.

The test above compares houses that sold in two particular years. In the Case-Shiller repeat-sales data, however, relatively few houses sell in any particular pair of years. To expand the data set, I compute the average annual appreciation rates for all houses with a first transaction date between January 1970 and December 1973 and a second transaction date between January 1979 and December 1982.[28]

A potential difficulty with this technique is that a house's estimated quartile at first sale is a noisy measure of its true quartile. If measurement errors are uncorrelated across sales for each house, houses that are observed high in the price distribution at first sale will tend to exhibit lower appreciation rates than those in the bottom of the first-price distribution. The rank for each house is therefore determined by computing its average real transaction price using the consumer price index and then by finding where this property ranks in the distribution of real house prices.

Table 3 presents summary statistics regarding house prices in the four cities with repeat-sales data. The center panel reports the real price for houses at the 25th and 75th percentiles of the distribution for each city. In Atlanta and Dallas, a home at the 25th percentile sold for slightly more than half as much as one at the 75th percentile. The difference is smaller in the other two cities. The lower panel of table 3 shows the marginal tax rates that would face households buying homes at the 25th and 75th percentiles.[29] In all four cities, the trade-up buyer (top octile) had a mar-

28. The average annual appreciation rate is computed over somewhat different sample periods for different houses depending on the particular dates when they were bought and sold.

29. I assume that households have incomes equal to one-third of the house price, itemize, and have nonhousing itemized deductions equal to the average amount for other itemizers in their income class.

Table 3. Statistics on Repeat Sales, Selected Cities, 1970–82

Statistic	*Atlanta*	*Chicago*	*Dallas*	*Oakland*
Sample size	475	875	259	126
Annual real appreciation (percent)	−1.5	1.4	1.8	6.0
Price statistics (thousands of 1990 dollars)				
Bottom-quartile cutoff	44.0	63.0	40.3	80.9
Median	62.8	82.8	56.2	97.3
Top-quartile cutoff	83.3	103.7	76.1	121.9
Marginal tax rates (percent)				
Bottom-quartile cutoff				
1973	15	19	14	19
1980	14	18	14	21
Top-quartile cutoff				
1973	19	22	19	22
1980	21	24	21	32
Top-octile cutoff				
1973	22	22	19	22
1980	24	32	24	32

Source: Author's tabulations using data provided by Karl Case. The sample includes all houses in the Case and Shiller (1987) data set that sold once between January 1970 and December 1973 and then again between January 1979 and December 1982. Marginal tax rate estimates assume that the homeowner has an adjusted gross income of one-third of the house price, is married with two children, files a joint tax return, and claims itemized deductions equal to the average for other households in the income class.

ginal tax rate 10 or more percentage points higher than the start-up buyer in 1980. These tax rate differentials translate into larger effects of rising inflation rates and nominal interest rates for the trade-up than for the starter-home buyer.

Table 4 reports the differential appreciation of houses in different quartiles of the price distribution. In each city, houses in the top quartile appreciated faster than houses in the bottom quartile; the differences are statistically significant in three of the four cities. On average, top-quartile homes appreciated between 1 and 2 percent *a year* faster than bottom-quartile homes. The middle panel of table 4 reports analogous evidence for the difference in appreciation rates between homes in the top octile of the price distribution and those in the bottom quartile. The appreciation differences are larger than those between the top and bottom quartiles.

The final panel of table 4 presents a more specific test of whether the inflation–income tax interaction during the 1970s accounted for differen-

Table 4. Relative Changes in House Prices, Selected Cities over the 1970s

Regression result	*Atlanta*	*Chicago*	*Dallas*	*Oakland*
Without inflation interactions[a]				
Quartile regressions				
Constant	−1.52	1.60	1.69	5.85
	(0.16)	(0.13)	(0.21)	(0.32)
Differential appreciation (γ_1)	0.78	2.01	2.82	1.27
	(0.33)	(0.25)	(0.42)	(0.65)
R^2	0.01	0.07	0.15	0.03
Sample size	475	875	259	126
Octile regressions				
Constant	−1.52	1.60	1.87	6.06
	(0.15)	(0.11)	(0.19)	(2.89)
Differential appreciation (γ_1)	1.28	2.54	3.45	1.03
	(0.40)	(0.31)	(0.52)	(0.81)
R^2	0.02	0.08	0.15	0.02
Sample size	475	875	259	126
With inflation interactions[a]				
Constant	−0.50	1.48	2.99	6.65
	(0.08)	(0.08)	(0.13)	(0.12)
Differential appreciation (γ_1)	0.71	−0.27	−0.33	−3.00
	(0.20)	(0.21)	(0.34)	(0.31)
Differential with interaction (γ_3)	22.13	33.78	81.60	191.42
	(5.74)	(8.05)	(10.57)	(12.01)
R^2	0.01	0.01	0.02	0.06
Sample size	7,457	12,584	5,501	6,663

Source: Author's calculations. The quartile and octile regressions include all houses in the Case and Shiller (1987) data set that sold once between January 1970 and December 1973 and then again between January 1979 and December 1982. The sample for the inflation-interaction regressions includes all houses from the Case-Shiller data set, regardless of the date of sale, provided the first and second sales were separated by more than four quarters. Equation 7 in the text shows the basic form of the regression.

a. The regression without inflation interactions excludes the two interactive terms in equation 7 from the analysis. The regression with inflation interactions is for quartiles only.

tial appreciation rates. This panel reports estimates of a regression equation,

$$(7) \quad R_i = \gamma_0 + \gamma_1 IQ1_i + \gamma_2(IQ1_i + IQ4_i) + \gamma_3 IQ1_i\Delta\pi_i^e + \gamma_4(IQ1_i + IQ4_i)\Delta\pi_i^e + \epsilon_i,$$

where $IQ1_i$ ($IQ4_i$) is a dummy variable indicating that house i is in the first (fourth) quartile of the price distribution. The variable $\Delta\pi_i^e$ denotes the change in the expected inflation rate between the first and second sale date for house i. This variable is interacted with each quartile dummy variable to explore possible differences in the effect of expected inflation on starter and trade-up houses. Testing whether γ_3 differs from zero amounts to testing whether the difference between the relative appreciation rates of high- and low-value homes depends on the amount by which the expected inflation rate has changed between the dates of purchase and sale.[30] A positive value for γ_3 corresponds to greater price increases for expensive than for less expensive homes during periods when the expected inflation rate increased. The expected inflation rate is measured using the median one-year expected inflation rate reported in the American Statistical Association–National Bureau of Economic Research survey of economic forecasters.[31]

Equation 7 is estimated using all of the repeat sales in the Case-Shiller data base, not just those with particular first- and second-sale dates. The results are consistent with the view that rising inflation rates were an important factor in the disparate appreciation of starter versus trade-up homes during the 1970s and early 1980s. In all four cities the null hypothesis of $\gamma_3 = 0$ can be rejected at very high confidence levels. The estimates of γ_1, the systematic difference in appreciation rates between the two quartiles, decline for all four cities relative to the differences reported in the upper panel of table 4. The point estimates suggest large effects of the expected inflation rate on relative appreciation rates. In Chicago, for example, the estimates suggest that a 1 percentage point rise in the expected inflation rate during the holding period generates an appreciation rate of top-quartile homes that is 0.3 percent a year greater than that for less expensive homes.[32]

I explored the sensitivity of the findings with respect to my procedure for classifying houses into the top and bottom quartiles. If houses are classified on the basis of their price at the first transaction, the findings on differences in interquartile appreciation rates, as in the upper panels

30. I include the variables $IQ1_i$ and $(IQ1_i + IQ4_i)$ in the regression, rather than $IQ1_i$ and $IQ4_i$ separately, because the coefficient on $IQ1_i$ in my specification estimates the *difference* between the coefficients on $IQ1_i$ and $IQ4_i$ if the variables are included separately.

31. I am grateful to Wayne Gray for help in accessing these data.

32. The focus on annual appreciation rates in this calculation is somewhat inappropriate, although it permits comparability with earlier results. Theory suggests that a shift to a higher inflation rate should result in a one-time increase in house prices, not a long period of differential appreciation.

of table 4, are much weaker than the results based on average price ranks.[33] The results on the interaction between inflation and the quartile rank, as in the lower panel of table 4, are virtually unchanged. These results, as well as those with the Census Bureau hedonic models, are consistent with the predictions of the after-tax user cost analysis.

Three alternative explanations of the relative patterns of large- and small-house price appreciation deserve comment. The first is that widening income inequality, with a greater share of buying power accruing to high-income households, has generated demand pressures similar to those implied by the after-tax user cost analysis. Between 1972 and 1980, the real pretax income of a family at the 25th percentile of the income distribution declined by 2 percent, real income for the median family rose 2 percent, and real income at the 75th percentile increased 4.3 percent.[34] After-tax income is likely to track pretax income reasonably well during this period. Assuming that housing demand has an income elasticity of one and that the buyer of a start-up home falls between the 25th and 50th percentiles of the income distribution, the widening disparity in incomes could explain between a 4 and 6 percent appreciation of larger homes relative to smaller ones. The estimated effects reported above are substantially larger than this.

A second possibility is that high nominal interest rates from the mid-1970s until the mid-1980s lowered housing demand, particularly among young households. Most lenders apply simple rules in approving mortgages, lending only up to the point where interest payments equal a fixed fraction of the household's income. High nominal interest rates therefore reduce the amount that any household can borrow, potentially lowering housing demand.[35] Since small houses are more typically purchased by first-time buyers, who tend to have higher loan-to-value ratios than repeat buyers, rising nominal rates in the late 1970s could have had a larger negative effect on the prices of smaller houses.

