Low Interest Rates and Housing Bubbles: Still No Smoking Gun

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Abstract

This paper revisits the relationship between interest rates and house prices. Surveying a number of recent studies and bringing to bear some new evidence on the question, this paper argues that in the data, the impact of interest rates on house prices appears to be quite modest. Specifically, the estimated effects are uniformly smaller than those implied by the conventional user cost theory of house prices, and they are too small to explain the previous decade's real estate boom in the U.S. and elsewhere. However in some countries, there does appear to have been a link between the rapid expansion of the monetary base and growth in house prices and housing credit.

JEL codes: E52, E44, E65

1 Introduction

The relationship between interest rates and property prices has come under intense scrutiny since the housing boom of the mid-2000s, and the ensuing financial crisis of 2007–09. Two views have emerged from this experience. One is that monetary policy should respond more proactively to asset price rises, and especially to excesses in the property markets. According to this view, by "leaning against the wind" central banks can prevent or attenuate asset price bubbles, and thus

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promote financial stability. This would represent a retreat from the Bernanke-Gertler (1999) dictum that monetary policy should respond only to the macroeconomic consequences of asset price fluctuations, rather than to asset prices themselves.[1]

A second, stronger view is that overly expansionary monetary policy is itself the cause of asset price bubbles, and in particular that the Federal Reserve deserves blame for the recent house price bubble. Taylor (2007, 2009) has forcefully articulated this view, which often surfaces in the financial press as well. If so, then monetary policymakers need to be extremely cautious about pursuing expansionary monetary policy, lest it eventually precipitate a financial crisis.

Both of these views rest on the hypothesis that interest rates have an economically significant effect on real estate prices. The validity of that hypothesis may appear self evident at first glance. Historically, interest rates declines do tend to precede periods of house price appreciation, and that was certainly true over the last decade. A more careful examination of the data yields little support for this hypothesis, however. Surveying a number of recent studies and bringing to bear some new evidence on the question, this paper argues that in the data, the impact of interest rates on house prices appears to be quite modest. In fact, the estimated effects are uniformly smaller than those implied by the conventional user cost theory of house prices, and insufficient to account for the rapid house price appreciation experienced in the U.S. and elsewhere.

A link between low interest rates and house price bubbles is especially tenuous. Standard theory says that low interest rates *should* increase house values (or the the value of any long-lived asset, for that matter). Consequently, the observation that house prices rise when interests rates fall is not by itself evidence that low interest rates cause bubbles. To make this case, one would have to argue house prices tend to *overreact* to interest rate reductions, i.e., that appreciations are larger than warranted by fundamentals. The generally muted response observed in the data suggests this is not the case.

The paper begins with a review of the ways in which interest rates can affect house prices, focusing primarily on the conventional user cost model. It goes on from there to survey some of the existing evidence on the relationship between interest rates and house prices. It then presents two new sets of empirical findings. One is an error correction model involving U.S. data on house

[1] See Kuttner (2011a) for a survey of the arguments for and against this view.

prices, rents, and the long-term interest rate. The second is a cross-country exploration of the relationships between interest rates, the monetary base, house prices, and housing credit. Both confirm that the effect of interest rates on property prices is small. However in some countries, there does appear to be a link between monetary factors — the monetary base in particular — and the property market.

2 *Why interest rates affect house prices*

This section reviews the channels through which interest rates affect house prices. While it breaks no new ground theoretically, such a review is useful for two reasons. One is that it gives some structure to discussions as to what constitutes a bubble, as opposed to the normal inverse relationship between interest rates and property pries. A second is that it provides a metric for assessing the economic and quantitative significance of empirical estimates of interest rates' impact on property prices.

2.1 *The user cost framework*

A natural starting point for analyzing the connection between interest rates and property prices is the venerable user cost model which, as argued by Himmelberg *et al.* (2005), provides a useful benchmark for gauging the importance of economic fundamentals. The model is based on the simple proposition that market forces should equate the cost of renting with the all-in risk-adjusted cost of home ownership. The equality is expressed as

$$\frac{R_t}{P_t} = (i_t + \tau_t^p)(1 - \tau_t^y) + \sigma_t + \delta - \frac{\dot{P}_t^e}{P_t} \quad , \tag{1}$$

where R/P is the rent-to-price ratio, i is the relevant nominal long-term interest rate, δ is the rate of physical depreciation, σ is the risk premium associated with owning a home, and $\dot{P}^e/P$ is expected nominal house price appreciation. The property and income tax rates, τ^p and τ^y, also figure into the calculation, as in Poterba (1984). Equivalently, subtracting the expected rate of inflation π^e yields an expression in terms of the real interest rate and the rate of real house price appreciation,

$$\frac{R_t}{P_t} = \left[(i_t + \tau_t^p)(1 - \tau_t^y) + \sigma_t + \delta - \pi_t^e\right] - \left(\frac{\dot{P}_t^e}{P} - \pi_t^e\right) \quad , \tag{2}$$

where the term in square brackets represents the real user cost, excluding expected real house price appreciation. While obvious at some level, an important and often overlooked point is that the interest rate is one of the economic fundamentals underlying property prices. One does not need to appeal to bubbles to explain why interest rate cuts lead to higher property prices.

The quantitative effects of interest rate changes are easily calculated by differentiating equation 1 or 2,