A final alternative explanation is that the rise in real house prices during the 1970s reflected the introduction of growth controls in many localities.[36] If growth controls were more stringent in communities with more

33. Rankings based on initial price induce a downward bias in the appreciation rate of high-value houses, so the weaker results in this case are not surprising.

34. See Karoly (1990).

35. See Schwab (1983).

36. Katz and Rosen (1987) present empirical evidence on the importance of this effect in the San Francisco Bay area.

expensive homes, then the observed pattern could be the result of these changes. This explanation does not, however, account for the differential appreciation patterns during the 1980s. All of these competing explanations deserve further empirical analysis.

Explaining Price Changes in Different Cities

The substantial differences in the appreciation rates of real house prices across cities suggest the possibility of using city-level data to evaluate alternative explanations for house price movements. This section analyzes how changes in demography, construction costs, incomes, and tax rates correlate with changes in city-level house prices over time.[37]

The reduced-form cross-section model that underlies the empirical work is

$$\Delta p_{it} = \delta_0 + \delta_1 \Delta c_{it} + \delta_2 \Delta d_{it} + \delta_3 \Delta y_{it} + \delta_4 \Delta u_{it} + \upsilon_{it}, \tag{8}$$

where p_{it} is the logarithm of the real median house price in city i at period t, c_{it} denotes the logarithm of real construction costs, d_{it} is the logarithm of a demand measure based on population structure, y_{it} is the logarithm of real per capita income, u_{it} is an indicator of real user costs of homeownership, and υ_{it} are residuals.

Data on per capita income are available from the Census Bureau at the SMSA level each year. I measure residential construction costs in each city with R. S. Means' city-specific cost indexes.[38] These indexes are used by project planners to evaluate the cost of building projects in many different cities. Means computes both a residential and a nonresidential cost index for each city. The indexes reflect labor and materials costs of construction. Unfortunately, the residential cost index is only available since 1987. I therefore use the nonresidential cost index, which is available for the entire 1980–90 period. In the years when both indexes are available, their correlation across cities is 0.96.

37. Some earlier work, notably that by Ozanne and Thibodeau (1983) and Black (1990), has tried to explain the levels of house or land prices across cities. Gyourko and Voith (1991) analyze the heterogeneity in price appreciation across housing markets in a larger data set, but the data they use are largely the result of interpolating cross-sectional patterns from census years using a few time series between censuses.

38. *Means Construction Cost Data* is published annually by R. S. Means Company of Kingston, Massachusetts.

The demographic demand variable (d_{it}) captures the changes in housing demand that occur as the age composition of the population changes. The index used by Mankiw and Weil is $d_t = \log(\Sigma N_{at}D_a)$, where N_{at} is the number of individuals of age a alive in year t, and D_a is the average housing demand of persons in age group a as estimated from the decennial census data. To construct the analogue to this variable at the city level ideally requires information on both the number of persons of each age and the age-specific housing demand pattern in each SMSA. The demand pattern is the result of tenure choice, household formation decisions, and decisions about how much housing to purchase conditional on tenure. All of these decisions are affected by the level of house prices.[39] To avoid the obvious endogeneity, I use national indexes of age-specific housing demand to compute d_{it}.[40]

Information on the number of persons of different ages in each SMSA was calculated from the March Current Population Surveys (CPS) for 1979, 1980, and 1981.[41] The CPS indicates a respondent's SMSA for those who live in large urban areas. Eleven of the SMSAs in the sample are not separately identified in CPS records at the beginning of the 1980s; for these cities, I estimate state-specific values and apply them to the cities.

Since migration decisions are affected by housing costs, the age composition of people in a city may be a function of house prices. Rather than relating the actual change in house prices between two years to the actual change in the demographic demand index, I therefore predict the change in the demographic index based on prevailing mortality rates in 1980. For example, a city with relatively more inhabitants between the ages of 10 and 20 in 1980 would be predicted to exhibit a relatively large change in its demographic housing demand as these individuals passed into their prime homebuying years during the subsequent decade. This predictable demand variation should have no effect on prices under the rational-expectations hypothesis.

The final variable is a measure of the user cost of housing facing homebuyers in different cities. Many components of the user cost, including the nominal interest rate and the expected inflation rate, do not

39. See Smith, Rosen, and Fallis (1988). Hendershott (1988b) presents empirical evidence on how household formation decisions depend on real house prices and rents.

40. The national weights are drawn from Mankiw and Weil (1989).

41. A detailed algorithm is available on request.

vary much across cities although they do vary over time. Since many of my estimating equations include year effects, it is not possible to analyze how these factors affect house prices within this data set. One component that does vary across cities is the federal marginal tax rate at which households can deduct mortgage interest and property taxes. The tax rate varies across cities because of differences in income and in state tax provisions that affect the chances of a given household itemizing. I explore two variables to proxy this user cost variation: the average marginal federal income tax rate at which interest would be deducted by residents of the city and the fraction of households in the city who itemize deductions on their federal tax returns.[42]

Table 5 presents the results of estimating equation 8 for the 39 cities in the NAR data base with 10 years of data.[43] The results suggest that shifts in income and in construction costs have important effects on real house prices but provide little support for the importance of demographic factors or after-tax user costs. The first column shows the result of including only changes in per capita income and the demographic variable in the equation. The estimates imply a substantial effect of real income growth on house prices, with an apparent income elasticity of two. The demography variable, which should have a positive coefficient on the view that house prices rise when the demographic mix shifts toward homeownership, actually has a negative (but statistically insignificant) estimated effect.

The second column in table 5 augments the first equation by adding the percentage change in construction costs to the set of explanatory variables. A 1 percent rise in real construction costs is associated with a 0.97 percent rise in real median house prices. If construction costs are disaggregated into materials and installation cost (these results are not shown in the table), the installation-cost coefficient remains close to unity while the coefficient on materials is positive but statistically insig-

42. House prices can affect the fraction of taxpayers who itemize. If house prices are low, more households will own their homes, have mortgage interest deductions, and therefore itemize. I therefore treat the tax variables as endogenous and instrument for them using average *state* income tax collections per capita. The latter variable affects the probability of itemizing but should not be affected by housing demand.

43. A longer time series of house prices for some cities is available from the Federal Home Loan Bank Board, which tabulates the characteristics (including house price) from a small sample of new loans in some cities. These data seem much noisier than the NAR data, so I confined my analysis to the shorter sample period.

Table 5. Explaining Changes in City-Specific House Prices between 1980 and 1989

	Specification				
Independent variable	*5.1*	*5.2*	*5.3*	*5.4*	*5.5*
Constant	−0.143	−0.066	−0.083	−0.287	−0.068
	(0.136)	(0.144)	(0.121)	(0.188)	(0.100)
Income per capita	2.054	1.740	1.795	2.079	1.327
	(0.349)	(0.297)	(0.325)	(0.368)	(0.297)
Construction costs	...	0.973	0.960	0.966	0.963
		(0.229)	(0.261)	(0.229)	(0.200)
Demographic demand	−0.958	−0.743	−0.648	−0.686	−0.056
	(0.869)	(0.718)	(0.773)	(0.722)	(0.652)
Percent who itemize	...	...	0.001	...	...
			(0.014)		
Average marginal federal tax rate	...	...	...	−0.057	...
				(0.042)	
Farm land price	...	...	...	...	0.208
					(0.058)
Summary statistic					
R^2	0.546	0.699	0.705	0.721	0.787

Source: Author's calculations. The sample includes 39 cities with data from 1980–89 in the NAR data base. Data on the percent who itemized and average marginal federal tax rates are from the NBER TAXSIM model. Land prices are from the USDA *Farm Market Real Estate Developments*. Other data are described in the text. The estimates shown give the coefficients of an OLS regression of the percentage change in city-specific house prices on the percentage change of the real independent variables shown. Percentage changes for all variables except the percent who itemized and the average marginal tax rate are measured by the change in logs. Standard errors are in parentheses.

nificant. This suggests a strong association between changes in house prices and changes in construction wages. The direction of causality in this relationship requires further exploration.

The third column in the table includes the change in the fraction of taxpayers itemizing in the state. The estimated effect is near zero. The results are similar when the fraction of taxpayers who itemize in the state where the SMSA is located is included as a regressor. The ordinary least squares results in table 5 are very similar to the results when the tax variables were treated as endogenous.

The last column in table 5 adds the percentage change in real agricultural land prices, measured as the change in the USDA's state-specific land price index, to the estimating equation. The results suggest that land price appreciation is positively and significantly associated with the

Table 6. Instrumental Variable Estimates of Changes in House Prices, 1980–89

Independent variable	Specification 6.1	6.2	6.3
Constant	−0.521 (0.233)	−0.338 (0.203)	−0.285 (0.185)
Income per capita	3.513 (0.774)	2.793 (0.697)	2.352 (0.761)
Construction costs	. . .	0.757 (0.291)	0.795 (0.258)
Demographic demand	0.237 (1.161)	0.018 (0.930)	0.245 (0.787)
Real farm land prices	. . .	. . .	0.119 (0.090)

Source: See table 5. In these regressions, the change in real per capita income is treated as endogenous; the change in the city's real per capita income over the previous decade and the contemporaneous change in real per capita federal procurement outlays are used as instrumental variables.

change in the median house price but that controlling for this variable has relatively little effect on the other estimated coefficients.

If house prices rise in a city, existing homeowners may increase their consumption and builders may start more new houses. Both developments contribute to a larger increase in the city's per capita income, making income and real house prices simultaneously determined. Table 6 reestimates several equations from table 5 but now treats the change in real income as endogenous and uses lagged changes in per capita income and the contemporaneous change in real per capita federal procurement awards as instrumental variables. The results are not substantially different from those in table 5. The estimated effect of changes in income on house prices is larger in table 6, but the coefficients on construction costs and the demographic variable are not affected by this change in specification.

The results in this section suggest that changes in real income and construction costs are important explanators of the cross-city pattern of house price appreciation, but they do not suggest a central role for predictable changes in the demographic composition of the city. These findings suggest caution in evaluating long-term house price forecasts that are based largely on demographic factors.

Are House Prices Forward Looking?

Local housing booms are one of the principal challenges to understanding house price dynamics. Table 7 presents the extreme values from the distribution of nominal house price appreciation in the NAR data set. There are 26 city-years with nominal appreciation of more than 20 percent in the 1980–90 period, with the 38.6 percent appreciation in Providence in 1987 being the single sharpest price change. By contrast, there is only one city-year, Houston in 1986, in which the median nominal price fell by more than 10 percent, and only 15 cases of more than 5 percent nominal declines.

House price booms in a single city are virtually impossible to explain on the basis of shifts in real user costs, since most of the factors affecting the user cost are determined nationally. Explanations must therefore focus on shifts in the local demand for housing, driven either by expectations of future income growth, population growth, or rising costs of building or acquiring land. Price bubbles are another possibility.

One explanation for large short-term shifts in city real estate markets involves changing expectations of economic growth. With a fixed supply of land, rising growth expectations would raise land values and median house prices.[44] The time series behavior of city income is central to this argument. If shocks to income growth rates persist, shifting expectations of income growth could account for some of the rapid increases in house prices. To test this view, I estimate

$$\Delta y_{it} = \alpha_i + \beta_1 \Delta y_{i,t-1} + \beta_2 \Delta y_{i,t-2} + \epsilon_{it}, \tag{9}$$

where Δy_{it} corresponds either to the change in the logarithm of real per capita income or to the change in the level of the unemployment rate.[45]

The results of estimating equation 9, with and without year and city effects in place of the constant, are shown in table 8. Innovations in real income growth rates persist, with next year's growth increment roughly half the size of the current year's. When economywide factors are re-

44. How changing growth expectations would affect the value of housing *structures* alone is a more complex issue, hinging on the speed at which new construction rises.

45. Earlier versions of this paper also included lags of the level of y_{it} to explore the convergence effects discussed by Barro and Sala-i-Martin (1991) and Blanchard (1991).

Table 7. House Price Booms and Busts, by City or Region, 1980–90
Percent

City or region	Year	Percent change: Nominal	Percent change: Real
Providence, RI	1987	38.6	33.7
Boston, MA	1985	34.2	29.6
Honolulu, HI	1990	30.4	23.7
Providence, RI	1986	29.8	27.4
Hartford, CT	1986	29.5	27.2
Honolulu, HI	1989	28.6	22.7
Atlanta, GA	1980	27.7	12.5
New York City, NY	1985	27.3	22.9
Kansas City, MO	1982	26.0	18.7
Orange County, CA	1988	23.1	18.2
Seattle, WA	1990	23.5	17.1
San Francisco, CA	1980	23.1	8.5
Aurora/Elgin, IL	1989	22.8	17.2
San Francisco, CA	1989	22.5	16.8
Seattle, WA	1989	22.3	16.7
Sacramento, CA	1990	22.3	16.0
Hartford, CT	1987	22.0	17.7
Los Angeles, CA	1988	21.6	16.8
Aurora/Elgin, IL	1990	21.5	15.3
Boston, MA	1984	21.1	16.1
Albany, NY	1986	20.6	18.4
Fort Lauderdale, FL	1980	20.6	6.3
San Francisco, CA	1988	20.4	15.6
Orange County, CA	1989	20.3	14.8
Los Angeles, CA	1989	20.1	14.5
Springfield, IL	1987	20.1	15.9
Houston, TX	1986	−11.1	−12.7
Oklahoma City, OK	1988	−9.8	−13.4
Bergen/Passaic, NJ	1990	−8.2	−12.9
Denver, CO	1988	−8.0	−11.6
San Antonio, TX	1988	−7.4	−11.1
Nassau/Suffolk, NY	1990	−6.4	−11.2
New Haven, CT	1990	−6.2	−11.0
Houston, TX	1988	−6.2	−9.9
Monmouth/Ocean City, NJ	1990	−5.9	−10.7
Charleston, WV	1990	−5.9	−10.7
Houston, TX	1987	−5.7	−9.0
Dallas, TX	1988	−5.5	−9.3
Hartford, CT	1990	−5.2	−10.0

Source: Author's calculations using NAR median sales price data for each locale.

Table 8. Persistence of Shocks to Real Activity

Independent variable	Dependent variable: Change in the log of income per capita			Change in the unemployment rate		
Constant	0.014	...	...	−0.042	...	...
	(0.001)			(0.056)		
Lagged dependent variable						
One lag	0.462	0.355	0.393	0.242	0.098	−0.034
	(0.033)	(0.036)	(0.095)	(0.045)	(0.050)	(0.091)
Two lags	−0.265	−0.045	−0.148	−0.172	0.013	−0.065
	(0.033)	(0.035)	(0.051)	(0.045)	(0.050)	(0.066)
Fixed effects						
Cities	No	Yes	Yes	No	Yes	Yes
Years	No	Yes	Yes	No	Yes	Yes
Estimation method	OLS	OLS	IV	OLS	OLS	IV
R^2	0.201	0.685	...	0.073	0.613	...

Source: Author's calculations. All estimates for per capita income use data for 21 years (1970–90) for the same 39 cities used throughout the paper (N = 819). The data samples for the unemployment rate are shorter, yielding 458 observations. The equations denoted IV estimation are estimated by differencing the specification, rather than including city intercepts, and using further lagged values of the lagged dependent variables as instruments for the explanatory variables. Standard errors are in parentheses.

moved by including year dummies, the estimated persistence declines substantially: only about one-third of a current shock persists through the next period.[46] These findings make it difficult to argue that jumps in house prices reflect rational expectations of prolonged real income growth in excess of the national average. The results for the unemployment rate in table 8 confirm the findings for per capita income. A 1 percentage point decline in the unemployment rate in one year is followed by at most a 0.24 percentage point decline in the next year.

Even if rapid house price increases are difficult to justify on the basis of future income expectations, it does not follow that house prices are completely uninformative about future income prospects for a metropolitan area. Anecdotal evidence suggests that house prices are forward looking to some degree. There is evidence that relative house prices in California adjusted to the permanent change in tax liabilities following

46. The equations in the second and fifth columns of table 8 estimate city effects by adding a set of city-specific intercepts to the estimating equation. This approach yields inconsistent estimates in models with lagged dependent variables; see Keane and Runkle (1991). The estimates in the third and sixth columns allow for city effects by differencing equation 9 and using further lagged values of the right-hand-side variables as instruments. This yields consistent estimates.

Table 9. Forecast Power of House Price Changes for Real Activity

Independent variable	*Dependent variable*: *Change in the log of income per capita*			*Change in the unemployment rate*		
Constant	0.012	. . .	. . .	−0.100	. . .	. . .
	(0.001)			(0.061)		
Lagged dependent variable						
One lag	0.470	0.483	0.385	0.204	0.078	0.053
	(0.044)	(0.047)	(0.049)	(0.050)	(0.051)	(0.053)
Two lags	−0.162	−0.065	−0.134	−0.161	0.009	−0.013
	(0.042)	(0.047)	(0.048)	(0.048)	(0.051)	(0.054)
Lagged change in house prices	0.040	0.020	0.016	−2.508	0.528	0.891
	(0.018)	(0.013)	(0.014)	(1.067)	(0.793)	(0.853)
Fixed effects						
Cities	No	Yes	Yes	No	Yes	Yes
Years	No	No	Yes	No	No	Yes
R^2	0.233	0.689	0.723	0.073	0.613	0.629

Source: Author's calculations using data from a panel of 39 cities with NAR median house prices for 1980–89, for the 1965–89 period for real per capita income, and 1970–89 for unemployment rates. The sample for the per capita income regressions includes 464 observations, and that for the unemployment rate regressions includes 392 observations. Standard errors are in parentheses.

Proposition 13, discounting future tax saving at an annual rate of approximately 7 percent. Within a week of the recent selection of Berlin as the new German capital, for example, realtors estimated that house prices had increased 5 percent.[47]

The informational content of house prices can be tested by analyzing their predictive power in autoregressions for real per capita income changes in a metropolitan area.[48] When equation 9 is estimated with time effects, the analysis focuses only on the house price variation in each city relative to the national average. Allowing for city effects as well removes the explanatory power resulting from differences in the average rates of house price appreciation and the average rates of income growth across cities.[49]

Table 9 presents evidence on the forecast power of housing capital gains. The data sample is the set of 39 NAR cities with complete median

47. See Rosen (1982) and "The Vote for Berlin," *Christian Science Monitor*, June 26, 1991, p. 20, respectively.

48. This is analogous to testing the role of the stock market in forecasting aggregate output fluctuations; for example, see Fischer and Merton (1984) or Barro (1990).