$$\frac{1}{P}\frac{\partial P}{\partial i} = -\frac{(1-\tau^y)}{UC} \tag{3}$$

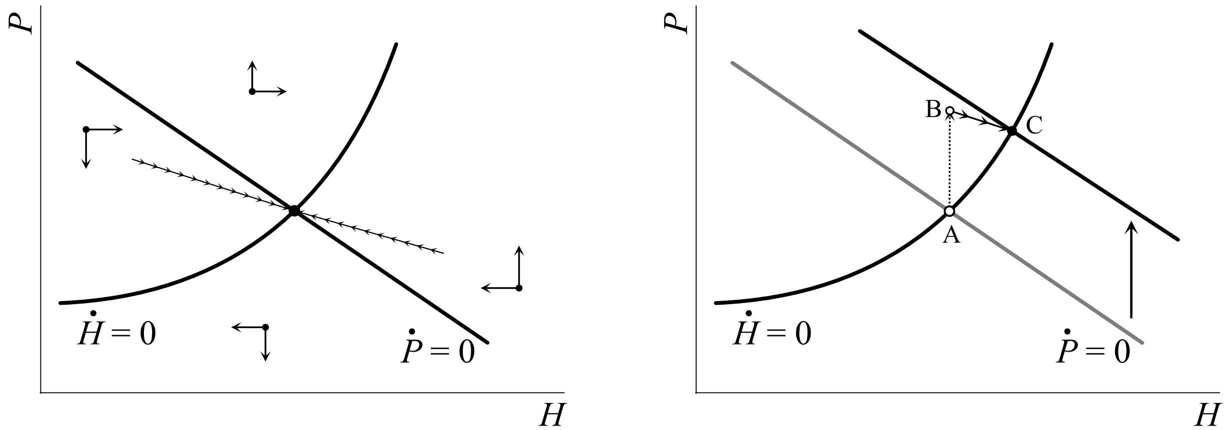
where UC is the right-hand side of equation 1. Historical values of real user cost (UC) and τ^y can be used to obtain a rough estimate of this sensitivity. With the mortgage rate in the 7% range (where it was in the late 1990s) $\delta = 1.3\%$, $\tau^p = 1.2\%$, $\tau^y = 21\%$ and expected 10-year consumer price inflation of 2%, real UC would have been roughly 6%, ignoring the risk premium and assuming zero expected real appreciation. As mortgage rates (and other long-term interest rates) fell in the early 2000s, real UC declined to approximately 5%. With real UC equal to 6%, equation 3 implies that a 10 basis point reduction in the mortgage rate would lead to a 1.3% increase in house prices; with real UC equal to 5%, the implied increase is 1.6%.

Naturally, this calculation is sensitive to assumptions about the unobserved risk premium and user costs terms. Reductions in σ and increases in π^e both increase P (i.e., reduce R/P) *and* increase the sensitivity of house prices to the interest rate. For example, with $\sigma = 0$ and $i = 6\%$, an increase in the expected rate of real appreciation from zero to 3% would double the impact of a change in the interest rate.

2.2 A dynamic user cost model

Given that expected house price appreciation increases house prices through its effect on UC, it is tempting to think of any increase in expected appreciation as a bubble. This conclusion is unwarranted, however, as nonzero rates of expected appreciation can arise naturally in the context of a dynamic user cost model. A simple version of such a model, similar to that presented in Poterba (1984), consists of three equations:

$$\frac{\dot{H}}{H} = g(P/C(H)) - \delta \tag{4}$$



(a) Phase diagram

(b) The effects of an interest rate reduction

Figure 1: Graphical depiction of the dynamic user cost model

$$R = f(H) + \varepsilon \tag{5}$$
$$\frac{R}{P} = i + \delta - \frac{\dot{P}}{P} \tag{6}$$

where H is the housing stock, P is the price of housing, R is rent, C is the marginal cost of new houses, i is the nominal interest rate, and δ is the rate of depreciation. Equation 4 represents the flow supply of new houses, and the function g satisfies $g'(\cdot) > 0$ and $g''(\cdot) < 0$. The marginal cost of new housing, $C(H)$, increases with H, so $C'(\cdot) > 0$. Equation 5 represents the demand for housing, and the f satisfies $f'(H) < 0$; ε is a housing demand shock. Equation 6 is the user cost relationship, equation 1, simplified by the omission of the income and property tax rates.

Assuming perfect foresight, the model is readily analyzed using a phase diagram involving P and H, as shown in figure 1a. Equation 4 determines $\dot{H}$, and setting this to zero yields the $\dot{H} = 0$ locus. Combining equations 5 and 6 gives an expression for $\dot{P}$, and setting this to zero results in the $\dot{P} = 0$ locus. The model exhibits familiar saddle path dynamics. An essential property is that when P is "too high" — meaning above the $\dot{P} = 0$ locus — P is *rising*. This may be counterintuitive, but it follows directly from equation 6: starting from a P that satisfies $\dot{P} = 0$, increasing P reduces the rent-to-price ratio, R/P. The user cost must fall so that households are indifferent between renting and owning. Given i and δ, this can only happen through an increase in expected appreciation.

The model delivers two insights relevant for understanding the link between interest rates and house prices. One is that with zero expected appreciation, the static user cost relationship, equation 1, applies only to the steady state. Increases in housing demand or the interest rate will shift the $\dot{P} = 0$ locus upward, as shown in figure 1b, and house prices will adjust as the economy moves to its new steady state. Expected appreciations and depreciations are therefore part of the normal adjustment process, and do not necessarily imply the existence of bubbles.

A second insight is that interest rate changes cause house prices to overshoot the steady state. The unanticipated rate reduction depicted in figure 1b, for example, leads to an immediate jump in house prices (from point A to point B in the diagram), followed by a subsequent *decline* (from point B to point C). The initial impact of interest rate changes therefore may exceed what is implied by the simple user cost model presented in the previous section.

2.3 The credit channel

The stylized user cost framework clearly leaves out a number of other factors that could potentially affect house prices, and alter prices' interest rate sensitivity. An obvious omission is the supply of credit: purchasing a house typically requires a loan, and many households are to some extent constrained in terms of the amount they can borrow. While not an explicit part of the framework, the user cost model is useful for thinking about how this might work. Because borrowing constrained households face a higher shadow cost of credit, the interest rate that appears in these households' version of equation 6 exceeds the market interest rate, i. An increase in the availability of credit, and the relaxation of borrowing constraints, would reduce this shadow cost. The effects would therefore be similar to those from an interest rate reduction. This is a natural interpretation of the development of the subprime mortgage market in the U.S., and a plausible story for why that market's development was associated with a house price boom. In this interpretation, the price rise would have been the result of a change in fundamentals, rather than a bubble.

To the extent that expansionary monetary policy relaxes credit constraints, an operative credit channel would tend to amplify the effects of monetary policy on house prices. According to this view, a monetary expansion has two effects. The first is to lower the mortgage rate. And second, by easing the availability of credit, the expansion would also increase the demand for owner-occupied housing by more than would be implied by the interest rate reduction alone. The $\dot{P}$ locus would shift up by a larger amount, amplifying the appreciation.

2.4 The risk taking channel

The risk taking channel is a third mechanism through which monetary policy could affect house prices. According to this view, which has been articulated by Rajan (2005), Borio & Zhu (2008) and Gambacorta (2009), lower interest rates induce intermediaries to take on additional risk in an effort to achieve a certain target rate of return. Dell'Ariccia *et al.* (2010) worked out a partial equilibrium model in which low interest rates can encourage risk-shifting, and Ioannidou *et al.* (2009) presented evidence suggesting that this mechanism was operative for Bolivian banks over the 1999 to 2003 period. A general theory of interest rates, risk-taking and asset pricing has yet to be developed, but presumably the increased demand for risky assets caused by low interest rates would boost the price of risky assets by a larger amount than they would otherwise have risen.

The risk-taking channel maps only loosely into the user cost framework. One interpretation parallels the credit channel. The increased appetite for risk brought forth by low interest rates would make intermediaries more willing to lend, increasing credit supply. The increased availability of credit would allow some credit-constrained households to purchase homes, thus increasing the demand for owner-occupied houses and, assuming imperfect substitutability between the two types of dwellings, decreasing the rent-to-price ratio. An alternative interpretation is that low interest rates somehow reduce σ, the risk premium associated with home ownership. The positive impact of such a reduction on house prices would be the same an increase in expected home price appreciation. Neither interpretation implies a bubble.

3 Evidence on the response of house prices to interest rates

This section summarizes the existing literature on the impact of interest rates on house prices, and presents some new evidence on the relationship between user cost and house prices in the U.S. from a simple error correction model. Collectively, the results are consistent with an inverse relationship between house prices and interest rates, but in quantitative terms the effect is modest: it is considerably weaker than implied by the user cost framework, and insufficient to explain the magnitude of most countries' real estate booms.

3.1 Existing literature

The cyclical properties of house prices and interest rates are well documented. Claessens *et al.* (2011), for example, showed that house prices are strongly procyclical in most countries. Ahearne *et al.* (2005) found that low interest rates tend to precede housing price peaks, with a lead of approximately one to three years. While these patterns are suggestive, discerning the impact of interest rates *per se* is complicated by the fact that other macroeconomic factors affecting the demand for housing are varying along with the interest rate. Moreover, it is impossible to tell from purely descriptive analysis whether the magnitude of the house price variations are consistent with the effects implied by user cost theory.

Some indirect evidence on the contribution of interest rates to house price fluctuations was furnished by Campbell *et al.* (2009). Using the methodology developed in Campbell (1991), the authors decomposed house price fluctuations in 23 metropolitan areas in the U.S. into components attributable to real interest rates, rent, and risk premia. They found that risk premia were the principal source of variance in U.S. house prices, and that interest rate fluctuations accounted for a relatively small share.

Another piece of evidence on interest rates' contribution to house prices, and in particular the mid-2000 boom, comes from Dokko *et al.* (2009), who looked at house price forecasts under alternative interest rate paths, directly addressing Taylor's (2007, 2009) assertion that overly expansionary monetary policy caused the boom. They found that deviations from the Taylor rule explained only a small portion of the pre-crisis rise in property values. Examining nearly 100 years' worth of data for the U.S., Reinhart & Reinhart (2011) reached a similar conclusion.

A number of recent studies have used vector autoregression (VAR) analysis to estimate the impact of interest rates on house prices, four of which are summarized in table 1. All four documented statistically significant effects of monetary policy on house prices, with estimates of the impact of a 25 basis point monetary policy shock ranging from 0.3% to 0.8%.

Del Negro & Otrok (2007) estimated a six-variable VAR on U.S. data spanning 1986 through 2005. The variables included in the system were the house price, total reserves, CPI inflation, GDP growth, the 30-year mortgage rate, and the Federal funds rate. Monetary shocks were identified using sign restrictions, and a novel feature of the analysis is its incorporation of a latent house price

Table 1: VAR estimates of monetary policy shocks' impact on house prices

	Effects of 25 bp policy shock		
	Immediate	10 quarters	Long run
Del Negro & Otrok (2007), fig. 5: U.S., 1986–2005	0.9%	0.2%	≈ 0
Goodhart & Hofmann (2008), fig. 3: 17 OECD countries, 1985–2006	0	0.4%	0.8%
Jarociński & Smets (2008), fig. 4: U.S., 1995–2007	0	0.5%	≈ 0
Sá *et al.* (2011), fig. 4: 18 OECD countries, 1984–2006	−0.1%	0.3%	0.1%

factor derived from a dynamic factor model. Their main finding was that a 25 basis point expansionary monetary policy shock led to a statistically significant 0.9% appreciation immediately on impact, decaying to only 0.2% after ten quarters.

Goodhart & Hofmann (2008) used a panel VAR to examine the relationship between house prices, macroeconomic variables, and other financial indicators in 17 industrialized countries. The six variables in their model were real GDP growth, CPI inflation, the short-term nominal interest rate, house price growth, broad money growth, and nominal private credit growth. The results revealed Granger-causal relationships between many of the variables, and in particular a causal relationship from interest rates to house prices and credit growth. While resisting the temptation to attach structural interpretations to the shocks, they found that a 25 basis point orthogonalized expansionary interest rate innovation leads to a statistically significant 0.8% increase in house prices. In terms of magnitude, this is very similar to the 0.9% response reported by Del Negro & Otrok (2007), but the dynamics are very different. In Goodhart & Hofmann (2008), there is no immediate impact: the effect builds slowly, reaching 0.4% after 10 quarters and gradually achieving its maximum after 40 quarters. In Del Negro & Otrok (2007), on the other hand, the 0.9% peak occurs immediately and dissipates rapidly.

Jarociński & Smets (2008) presented two sets of estimates from Bayesian VARs for the U.S.: one in levels, and an alternative first-difference specification. Their nine-variable models included output, consumption, the GDP deflator, housing investment, the house price, the short-term interest rate, the term spread, a commodity price index, and the money supply. Like Del Negro & Otrok (2007), they identified structural shocks via sign restrictions on the impulse response functions. In the levels VAR, an expansionary 25 basis point monetary policy shock leads to a gradual rise in house prices, peaking at a statistically significant 0.5% after ten quarters. This is accompanied by a decline in the long-term interest rate of roughly 10 basis points. The effects subsequently diminish, and 20 quarters after the shock the house price has returned to its mean. The differenced VAR yielded somewhat larger and more persistent estimates, but the confidence intervals are much wider, especially at longer horizons.