49. Models with city effects are estimated by differencing and using further lags of the dependent variable as instruments.

house price histories between 1980 and 1989. The results suggest that the change in house prices during the previous year has significant forecasting power for next year's change in per capita income. A 10 percent rise in house prices forecasts a rise of 0.40 percent in the next year's income growth rate. The estimated effect declines slightly when year and city effects are added to the specification. For the unemployment rate equations, a 10 percent house price rise forecasts a 0.25 percentage point decline in the next year's unemployment rate.

The finding that house prices have some predictive power supports the notion that house prices are forward looking. One might also ask, however, whether they contain information not found in other asset prices. At the national level, the level of the stock market would be the obvious comparison asset. Unfortunately, there are no stock price indexes for the economies of particular cities. I therefore constructed pseudo-indexes using industry-level stock returns from Standard and Poor's (S&P) along with city-specific employment data.[50] The index for city i in year t is $I_{it} = \Sigma\, e_{ij} I_{jt}$, where e_{ij} is the share of employment in city i in sector j in a base year (in this case 1986) and I_{jt} is the S&P price index for industry j at time t. I exclude all agricultural employees from the calculation and assign the total market return to any industries not included in an explicit S&P category (government, for example).[51]

Table 10 shows the results of including the city-specific stock return in regression equations for future changes in per capita income and the unemployment rate. Changes in the city-specific stock market index have substantial predictive power for future income growth, even after controlling for the level of house prices. The lagged house price return remains positive and statistically significant in some equations, even after including the lagged stock return measure. The coefficient on the lagged house price change is virtually the same in equations with and without the change in the stock price.

Changes in the city-specific stock return predict substantively large

50. I am grateful to David Cutler for providing much of the data that was used for this calculation.

51. There are many reasons to suspect that the growth rate of the government sector differs from that of the economy as a whole. The treatment of the government sector is most important in Washington, where 34.4 percent of employment is in non-S&P industries, Sacramento (26.9 percent), and Albany (23.3 percent). The average share of non-S&P industry employment in other sample cities is 15.7 percent.

Table 10. Relative Forecast Power of House Prices and Stock Prices

Independent variable	Dependent variable: Change in the log of income per capita			Change in the unemployment rate		
Constant	0.012	...	...	−0.108	...	...
	(0.001)			(0.061)		
Lagged dependent variable						
One lag	0.441	0.464	0.368	0.192	0.061	0.036
	(0.044)	(0.047)	(0.048)	(0.049)	(0.050)	(0.053)
Two lags	−0.151	−0.060	−0.129	−0.158	0.010	−0.010
	(0.041)	(0.046)	(0.047)	(0.048)	(0.050)	(0.053)
Lagged change in house price	0.047	0.024	0.019	−2.649	0.402	0.731
	(0.018)	(0.013)	(0.013)	(1.058)	(0.733)	(0.838)
Lagged change in stock return	0.296	0.169	0.177	−14.025	−12.749	−13.375
	(0.077)	(0.051)	(0.053)	(4.806)	(3.167)	(3.477)
Fixed effects						
Cities	No	Yes	Yes	No	Yes	Yes
Years	No	No	Yes	No	No	Yes
R^2	0.257	0.696	0.730	0.092	0.629	0.644

Source: See table 9. These regressions also include the lagged city-specific stock return as an independent variable.

movements in house prices. The estimates in the second and fifth columns of table 10 imply that a 10 percent increase in the city-specific stock index relative to the national index forecasts a 1.7 percentage point increase in the SMSA's per capita income growth rate and a 1.3 percentage point reduction in the SMSA unemployment rate, respectively.

City-level data provide more variation in house prices and subsequent income movements than national data, but equations similar to those reported above can also be estimated for the United States as a whole. With annual data, the change in real GNP, $\Delta \ln GNP_t$, in two consecutive years can be regressed on the lagged changes in real house prices, $\Delta \ln P_{H,t-1}$ (measured in the fourth quarter of the year), and the real value of the stock market, $\Delta \ln P_{M,t-1}$ (the lagged end-of-year value of the S&P 500). Results for the 1965–89 period are shown in the following equation:

$$(10) \quad \underset{}{\Delta \ln GNP_t} = \underset{(0.004)}{0.026} + \underset{(0.130)}{0.220}\, \Delta \ln P_{H,t-1} + \underset{(0.023)}{0.085}\, \Delta \ln P_{M,t-1}. \qquad R^2 = 0.334$$

Increases in house prices signal a future increase in GNP, even after controlling for real stock market changes. If this equation is estimated without the lagged stock-market–return variable, the coefficient on changes in house prices is smaller (0.157).

Are House Price Movements Forecastable?

The foregoing results suggest that house prices forecast real activity. A more traditional question in financial economics is whether asset returns—for example, the returns to owning a home—can be forecast using lagged information. If house prices always incorporate all available information, it should not be possible to predict the future trajectory of these prices using lagged information. The set of potential predictors is large, and I focus on a relatively small set of lagged variables: changes in real house prices themselves and changes in SMSA per capita income.

A number of recent studies suggest that changes in house prices may be predictable.[52] To explore this issue with the NAR median price data set, I estimate

$$(11) \qquad (\Delta p_{it} - r_t) = \alpha + \beta_1(\Delta p_{i,t-1} - r_{t-1}) + \beta_2 \Delta y_{i,t-1} + \epsilon_{it},$$

where r_t is the return on 90-day Treasury bills. The dependent variable is the excess return on houses. Table 11 shows the estimation results. The findings confirm earlier evidence that house price movements are predictable on the basis of lagged information. Both lagged house price appreciation and the lagged change in real per capita income in the SMSA help forecast future price movements. The results imply positive serial correlation in excess returns in local housing markets at the one-year horizon.[53]

There is no evidence that house prices revert toward some common mean in the long run. Figure 4 addresses this issue by plotting the house

52. See Case and Shiller (1989) and Cutler, Poterba, and Summers (1991). Case and Shiller (1990) find that lagged changes in real per capita income, construction costs, and house prices all forecast future excess returns on houses.

53. An earlier draft of this paper, available from the author, also analyzed the stochastic properties of house prices between 1900 and 1934 using a data set collected by the Civil Works Administration and reported in the Bureau of Foreign and Domestic Commerce (1937).

Table 11. Predictability of Excess Returns on Houses

Independent variable	*Specification* 11.1	11.2	11.3	11.4
Constant	−0.015	−0.026	. . .	. . .
	(0.003)	(0.003)		
Lagged excess return on houses	0.503	0.450	0.499	0.506
	(0.039)	(0.037)	(0.124)	(0.126)
Lagged change in real per capita income	. . .	0.668	. . .	−0.123
		(0.099)		(0.222)
Fixed effects				
Cities	No	No	Yes	Yes
Years	No	No	Yes	Yes
R^2	0.255	0.317	. . .	. . .

Source: Author's calculations using a panel of 39 cities in the NAR data base with median house price information for 1980–90. The basic estimating equation is

$$(\Delta p_{it} - r_t) = \alpha_i + \beta_1 (\Delta p_{i,t-1} - r_{t-1}) + \beta_2 \Delta y_{i,t-1} + \epsilon_{it},$$

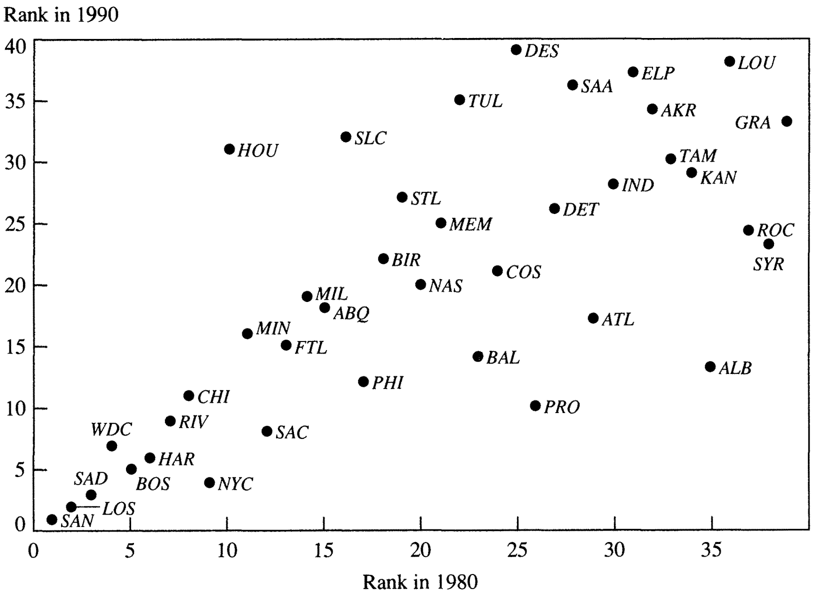
where the dependent variable is the excess return on houses, measured by the change in house prices in city i in year t minus the return on 90-day Treasury bills. Equations 11.3 and 11.4 are estimated by differencing and instrumental variables, as suggested by Anderson and Hsiao (1981). Standard errors are in parentheses.

price rank of each SMSA in the NAR sample in both 1980 and 1990. Several cities—those in California and those in the Northeast—exhibited high house prices in 1980 and again in 1990. One explanation for this pattern is that cities differ in their median incomes and that high-income cities display high house prices. A plot of house-price-to-income ratios, however, looks similar to figure 4.

The findings in table 11 confirm earlier findings on the statistical properties of house prices. Richard Meese and Nancy Wallace, for example, find important evidence of positive serial correlation in house price movements in the San Francisco Bay area. Their study suggests that over long periods fundamentals—such as construction cost, the user cost, and the income of potential homeowners—tend to explain house price movements, but that short-run fluctuations are more difficult to explain on this basis.[54] Analysis of the Boston house price increase in the mid-1980s suggests a similar conclusion: short-term price movements seem to resemble a price bubble.[55]

54. Meese and Wallace (1991).
55. See Case (1986).

Figure 4. Cities Ranked by House Prices, 1980 Relative to 1990



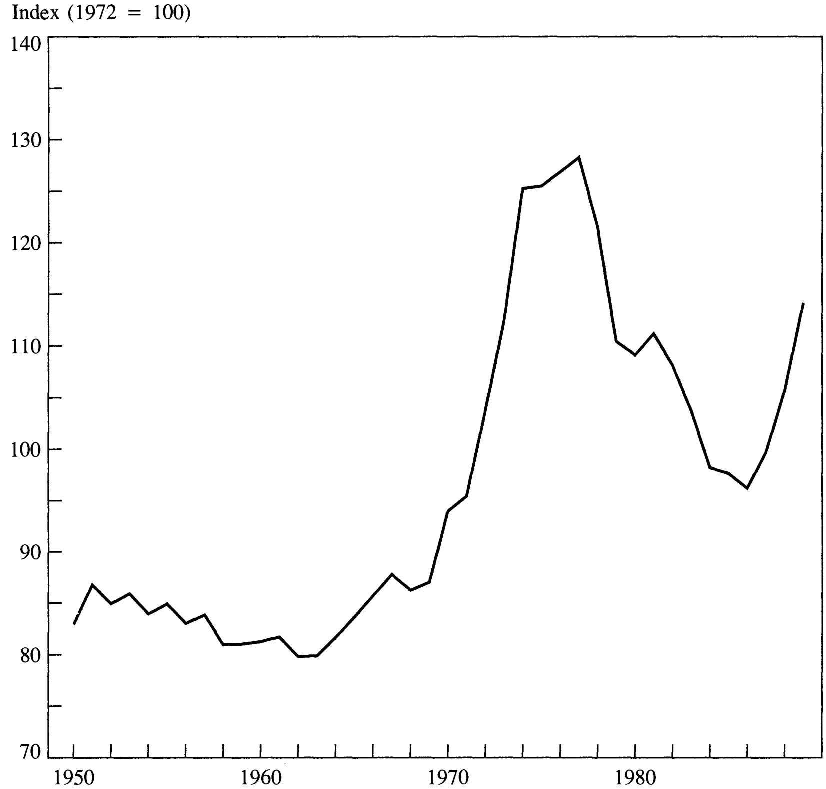
Source: Author's calculation from NAR data.

Do House Prices Go Down?

For the United States as a whole, real house prices have yet to experience any sharp decline. Other countries, however, have experienced precipitous house price declines. This section exploits data from three other nations—Canada, the United Kingdom, and the Netherlands—to suggest that the U.S. historical experience may be somewhat unusual.

Figure 5 presents three decades of real house price movements in Canada. The figure plots indexes of constant-quality new-house prices, excluding lot values, computed by Statistics Canada. The data suggest a strikingly different pattern of real house price movements than that found in the United States, with a rapid rise in the early 1970s followed by a deep decline that bottomed out about 1985. Between the peak and trough of this cycle, real house prices declined by more than 40 percent. The disparate experiences of the United States and Canada are notable because the two countries exhibit very similar demographic struc-

Figure 5. Real House Prices in Canada, 1950–89



Source: Statistics Canada. An index of real prices of constant-quality new houses, excluding lot values, is shown. Prices are deflated using Canadian CPI.

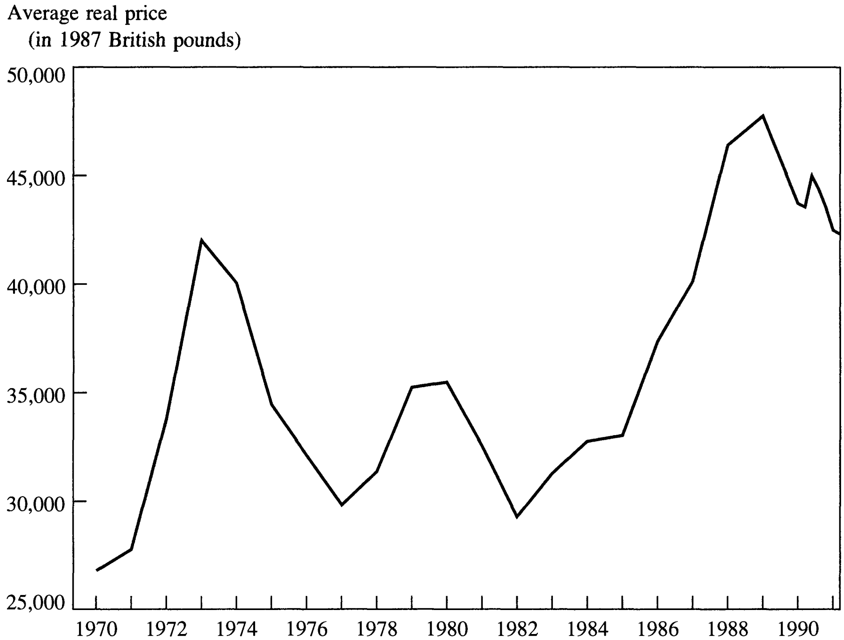
tures.[56] The movement of the baby-boom population into the peak homebuying years does not seem to have triggered a rapid increase in house prices in Canada.

The price movements in Vancouver in the early 1980s bear special comment.[57] House prices in that city rose more than 60 percent between late 1979 and early 1981 and then fell to approximately their 1979 level by mid-1982. The period of run-up was one of high inflation and high nominal interest rates, whereas the downturn coincided with the reces-

56. Engelhardt and Poterba (1991) develop this argument in more detail.

57. Hamilton and Dale-Johnson (1990) create repeat-sales price indexes for houses in Vancouver; their data are the basis for this discussion.

Figure 6. Average Real House Prices in the United Kingdom, 1970–91



Source: *Housing and Construction Statistics: 1979–89*, published by the British Central Statistical Office (CSO). Earlier and later data are also from CSO.

sion of 1982. The pattern of rapid but soon reversed housing capital gains suggests that house prices can decline quickly and is reminiscent of discussions of asset-price bubbles.[58]

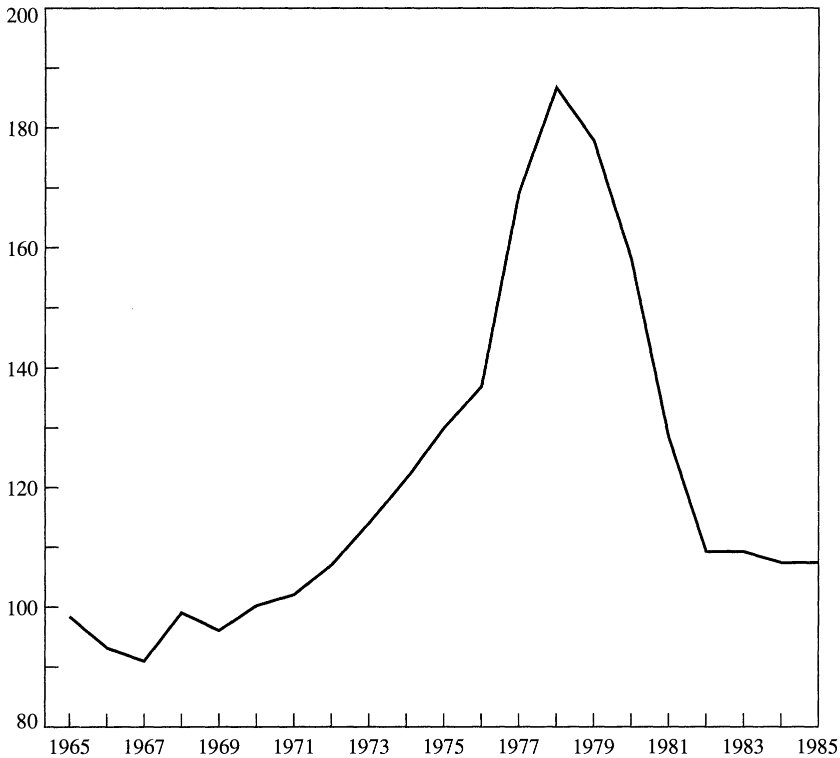
Figure 6 displays the pattern of real house price movements in the United Kingdom for the past two decades. There are three episodes of house price increases followed by sharp declines: one in the mid-1970s, one in the early 1980s, and most recently one in the late 1980s and early 1990s. The recent decline has been particularly severe in some regions, with a nominal house price decline in the Southeast of 20 percent since the end of 1988. For the entire United Kingdom, nominal prices have been constant since 1988. They have fallen by 12 percent in real terms during the same period.[59]

58. See Kindleberger (1978).

59. *The Economist*, August 17, 1991, p. 51, presents more detail on the circumstances surrounding the relative price patterns across regions.

Figure 7. Real House Prices in the Netherlands, 1965–85

Index, 1970 = 100



Source: *Maandstatistiek Bouwnijverheid*, December 1983, table 14.2H, and June 1986, table 14.13H. See Holmans (1989, p. 212).

The earlier real price declines are even sharper. The price "bubble" of the mid-1970s included a 60 percent real increase in prices between 1971 and 1973, followed by a 30 percent real (but not nominal) decline by 1977. This price increase and decrease is at least partly attributable to changes in the availability of mortgage funds and to slowing real income growth.[60] The real price decline between 1980 and 1982 was 18 percent, in this case partly sparked by rising interest rates and a credit crunch.