Finally, a recent paper by Sá *et al.* (2011) reported panel VAR results for 18 OECD countries from a 12-variable model, using data from 1984 through 2006. In addition to the standard macro variables (output, the price level, consumption, non-residential and residential investment, short- and long-term interest rates, and a measure of credit), the specification also included four variables reflecting global factors: world GDP, world prices, the trade-weighted exchange rate, and the current account balance. Like Del Negro & Otrok (2007) and Jarociński & Smets (2008), the shocks were identified using sign restrictions. The results are remarkably similar to those of Jarociński & Smets (2008): the response to a 25 basis expansionary shock is initially slightly negative, subsequently rising to a statistically significant but modest 0.3% effect after 10 quarters. Over a similar horizon, the long-term interest rate declines by approximately 10 basis points. Interestingly, the response is somewhat larger for countries with more sophisticated financial systems (including the U.S.), where the response at ten quarters is closer to 0.5%. For all countries, the effect subsequently diminishes, falling to 0.1% after 30 quarters.

These VAR-based estimates are remarkably similar to those reported by Glaeser *et al.* (2010), who used a completely different econometric method. Running a simple regression of the log house price on the real 10-year interest rate, they concluded that a 10 basis point reduction in the interest rate would result in a 0.7% rise in house prices.

Because it is specified in terms of the long-term interest rate rather than the short-term policy rate, mapping the Glaeser *et al.* (2010) figure into the VAR literature requires making an assumption about the effect of policy shocks on longer-term interest rates. An estimate of this effect can be gleaned from the VAR results summarized above: In both Jarociński & Smets (2008) and Sá *et al.* (2011), a 25 basis point expansionary monetary policy shock is associated with a reduction in the long term interest rate of roughly 10 basis points. This is similar to the results in Kuttner (2001), which imply a response of approximately 8 basis points. Using the 10 basis point figure as a rough rule of thumb, the 10 basis point effect implied by the Glaeser *et al.* (2010) regression is comparable to the implications of a 25 basis point identified monetary policy shock.

All of these effects are quite modest in economic terms, and considerably smaller than the effects implied by standard theory. As discussed above in section 2.1, the user cost model suggests that a 10 basis point reduction in the long-term interest rate, the magnitude typically associated with a 25 basis point expansionary monetary policy shock, should cause house prices to rise by 1.3% to 1.6%, depending on the initial level of interest rates. By contrast, the VAR estimates, which range from 0.3% to 0.8%, are one-fourth to one-half the magnitude implied by the user cost model.

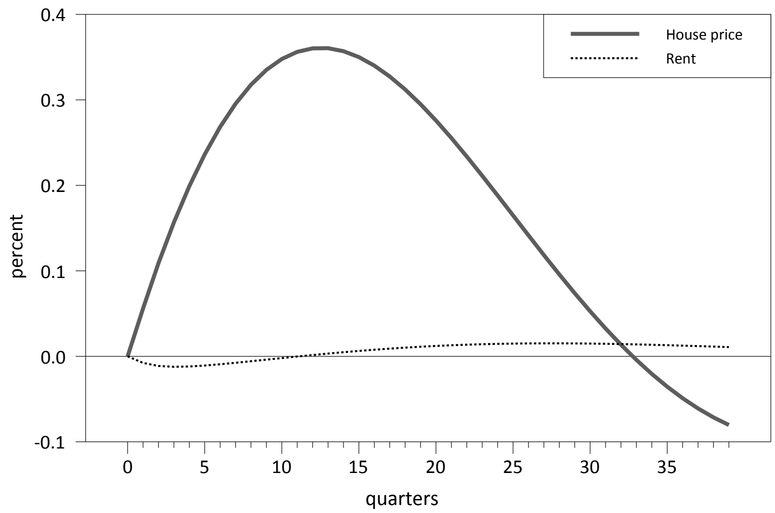
3.2 Results from an error-correction model

While the structural VAR exercises summarized above paid careful attention to the identification of monetary policy shocks, they failed to incorporate the main features of the user cost model sketched in section 2.1. If the real UC and expected rate of real appreciation are stationary, equation 1 says that the rent-to-price ratio should also be stationary. Including rent in the model could therefore be useful for understanding why macro variables affect the property market, and for determining whether the observed house price response is excessive relative to the user cost benchmark. This section presents the results from a simple error-correction model of house prices that represents a first step in this direction.

But before developing such an error-correction model, one first has to verify that rents and house prices are indeed cointegrated. As reported in Kuttner (2011b), standard augmented Dicky-Fuller tests consistently reject the null of non-stationarity for the long of the rent-to-price ratio calculated using the Freddie Mac FMHPI index for the 1975Q1 to 2011Q1 sample.[2] This suggests

[2]Nonstationarity is also rejected for the discontinued Freddie Mac CMHPI used in Gallin (2008), the FHFA, and the Census property price indexes. Interestingly, the evidence is weaker for samples ending in the middle of the boom period, since at that time property prices had yet to revert to their mean.

Figure 2: The effect of a -10 basis point real UC shock on house prices and rents



that an error-correction specification would be an appropriate way to model the joint behavior of rents and house prices. The null hypothesis of nonstationarity is also rejected for the real UC variable calculated as described in section 2.1, using the 30-year conventional mortgage rate.[3]

Following Gallin (2008), these considerations led to the specification of a three variable vector error correction model involving the log of the house price (the FMHPI index), the log of the rent component of of the CPI, and UC. No attempt is made to identify structural features other than the long-run relationship implied by the user cost model, so it would be hazardous to attach economic interpretations to the shocks. The model was estimated with two lags on quarterly U.S. data for the 1984Q1 through 2011Q1 sample period, imposing a cointegrating relationship with coefficients $(1, -1)$ on the house price and rent variables, and ensuring that the rent-to-price ratio reverts to a constant mean. Consistent with the cointegration results, the error correction term is significant in the price (but not the rent) equation; and UC has a negative, statistically significant effect on the house price.

The most interesting results from the standpoint of this paper have to do with the way in which house prices and rents react to changes in UC. Figure 2 plots the responses to a 10 basis point negative real UC innovation: house prices gradually increase, with a maximum response of roughly

[3] I am indebted to Joshua Gallin for sharing the tax rate and inflation expectations data used in the calculation of real UC.

0.35% at 12 quarters.[4] The effect subsequently diminishes, and by 30 quarters the effects have dissipated. The effect on rent is trivial.

Although it uses a very different econometric specification, these results are comparable to (but on the low end of) those based the VAR approach. Taken together, the available evidence points to a modest effect of interest rates on property prices. There is therefore no evidence that house prices overreact to interest rates, relative to the user cost benchmark. Rather, these results collectively raise the question of why house prices should be so *insensitive* to interest rates.[5]

4 Interest rates and the property price boom of the mid-2000s

Turning from the time series evidence on the effects of interest rates on property prices, this section focuses in on the behavior of the housing market during the previous decade's boom. One objective is to evaluate informally the plausibility of low interest rates as a cause of significant house price appreciation in the U.S. The second is to determine whether differences in interest rates can explain why the housing boom was large in some countries, but small in others.

4.1 The U.S. experience

Figure 3 plots the rent-to-price ratio for the U.S. from 1985 onward, using the FMHPI index and the rent component of the CPI.[6] The spectacular rise in house prices drove the rent-to-price ratio down to just over 0.75 at the late 2006 peak, from roughly 1.1 in 1997. Relative to rents, house prices appreciated by approximately 32% over this period, which corresponds to the shaded area in the figure.

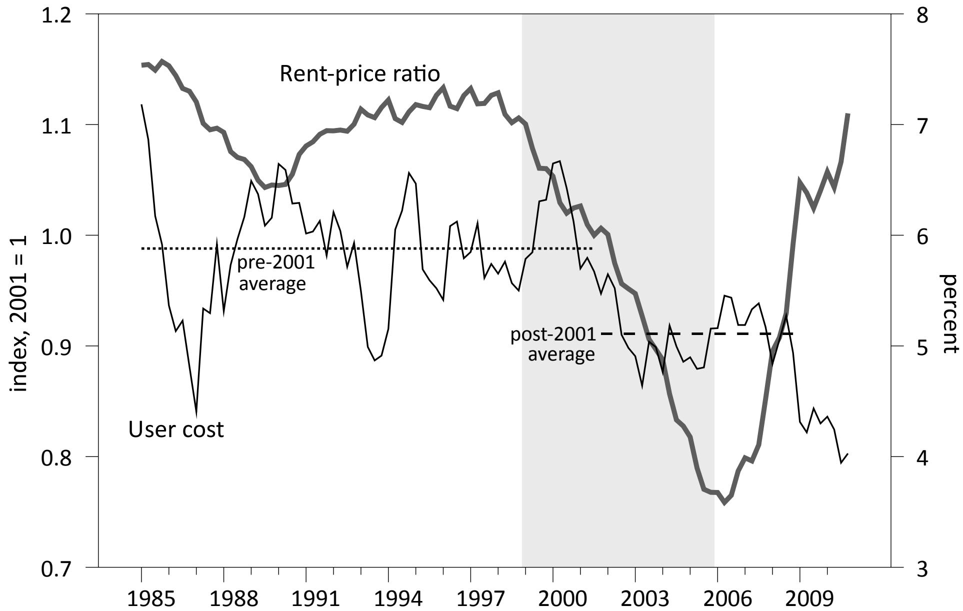
Also shown on the plot is real UC, calculated as described in section 2.1, which was in fact unusually low during much of the boom period. Prior to 2001, real UC fluctuated around a level of just under 6%. At about that time, UC fell by roughly 80 basis points, to just over 5%, a decline that was associated with the the Fed's expansionary policy in the early 2000s. Puzzlingly, real UC remained low even as the Fed raised its funds rate target by 3.25% from mid-2004 to mid-2006, a manifestation of Alan Greenspan's (2005) low bond yield "conundrum."

[4] The standard choleski decomposition is used, with UC ordered last. The effect of the UC shock is roughly one-third smaller when UC is ordered first.

[5] Glaeser *et al.* (2010) showed that the option to refinance, plus labor mobility, reduces the interest rate sensitivity by roughly one-half.

[6] Other house price measures, including the FHFA and Case-Shiller indexes, exhibited similar behavior.

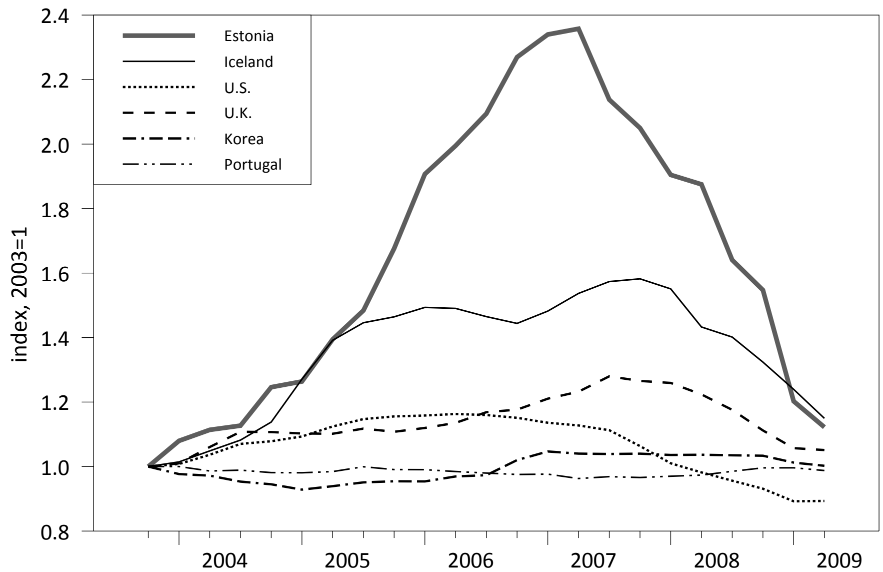
Figure 3: The rent-price ratio and user cost in the U.S., 1985-2010



The drop in real UC by itself cannot fully explain the escalation in house prices, however. For one thing, the timing does not line up. House prices began to appreciate in 1998, three years before the drop in UC, and by 2001 the FMHPI index had already outpaced rents by 10%. The initial stages of the boom therefore appear to have had nothing to do with interest rates. It is only after 2001 that low interest rates enter the picture.

Moreover, the size of the boom exceeds the implications of the user cost model, and the VAR estimates summarized in section 3.1. According to the user cost calculations discussed in section 2.1, an 80 basis point decline in UC should have led to an increase in the rent-to-price ratio of approximately 10% to 13%, accounting for roughly half of the post-2001 boom. But if the VAR estimates are taken at face value, it is hard to attribute the boom to expansionary monetary policy. Even if one were to assume that a 25 basis point expansionary shock led to a 1% appreciation in house prices — a response that exceeds any of the VARs' estimates — a 20% rise in house prices would have required 20 such shocks, and consequently a cumulative 5 percentage point deviation from the interest rate rule embedded in the VAR model.