The Netherlands provides a further example of a rapid rise, and then decline, in house prices. Figure 7 shows that between 1972 and 1976, real

60. See Holmans (1989) and Muellbauer (1989).

house prices rose nearly 30 percent. They increased sharply, by more than 30 percent again, between 1976 and 1978 only to fall by nearly 50 percent, back to their 1972 levels, by 1981.

A detailed event study of each of these national markets would be a worthy topic of future research. The broad pattern of price increase and decrease suggests, however, that real house prices can be quite unstable even over relatively short time horizons.

Conclusions

This paper has presented a variety of new results on the determinants of house prices. For the 1970s, the results on relative house price appreciation, as well as on the broad movements in house prices, are consistent with the real user cost analysis of the owner-occupied housing market. This analysis stresses the interaction of high inflation rates with an income tax code that allowed households to deduct nominal interest payments, which can result in negative real after-tax borrowing rates and low real user costs. The 1980s, however, challenge this view: real house prices did not fall to their 1970 level, as the increase in real user costs suggests they should have.

Demographic changes provide a possible explanation for the failure of house prices to decline in the 1980s. There is a strong statistical relationship for the United States as a whole between the level of real house prices and the housing demand predicted by the age structure of the population. There have been many attempts to demonstrate that this simple relationship is spurious,[61] and the results in this paper indicate that the demography–house price link does not hold across SMSAs. These results suggest caution in extrapolating historical patterns of house prices and demography far into the future, particularly when such forecasts suggest dramatic changes in real house prices.

Despite its limitations, the demography-based account of recent house price changes can only be displaced ultimately by an alternative explanation of house price dynamics. One possibility that is suggested by the forecastability of house prices and that is consistent with earlier

61. See Hamilton (1991) and DiPasquale and Wheaton (1990), as well as the rejoinder by Mankiw and Weil (1991).

survey evidence is that investors in owner-occupied homes do not have rational expectations, but extrapolate the past in estimating the prospective capital gains on housing. This could explain the relatively robust performance of house prices in the 1980s, since investors had not yet recognized that real user costs were substantially higher than in the 1970s. It also implies that the aftermath of declining house prices in many regions during the late 1980s could be a period of slack housing demand, as many potential homebuyers extrapolate recent price reductions and conclude that house prices will continue to fall.

Comments and Discussion

David N. Weil: James Poterba has written an interesting paper that uses some clever approaches to examine a very important issue. The paper aims to use disaggregated data (both at the city level and at the level of individual houses) to test some of the hypotheses that try to explain housing prices at the aggregate level.

The author spends his largest effort assessing what he calls the real user cost model of housing prices. This is the view that changes in the after-tax user cost of housing are responsible for large shifts in housing demand and that these demand shifts in turn explain a large part of housing price movements.

One way of testing the user cost view is by taking advantage of shifts in the user cost of housing that have affected different parts of the population differently. If these subsets of the population demand different sorts of housing, one might expect the prices of these types of houses to diverge. The author divides the population by income: the high inflation of the late 1970s lowered the after-tax user cost of housing for the wealthy by more than it lowered the user cost for the nonwealthy; this was because the wealthy are in higher tax brackets and nominal interest was deductible. The user cost model thus predicts that demand for housing by the wealthy would have gone up by more than demand by the nonwealthy in the late 1970s. Here the author's model appears successful. Poterba looks at the difference in appreciation between starter homes and trade-up homes (using the Census Bureau's hedonic house price estimates) and between inexpensive houses and expensive houses (using data on repeat sales). In both cases he finds that in the 1970s the houses that experienced larger declines in user cost appreciated more quickly. The success of the user cost model in cross section makes the user cost model an appealing explanation of the run-up in aggregate prices during the 1970s, when aggregate user costs were falling.

But the picture that Poterba paints is not without flaws. One problem with the real user cost view is aggregate house prices in the 1980s. If one is to believe that a decline in user costs was responsible for the run-up in prices in the 1970s, then the increase in user costs in the 1980s (which was nearly twice as large as the decrease in the 1970s) might have been expected to produce a huge decline in prices over the past decade.

But in the 1980s the user cost model also has problems explaining the cross section of changes in housing prices. The author's table 2 looks at the differential between starter and trade-up homes based on the hedonic index. Adding up the total change from 1980 to 1989, the evidence suggests little change in the relative price of starter and trade-up homes over the decade, despite the fact that table 1 shows that real user costs increased more than twice as much for high-income families as for middle- or low-income families.

Another problem with the user cost model is that there may be an alternative explanation for the divergence between price movements of expensive homes and those of inexpensive homes. In the 1970s, low user costs were a product of high inflation and high nominal interest rates. Holding the real interest rate constant, an important effect of high nominal interest rates is to increase the extent to which the real payments on a mortgage are front-loaded. In other words, high inflation has the effect of exacerbating the liquidity "squeeze" associated with paying a mortgage. One would expect that this liquidity-squeeze effect would be more important to people at the lower end of the housing market and would thus provide another reason why the prices of expensive homes rose more rapidly in the 1970s. Similarly, this liquidity problem might be more important for people buying first homes than for those trading up. For example, in the Chicago Title and Trust survey of recent home buyers for 1985, mortgage payments averaged 33 percent of income for first-time home buyers but averaged 28 percent of income for repeat buyers.

In terms of its cross sectional predictions, the inflation-effects model resembles Poterba's user cost model for the 1970s. For the 1980s, it predicts a less dramatic reversal of the differential between high-priced and low-priced homes, because the effects of reduced inflation are not compounded by the effects of tax reductions. At the aggregate level, the inflation-effects model does not do so well: the liquidity effect of inflation should have had a negative effect on prices in the 1970s and a positive effect in the 1980s.

Another hypothesis that is examined by Poterba is the demographic hypothesis about housing prices at the national level, which has been advanced by Gregory Mankiw and myself, among others. The demographic hypothesis and the user cost hypothesis are not essentially different in spirit—in arguing that shifts in demand explain large price movements, both hypotheses rely on a fairly inelastic supply of housing.

The demographic hypothesis suggests that aggregate movements in housing prices can be explained by changes in the rate of growth of housing demand resulting from the predictable aging of the population—for example, the high rate of price growth in the 1970s was due to the entry of the postwar baby boom cohort into its house-buying years.

Poterba suggests that this hypothesis can be checked by looking at demographic changes and house prices in cities. Specifically, he calculates for each city the rate at which Mankiw-Weil housing demand (which is essentially the same as the adult population) would have grown over the 1980s, based on the age structure of the population that existed in 1980. Mankiw and I showed that at the *national* level this sort of forecast comes very close to the growth rate of *actual* demand.[1] Poterba finds essentially no relation between the rate of growth of his demographic variable and actual house price movements over the 1980s. He believes this finding casts doubt on the demographic explanation for house price movements at the aggregate level.

I think that the problem with this analysis is that it underestimates the huge importance of immigration at the city, as opposed to the national, level. To give a feel for the potential importance of migration, in 1985, 16 percent of individuals in the 25- to 29-year-old age group were living in a state different than the one they had lived in during 1980, and a further 17 percent were living in a different county in the same state. (By contrast, only 3 percent had lived abroad five years earlier.)

Thus movements in population should be large enough to swamp changes in the size of a city's adult population resulting from natural increase. Further, these population movements are almost certainly dependent on economic outcomes in the cities where people move. For ex-

1. Mankiw and Weil (1989).

ample, between 1980 and 1985, the population of Texas increased at an annual rate of 2.9 percent, over half of which was accounted for by net in-migration. Between 1985 and 1988, the population only increased at an annual rate of 0.9 percent, and net migration was negative.[2]

Thus, not only do I think that the use of Poterba's demographic variable as a test of the demographic hypothesis about housing prices at the national level is flawed, but I also think that the coefficient on income per capita in his cross-city regressions is difficult to interpret. This coefficient should not be thought of as giving information about the income elasticity of the demand of individual residents of a city. Rather it conveys a combination of this income elasticity of demand and the income elasticity of in-migration. If it is true that migration greatly increases the estimated effect of income growth on house prices in a cross section, one implication is that income growth will not predict house price growth in time series regressions as well as it does in cross section.

Another place where the problem of migration comes up is in the regressions examining the persistence of shocks to income per capita. Poterba finds that shocks to the growth rate of income per capita are not persistent enough to explain the large house price movements observed in the data. But housing demand should depend not only on income per capita but also on the total number of people in the city. If migration is very income elastic, small changes in income per capita may lead to large increases in population, and thus may justify large increases in house prices. Thus one set of regressions that I would like to see is a test of the time series properties of *total* income rather than of income per capita. If shocks to the growth rate of total income are persistent, there may indeed be a good explanation for the observed movements in house prices.

Let me now discuss one way to put together the different pieces of this paper. The evidence that Poterba presents on shocks to the construction cost index seems to show that changes in cost can explain only a part of house price movements at the aggregate level. Further, it is not clear what fraction of the observed shocks to cost are exogenous (for example, changes in the price of lumber) as opposed to endogenous

2. Migration data in the preceding paragraphs are from the *Statistical Abstract of the United States*, 1987, tables 27 and 29, and 1990, table 27.

(changes in construction wages). And shocks to lumber prices are not going to explain the huge variance in price changes across cities or across different types of houses within a city.

On the other hand, the evidence on the decline in construction that has taken place in response to the current decline in prices seems to indicate that supply is fairly elastic. This presents a problem, because if supply is elastic, it is hard to get any model to produce large changes in price in response to a demand shock. It is especially hard to get such movements in a forward-looking model, where the expected future supply response keeps current prices from moving too much.