Figure 4: Real house prices in selected countries



4.2 A cross-country exploration

From a global perspective, two observations about the recent real estate boom and bust stand out. First, the boom was a global phenomenon: most countries experienced rapidly rising real estate prices during the early and middle part of the last decade. The second observation is that the degree of appreciation varied widely across countries. This is vividly illustrated in figure 4, which plots real house prices for six countries: Estonia, Iceland, the U.S., the U.K., Korea, and Portugal, a set of countries chosen to emphasize the wide variation in the size of the boom. Estonia takes the prize for the most spectacular bubble, with real house prices in that country increasing by a factor of nearly 2.4 between the fourth quarter of 2003 and the second quarter of 2007. In comparison with Estonia, Iceland's 60% appreciation seems restrained. Both countries' booms dwarf those of the U.S. and the U.K., which experienced real house price appreciation over a comparable period of 17% and 28% respectively.[7] House prices barely appreciated at all in Korea, and actually fell slightly in Portugal.

Some of the cross country differences may be due to discrepancies in the definition and con-

[7]Note that because these numbers, and figure 4, only cover 2003Q4 through 2007Q2, they understate the size of the boom, which began earlier in many countries.

struction of the series. Some control for changes in composition (e.g., the repeat sales FMHPI index in the U.S.) whereas others do not. Moreover, some are national averages, while others, like Iceland's, are specific to the capital city. (Details on the house price series used can be found in the appendix.) It is unlikely that differences in data construction can account for the extreme range of outcomes across countries, however.

A variety of country- and region-specific factors surely account for much of this diversity. But in light of concerns about interest rates' putative contribution to property price bubbles, an important question is the extent to which differences in interest rates across countries are in any way related to the relative sizes of the booms. If low interest rates inflate house prices, then one would expect those countries with lower rates to have experienced more appreciation. And more broadly, if low interest rates were also associated with more relaxed lending standards and greater credit supply, as suggested by the credit and risk-taking channels, then low rates would also give rise to rapid credit growth.

Analogous questions have been examined empirically using the VAR approach surveyed in section 3.1. Those studies' emphasis was on the comovements over time between interest rates, credit, and house prices, however, rather on cross-country differences in the average rates of appreciation that are the focus of this section.[8] Here, the aim is to determine the extent to which the prevailing level of real interest rates were an important determinant of the booms' relative sizes.

Perhaps the most difficult part of this exercise is obtaining usable property price data. The primary source of the data used in this analysis is the dataset compiled by the Bank for International Settlements (BIS). One problem is that many countries, especially transition and emerging market economies, have only recently begun collecting property price data, which severely constrains the time series dimension of the analysis. In the end, property price data from 2003Q4 onward were available for only 36 countries. Details on data sources and definitions can be found in the appendix.

Another problem is, as noted earlier, that there is no standard methodology for constructing house price indexes. It therefore goes without saying that the property price *levels* are not directly comparable across countries. One has to assume that it is possible to make meaningful comparisons

[8] In panel data parlance, one could say that VAR analysis corresponds loosely to a "within" estimator, whereas the cross-sectional analysis of averages can be interpreted as a "between" estimator.

of the growth rates calculated from these series. Methodological differences will surely introduce country-specific measurement error, but since property price growth will be used as the dependent variable in the regressions, the additional noise would increase the regression standard error, but not bias the parameter estimates.

Finding data on housing-related credit presents another challenge. This paper relies on data taken from several sources, including the BIS, CEIC, Datastream, and central banks. Cross-country consistency is again a problem with no clear solution, but as in the case of property prices, there is reason to believe that any measurement error introduced by methodological differences and other data issues would increase the standard errors, but not cause bias. Data availability limits to 33 the number of countries with suitable data from 2003Q4.

Compared with property price and credit data, basic monetary and financial series are relatively easy to find, as they are available from the IMF's International Financial Statistics database. Short-term and lending interest rate series are used, the latter as a proxy for the interest rate that would be relevant for home purchases. Monetary base data are also obtained form the IMF.[9]

Histograms of house price growth, credit growth, and interest rates are shown in figures 5 and 6, distinguished by country group: Eurozone, emerging market, and an "other" category that includes countries such as U.S., the U.K., Canada, Australia and New Zealand. All figures are calculated for the 2003Q4 to 2007Q2 time span, the end date corresponding approximately to the housing market peak.

The distribution of house price growth is shown in the top panel of figure 5. Over the 2003Q4 to 2007Q2 period, the majority of countries experienced real property price growth of 5% per year or more, with many exceeding 10%. Four emerging market economies had real appreciation in excess of 15% per year. The bottom panel of figure 5 shows the distribution of credit growth, expressed as the annualized percentage point change in housing credit as a share of GDP. Outcomes here are similarly varied. The modal growth rates are in the 1–3% range (indicating that housing credit grew 1–3% more rapidly than GDP), but the rate exceeded 3% in a sizable minority of the countries in the sample.

As shown in the top panel of figure 6, while relatively low, ex post real short-term interest rates

[9] For Euro area members, the monetary base data reported by the IMF corresponds to the reserves held by the country's banking system.

Figure 5: Distribution of real house price and credit growth

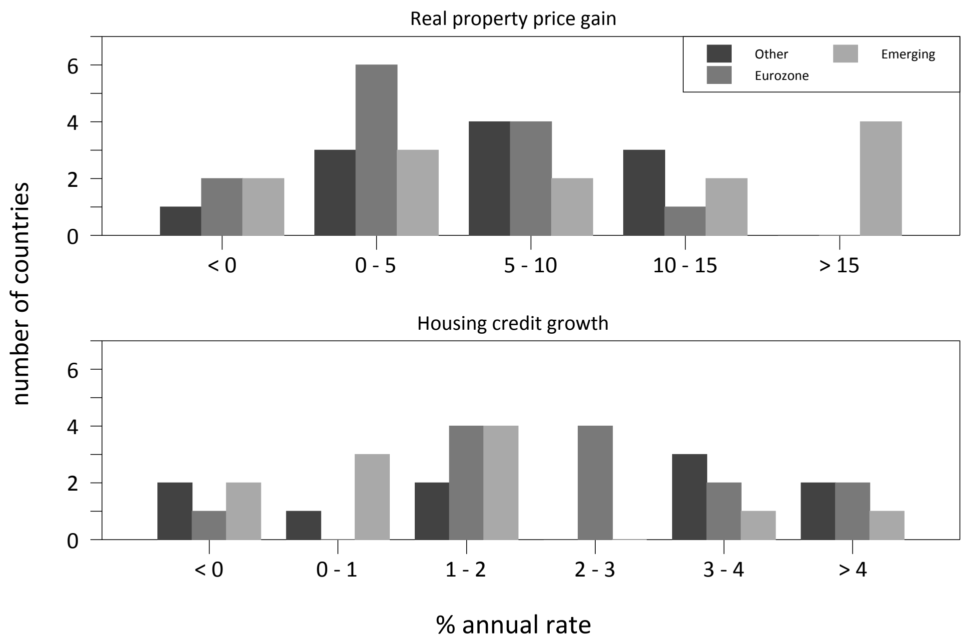
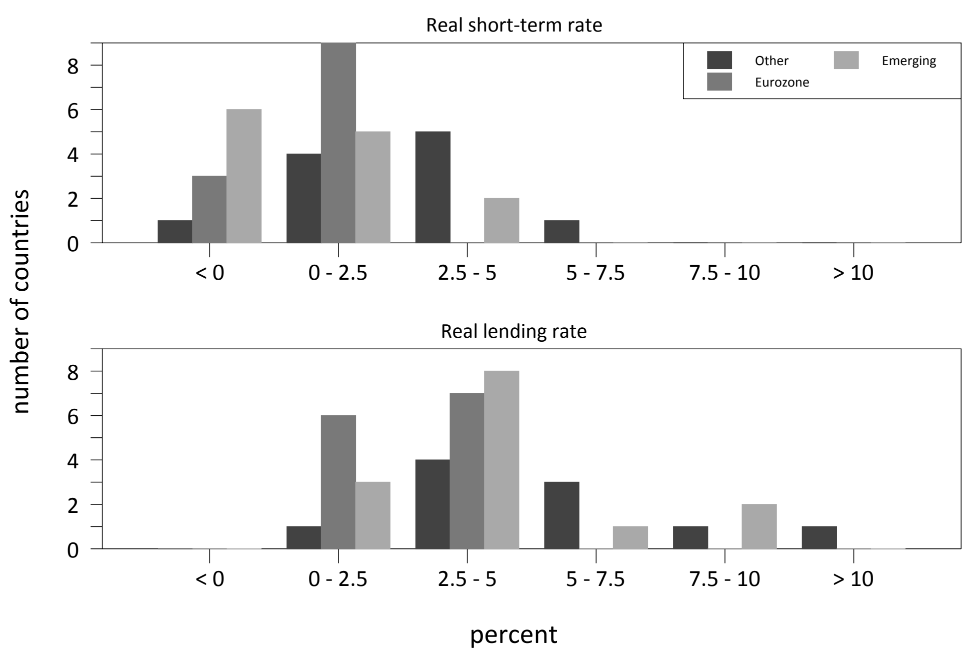


Figure 6: Distribution of real short-term and lending interest rates



did not vary much across countries. Most fall in the 0–2.5% range, with a few below zero and some exceeding 2.5%. Real lending rates, shown in the bottom panel, tended to be higher, and most fall into the 2.5–5% range. Some are lower, but still positive, and a few exceed 5%. The relatively low dispersion of interest rates alone suggests that they are unlikely to explain much of the cross-country variation in house price appreciation: property prices would have to be extraordinarily interest sensitive for changes of one or two percentage points to account for the wildly differing rates of house price appreciation plotted in figure 5.

A cross-sectional regression model will be used to evaluate the relationship between monetary conditions and the housing market,

$$Y_i = \beta_0 + \beta_1 r_i^L + \beta_2 r_i^S + \beta_3 \%\Delta MB_i + \beta_4 D_i^{eu} + \beta_5 D_i^{em} + u_i \ , \tag{7}$$

where the dependent variable Y represents either the real property price gain or the growth in housing credit. The regressors are r^S, the average real short-term interest rate; r^L, the average real lending rate; and $\%\Delta MB$, the annualized average change in the real monetary base. All changes are calculated over the 2003Q4 to 2007Q2 period. The regression also includes dummies for euro-area emerging market/transition economies, D^{eu} and D^{em}.

The inclusion of the monetary base term requires some explanation. Strictly speaking, the user cost model has no place for monetary quantities, since in the steady state house prices should be determined solely by rents and interest rates (plus taxes, depreciation, and the risk premium). However in some countries, base money may serve as a proxy for credit conditions, loosely defined. A central bank targeting a short-term interest may find itself in a position of having to accommodate increased credit demand by allowing an expansion in the base, for example. Alternatively, in countries with actively managed exchange rates, base growth may be associated with unsterilized capital inflows. Either way, the base may convey some information about the availability of bank credit beyond that contained in the short-term and lending interest rates.

Many aspects of this regression are problematic, of course. It would be hard to argue that any of the regressors are exogenous. Since it includes the effects of omitted variables, such as GDP, that affect property prices and housing credit, these omitted variables' effects will be subsumed into the

Table 2: Results from house price and credit regressions

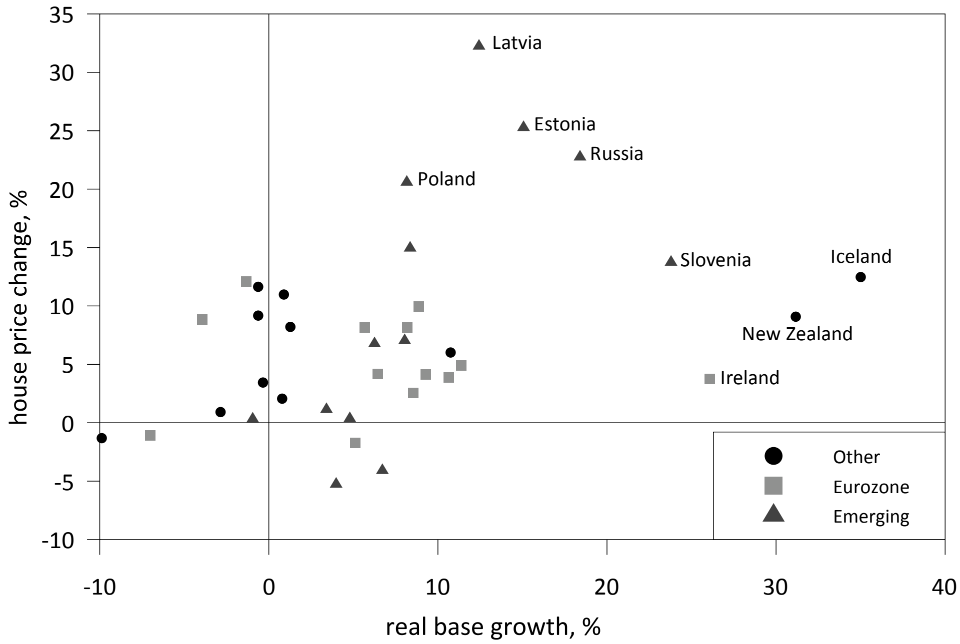
Regressor	Dependent variable: Real property price growth		Real housing credit growth
Intercept	9.57***	9.69***	3.33***
	(2.74)	(2.87)	(0.81)
Real short-term interest rate	0.37		−0.11
	(0.89)		(0.24)
Real lending rate	−1.22	−1.07**	−0.43**
	(0.76)	(0.54)	(0.17)
Real monetary base growth	0.35***	0.36***	0.17***
	(0.11)	(0.11)	(0.03)
Emerging market dummy	4.17	2.21	−0.99
	(3.41)	(2.92)	(1.10)
Euro area dummy	−3.95	−4.34*	−0.72
	(2.44)	(2.47)	(0.84)
p-value for interest rates' exclusion	0.14		0.05
Adjusted R-squared	0.21	0.19	0.40
Observations	35	36	33