On the demand side, there are some stories—the user cost model and the demographic model—that explain some shifts in demand. The demographic model does well at the aggregate level, but, as Poterba points out, it goes the wrong way in explaining the differential appreciation of starter versus trade-up homes in the 1970s. The user cost model does a good job of explaining this differential appreciation in the 1970s but not in the 1980s. Neither model does much to explain the cross-city variance of price movements.

So how can one explain why prices in Providence, Rhode Island, increased 70 percent in two years? Poterba's evidence that shocks to growth rates of income per capita are not persistent makes it seem unlikely that big revisions in projected demand growth would be rational. Including the effect of income growth on migration would increase the expected size of the revisions in demand growth (and thus price)—but I do not think that this could do the job either.

It seems to me that economists are going to have to bite the bullet and look at models that allow for not-fully-rational expectations: people see rising prices, and they calculate that the user cost of housing is low, without recognizing that the path of prices is not on a stable arm leading to some steady state. Furthermore, this process is observed more on the upside than on the downside, because of an apparent downward nominal rigidity in house prices.

Poterba's evidence that excess returns to holding housing are somewhat predictable on the basis of lagged variables—which they should not be in an efficient asset market—is further reason to consider expectation formation as an empirical rather than a theoretical matter. This seems to be the direction that Poterba is heading at the end of the paper. I think it is a good way to go.

Robert Shiller: This paper by James Poterba makes two important points: over time house prices move a great deal, and they move independently of construction costs. These movements in price around construction cost are partially, but not completely, correlated with changing user costs. The differences across cities in growth rates in house prices can be explained only partially in terms of a set of rational or fundamental factors. Housing prices are not set in an efficient market and are only partially forward looking. There appears to be a purely speculative component of real estate prices.

I can think of several other things that Poterba might have done to establish these points more solidly, approaches to these data that might be more rigorous, but had he done them he would not have had room for the splendidly broad and comprehensive view of the housing market that he has provided. The main limitation of this paper is that the results are sometimes of questionable statistical significance when the paucity of effectively independent observations is accounted for. This is not Poterba's fault; it is the impossibility theorem of macroeconomics once again: any question that is truly interesting is essentially unanswerable because it concerns either very infrequent events, long swings, or low-frequency movements, for which there are few effective observations.

Construction Costs and Land Prices

It is important to look at construction costs to learn about the ultimate source of real estate price movements. Suppose one learned that the price of construction in the United States was highly correlated with the price of housing and that the cost of construction was driven by lumber prices, which in turn were driven by weather events, such as a hurricane that destroyed part of the nation's forests. Then, a simple interpretation for house price movements is possible. This, however, is not the kind of result Poterba finds. He finds that the increase in the price-to-cost ratio from 1970 to 1980 accounted for half of the increase in U.S. house prices relative to the GNP deflator.

Clearly, though, prices cannot be highly correlated with a variation in world-market construction costs—the fact that prices have moved very differently from one region of the country to another and from one country to another over the past few decades suggests little relationship.

There is also good reason to suspect, before even looking at the data, that exogenous interregional shifts in construction costs are not the primary cause of interregional differences in house price changes. The interregional differences in house price movements in the sample period have been enormous, and no stories come to mind that would explain these differences in terms of exogenous cost changes. There have been no stories of precipitous increases in the monopoly power of construction unions in certain regions, no stories of natural disasters that made it suddenly more difficult for construction to take place in certain regions, and no major hurricanes.

The correlation that Poterba does observe between construction costs and prices may be driven primarily from housing demand to construction costs. When demand for houses in the United States picks up, the price of construction labor rises, so too does the price of construction materials in the U.S. market relative to the world market, and so too do the prices of construction materials in the world market, given the importance of the United States in the world economy.

Poterba presents only aggregate national data on the relation of house prices to construction costs through time; I would think that if he looked separately at regions, say the Northeast or California, he would see more variation in the ratio of house price to construction costs.

His analysis of the relation of house prices to land prices offers a nice contrast to his analysis of construction costs. Land is the one input to housing construction that is totally immobile; there are no substitutes on the world market nor is there any production of it. If house prices are highly correlated with land prices, it suggests that little of the variation in house-cum-land prices is directly associated with exogenous changes in construction costs, but rather such changes are associated with demand changes. In this vein, Poterba presents some unexpected results. He finds substantial correlation between house prices and land costs *across cities*, but finds very little correlation *through time*, over five-year intervals, between changes in house prices and changes in land prices. The first correlation supports the demand change story; the second does not. Perhaps the second reflects the relative inaccuracy of the Urban Land Institute (ULI) land price series; measurement error might make it particularly inaccurate over short intervals. In judging the potential for inaccuracies in this series, recall that the land that should be priced is land that is as suitable for residential construction as the land under the typical house. For example, what is scarce about a house in an expensive neighborhood is the neighborhood itself; the same house in a different neighborhood might have a significantly lower price. Consider the fact that when land is undeveloped there is probably a good reason why; hence the price of undeveloped land may differ from that of the land with houses on it.

Starter and Trade-up Houses

Poterba finds some convergence in results using two different methods and data sets. Using the hedonic, constant-quality index data, he finds that between 1977 and 1980 the prices of trade-up houses rose more than those of starter houses; using repeat-sales data he finds that between the early 1970s and early 1980s the price of a top-quartile house increased more than the price of a bottom-quartile house. Thus, he appears to have confirmed that large or expensive houses appreciated relatively more over this period.

He admits that he does not have a clear theory about which direction house prices *should* have moved over the 1970s and 1980s. The real user cost analysis suggests that the prices of expensive homes should have risen as they did toward the end of the 1970s, whereas the demographic story would suggest the opposite. To know how these relative price movements might make sense, more data are needed so that a satisfactory multiple regression analysis of both user cost and demographics can be applied. But the present shortage of data unfortunately means that it may take years to get substantially more U.S. data; perhaps international data could provide greater insight now.

It was a clever idea to use the hedonic regression coefficients from the constant-quality index regression to produce separate indexes for starter and trade-up homes. The results probably have the interpretation the author claims, but let me raise some doubts.

The Census Bureau's constant-quality index prices *new* houses only. This presents a problem if the index is to be used to infer the prices of *all* houses. Referring to Poterba's model, equation 3 says that construction will tend to occur only when house prices are higher than construction costs. In a city where housing prices are generally lower than construction costs, some construction will still take place; it will occur in parts of the city where demand is unusually high or will occur in styles of homes that are in particular demand. Moreover, even when prices are higher than construction costs for all houses, construction will tend to occur in regions of the city or in styles of houses where the ratio of house price to construction cost is highest. Consider an extreme story in which the construction industry is completely mobile and flexible. It will build homes only in styles and in regions with the highest available ratio of house price to construction cost; this arbitraging in the construction market will keep this ratio the same everywhere and for all kinds of houses. Under this assumption, there will be no variation in the ratio of price to cost for starter homes versus trade-up homes as measured by Poterba. If Poterba's interpretation of these data is correct, why would construction be undertaken for starter homes when their price is lower relative to construction cost than the prices of other, larger homes that could be built? Presumably builders specialize to some degree between starter and trade-up homes, so that they cannot completely switch from building one to the other. Because the construction industry tends to build homes that promise the highest price relative to cost, the characteristics of homes change through time in a systematic way. If these changing characteristics are measured by right-hand variables in the hedonic regressions, the effect of these variations on the bias in price will tend to be reduced. On the other hand, the changing characteristics of houses that are actually built are not likely to be captured by observed hedonic variables.

It is a common problem with hedonic regression index methods that the indexes may not be good if there are unobserved hedonic variables. One example from the constant-quality construction index will illustrate this problem. The coefficient on the variable denoting central air conditioning in the Census Bureau's constant-quality regression of log price on characteristics has recently had the wrong sign in the West. Homes with central air conditioning are, according to the regression, *less* valuable than homes without it. One interpretation might be that homes near the shore need less air conditioning yet are also more valuable because they are near the shore. In Poterba's specifications, only trade-up homes have central air conditioning; therefore, if the negative bias in the air conditioning coefficient changes through time, his estimate of the relative movement of starter and trade-up house prices will be inaccurate. It is difficult to judge from the information presented here how large the biases in the index might be; I suspect that his starter and trade-up indexes can be trusted only for the broadest outlines of the relative price movements.

Explaining Intercity Variation in House Price Changes

There has been so much puzzlement over the recent changes in relative prices in different parts of the country that Poterba's efforts to explain them should be welcomed. He should not have been expected, however, to succeed in fully explaining why the Northeast underwent a spectacular boom in the mid-1980s and why California underwent a boom in the late 1980s; no one else seems to know why these booms happened when they did. Poterba does achieve some success in explaining intercity variation in house price movements in his cross-sectional regression, table 5. He does not make it clear whether a regression like this could fit the aforementioned booms; the dependent variable is just the change in house prices over the decade, a time interval not fine enough to say much about timing. Nor does he say whether the regression fits California or the Northeast; maybe it explains just the normal variation in house price changes and not the booms.

In interpreting the relatively high R^2 in the cross-sectional regression in table 5, it should also be remembered that the right-hand-side variables include the change in the log of construction cost. As noted above, construction cost probably proxies in large part for price itself, because of the feedback from price to cost. Note that the change in the log of construction cost always gets a coefficient fairly close to one.

The standard errors reported in table 5 probably cannot be trusted because of spatial (not serial) correlation of the residuals. All the cities in the West would be expected to move somewhat together; the same would be true in other regions. It may not be possible to correct these standard errors and still get significant results because of the shortage of data.

Are House Prices Forward Looking?

To some extent, house prices must be forward looking. When people learn something will happen to affect the desirability of their property, some of them will surely respond to the information. Still, the big question remains—how strongly and reliably forward looking is the market? N. Gregory Mankiw and David Weil, for example, asserted from their study of housing prices that prices do not seem to incorporate basic information about demographics that could have been forecasted 20 years ahead.[1]

Poterba cites the example of real estate prices in Berlin; house prices in Berlin are reported to have risen 5 percent within a week of the selection of Berlin as the new capital of Germany. This is a nice story; there do not seem to be many stories of such sudden price movements in the market for houses, so I thought it was an important piece of evidence. The June 20, 1991, vote in the Bundestag to move the capital had a well-defined timing: the date of the vote (though not the outcome) was known in advance. By comparing prices shortly before and after that date, one can single out the effects of that decision, since factors unrelated to the decision are unlikely to have changed much at just that time. Poterba's method here is well-enshrined in finance—it is called an event study.

The source Poterba gives for this story does not seem fully reliable (a newspaper citation), so I asked my research assistant, Gerwin Bell, to do some simple checking; he spoke to three real estate brokers in Berlin. The brokers had to be prodded to comment on price changes during the day or week of the announcement, preferring to discuss longer-term trends in housing prices; one claimed we were asking a silly question. In fact, brokers really have no accurate way of telling whether prices have changed in any given day or week, since there are so few sales and since the quality of real estate is so heterogeneous. Nonetheless, these brokers did say that they were aware of a sharp increase in condominium prices in West Berlin within weeks of the announcement. Two of them were willing to venture that they sensed that there was a jump on the announcement day, but they also said that it was not a one-shot increase, that prices kept increasing for at least a week after that, by more than 20 percent within two weeks according to one broker. Two of the three brokers reported that a few of their clients called them on the day of the announcement asking to increase their asking price; the other said he received no such calls. One of them said that he himself had called clients that day, prodding them to increase their asking price. I take the

1. Mankiw and Weil (1989).

brokers' comments as evidence supporting the general notion of Poterba's story about Berlin, although they do suggest that the price jump was not instantaneous.

That prices jumped up so soon after the Bundestag's decision appears to be solid evidence that prices respond fairly quickly to some information. The evidence is *consistent* with the notion that real estate markets are efficient; however, it is really not very impressive evidence *for* efficiency. Surely, people who were shopping for homes in Berlin on that day sensed a new urgency to buy; those who were selling must have suspected a new pickup in demand given the prominent stories in the newspapers that there would be some difficulty finding places to work and live with the government moving to Berlin. But this does not mean that prices were at the right level either before or after the date of the decision, nor does it mean that prices increased by the right amount in response to the new information. Most event studies in finance are subject to the same limitation; they may discover that stock prices jump up in response to some news event, such as a positive-earnings announcement, but the studies generally do not have any way of confirming whether the price after the announcement, or the price change, was appropriate. Thus, event studies typically do nothing more than confirm the obvious—prices respond to information.

Estimating an equation like Poterba's equation 10 suffers from various technical problems. The price at time t is, according to theory, a forecast of the present value at time t of some fundamental variable, such as implicit rent on housing. The change in price between $t - 1$ and t is therefore the forecast at time t of the present value of the fundamental variable starting at t minus the forecast at $t - 1$ of the present value of the fundamental variable starting at $t - 1$. In equation 10, the timing and definitions differ: the change in the fundamental variable (not its present value) between $t - 1$ and t is regressed on the change in price between $t - 2$ and $t - 1$. Efficient-markets theory has nothing to say, strictly speaking, on whether the coefficient should be positive, zero, or negative. Of course, the notion that prices are forward looking might *suggest* that they would survive in a regression like this.

The alternative theory, that house prices are *not* efficient, also has no clear implications for the coefficient on the change in house price. Many variables help forecast macroeconomic variables, even if they are not set in an efficient market. It is possible that housing prices come into this regression with significance just because they are a smoother series than per capita income itself; they might proxy for a longer distributed lag on changes in growth rates in per capita income.

It was an ingenious idea to compute a stock price index for each city using industry indexes and data on the breakdown of employment by industry in the city. Clearly, these city indexes are likely dominated by the aggregate stock market; as Poterba points out, the cross-sectional variation is low for these indexes. Thus, it is important to note that he included separate dummies for time effects and city effects in the table 10 regressions. From the fact that the coefficient on the lagged change in stock prices remains significant when the dummies are included in the regression, one can conclude that the time series cross-section results in table 10 are not dominated by the time series components. Thus, Poterba is right in concluding that the significance of the city stock-price variable is informative about the stock market's ability to predict intercity changes and is not just saying that the stock market is a leading indicator for the aggregate economy. However, the significance of any of these coefficients should be judged with caution since the standard errors do not take account of the time series and cross-sectional nature of the data and of the spatial correlation of house prices.

Do House Prices Go Down?

Poterba devotes a section of his paper to whether house prices can go down. On the face of it, this seems an odd question to ask; certainly these prices cannot only go up. Apparently he is merely addressing a popular misconception and stressing how wrong the conception is. But is there really such a misconception? Karl Case and I did a questionnaire survey of home buyers in various cities in 1988, including California where nominal prices had shown essentially uninterrupted price increases for decades and were currently booming.[2] We asked, "Buying a home in your city today involves (a) a great deal of risk, (b) some risk, or (c) little or no risk." Of our California respondents, 60 percent chose little or no risk, and only 4 percent chose a great deal of risk. Still, it is noteworthy that even in this boom situation 40 percent of respondents

2. Case and Shiller (1988).

were aware of at least some risk. In Boston, which at the same time was in the immediate aftermath of a boom, only 37 percent thought there was little or no risk. Declining prices serve to disabuse most people of the notion that there is no risk in real estate investment.

Incidentally, the evidence on actual asymmetry of price changes reported in table 7 is of questionable significance. Because of spatial correlation of price changes, there are far fewer effectively independent observations here than it would appear.

The Predictability of Excess Returns

The regressions in table 11, confirming the forecastability of excess returns to housing over Treasury bills, show that it is very important for prospective home buyers to try to time the purchase of their homes. The coefficient on the one-year lagged excess return is around a half in all of the regressions, indicating substantial forecastability and substantial incentives to respond to the real estate situation over the past year. It should be stressed, however, that these regressions are not direct evidence of whether real housing prices can be forecasted. There has been substantial forecastability of real interest rates over this period, and so there is an implied forecastability of excess returns to housing, unless the behavior of real housing prices is such that it offsets the effects of changed real interest rates.

General Discussion

Robert Gordon reasoned that the different dynamics of house prices and quantities before and after 1982 could be explained by the deregulation of financial institutions. Before the 1980s, much of the impact of monetary policy came through disintermediation. Because tight money raised market interest rates, attracting deposits out of the thrift institutions and forcing them to reduce the volume of home mortgages, it had a major effect on the timing of movements in both housing prices and construction. By the 1980s financial deregulation had largely eliminated this mechanism, smoothing the path of both construction and prices. James Poterba agreed that changes in the financial environment have been important for understanding construction. In addition to the reduced risk of disintermediation, he noted that the better integration of the mortgage market with other financial markets and the development of the adjustable-rate mortgage were other innovations making the 1980s different from earlier periods. Poterba believed that such changes would mainly result in less cyclical variation in housing investment and would not affect the equilibrium size of the housing stock. Gordon also suggested that neither land prices nor dwelling prices were properly adjusted for quality differences. He cited work by Paul Pieper showing that higher-priced homes had more amenities, such as pools, that were not properly adjusted for; he also observed that the raw land was unlikely to be of constant quality, precisely because it had not yet been developed.

Lawrence Katz suggested that the environmental movement and the increase of land-use regulations, which restricted new developments in primarily wealthy areas, could help explain the huge increase in housing prices in the 1970s. Anthony Downs agreed with the importance of such supply-side constraints but did not believe their effects were confined to the late 1970s, even though that is when they began. He reported that a recent study in California showed that growth management intensified in the 1980s, roughly coinciding with the run-up in prices in the late 1980s. Downs believed such restrictions could help explain price divergences between regions of the country but conceded that it was not possible to quantify their importance for cross-sectional analysis.

Joseph Stiglitz observed that the market for housing is an asset market where expectations of future price changes influence demand but where transactions costs and other frictions as well as liquidity problems may all be important in causing the market to depart from the predictions of simple asset market theory. He noted that the hypothesis that housing prices behave like the prices of highly marketable financial assets calls for looking at the effects of announcements or anticipated changes in the user cost of capital, not the actual movements. He also observed that liquidity effects can generate accelerator effects like those in an expectations-based accelerator model. In a liquidity-constrained model, capital from rising house prices can be used as down payments to buy larger houses, adding to effective demand, which can push up house prices. Robert Hall and Alan Blinder noted that people appear to care a lot more about avoiding losses than making gains and that this could explain the asymmetrical behavior of housing prices. Stiglitz replied that in other countries one did see decreases in housing prices, suggesting that the asymmetry should not be explained in terms of a different psychology. Rather, it may be that expectations are based on previous experience and so can be self-perpetuating.

Poterba responded to David Weil's observation that immigration, which Poterba did not account for, would dominate other demographic factors in state cross sections. Poterba reported that net migration flows are much smaller than the gross migration flows cited by Weil and noted that the effect of demographic changes on housing prices tend to be offset by changes in migration.

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