Notes: The table reports the estimates of equation 7. Asterisks denote statistical significance: *** for 1%, ** for 5%, and * for 10%, heteroskedasticity-consistent t-statistics are in parentheses.

error term. If the monetary authority takes GDP into account in setting its short-term interest rate (or if it responds directly to house prices), then the coefficient on the interest rate will be biased. In addition, the lending rate and monetary base growth are endogenously determined. The regression is therefore unable to provide a credible answer to counterfactuals involving the likely effect of an interest rate cut on property prices or credit. At most, it can say something about the expectation of property prices or credit conditional on the observed behavior of interest rates and the monetary base.

With these caveats in mind, table 2 displays the results from estimating equation 7. The regression with real property price growth as the dependent variable, shown in the first column, provides

Figure 7: Real monetary base and property price growth



only weak evidence of an interest rate effect. Neither of the two interest rate coefficients is statistically significant, nor are they jointly significant. The coefficient on the lending rate does have the correct sign, however, and with a p-value of 0.11 it is *almost* significant at the 10% level. Indeed, if the short-term interest rate is dropped, as in the second column of the table, the coefficient on the lending rate becomes significant at the 5% level. Even so, the parameter estimate of roughly -1 implies a relatively modest effect: a 1 percentage point increase in the real long-term interest rate is associated with a 1 percentage point reduction in the annualized real rate of house price appreciation. During normal periods with stable property prices, this would represent a sizable effect. And taking the estimate at face value, one could point out that a one percentage point increase in the lending rate in the U.S. would have significantly reduced the annualized growth rate of house prices from 3.4% to 2.4%. But for countries experiencing double-digit annual growth rates, such as Estonia and Iceland, a change in the lending rate of a percentage point or two would not have made a tangible difference.

Interestingly, the coefficient on the monetary base is highly statistically significant, with a 1 percentage point increase in the rate of base growth implying a 0.35% increase in house prices.

This may seem like a relatively small effect, and, for those countries with modest rates of real base growth, it is. But a significant number of countries experienced spectacular real base growth during this period, including: Iceland (35%), New Zealand (31%), Ireland (26%), Slovenia (24%), Russia (18%), Estonia (15%) and Latvia (12%). For these countries, the estimated coefficient on the base growth variable implies quite large effects on property prices. These extreme observations stand out in figure 7, which plots real house price growth against real base growth, illustrating how rapid base growth was in some countries accompanied by pronounced house price appreciations.

The third column of table 2 shows an analogous set of estimates for the regression with housing credit growth (expressed as the percentage point change in the share of housing credit relative to GDP) as the dependent variable. Here, the lending rate is individually significant at the 5% level, and the two interest rates are also jointly significant at that level. The -0.43 parameter estimate says that a 1 percentage point increase in the real lending rate is associated in a 0.43 percentage point reduction in credit growth. The effect is not large, but with annualized credit growth rates in the 0 to 4% range, a 1 or 2 percentage point change in the lending rate would make a noticeable difference.

As in the interest rate regression, the monetary base is highly significant. The point estimate of 0.17 says that a 1 percentage point increase in base growth would translate into a 0.17 percentage point increase in credit growth. This would not have been a major contributor to credit growth for those countries with modest rates of base growth. But as with property prices, double-digit growth in the monetary base in some countries seems to have been associated with sizable increases in housing-related credit.

5 *Conclusions*

This paper's main conclusions are twofold. The first is that all available evidence — existing studies, plus the new findings presented above — points to a rather small effect of interest rates on housing prices. VAR-based estimates of the effect of a 25 basis point expansionary monetary policy shock range from 0.3% to 0.9%, both in the U.S. and in other industrialized countries. These estimates are broadly consistent with results from other methodologies, including simple OLS regressions and error-correction models. They are also considerably smaller than the effects implied by the standard user cost model. Moreover, they are too small to explain the previous decade's tremendous real estate boom in the U.S. and elsewhere.

This is not to say that low interest rates had nothing to do the real estate boom. The real UC of home ownership in the U.S. fell by roughly 0.8% after 2001, a change that appears to have been only partly attributable to monetary policy. If one were to ignore the empirical evidence showing a much smaller interest sensitivity, taken literally the user cost model could account for roughly half of the post-2001 house price appreciation. And given that UC did not begin to decline until 2001, interest rates could not have been a contributor to the the 10% appreciation that occurred *before* 2001.

But even if a robust inverse relationship between interest rates and house prices existed, it would not follow from that alone that low interest rates caused bubbles. In the context of standard theory, the interest rate, along with rents and tax rates, is a fundamental determinant of valuations. Making the case that low interest rates cause bubbles would require showing that house prices tend to overreact to rate reductions. Although the previous decade's house price boom was out of proportion to the interest rate decline, there is no evidence that this happens systematically. The puzzle is why house prices are *less* sensitive to interest rates than theory says they should be, not more so.

Still lacking is an explanation of why low interest rates sometimes seem to be associated with bubbles, and sometimes not. The user cost model may contain a clue. As noted earlier, the expected rate of house price appreciation is an important if unobserved ingredient in user cost. As such, it is a *deus ex machina* capable of explaining any level of house prices. But it also suggests that the interest sensitivity of house prices depends on the expected rate of appreciation, since the interest semi-elasticity is inversely proportional to user cost. Consequently, in an environment of rapidly rising house prices, interest rate reductions may have a larger effect than when prices are stable. Low interest rates may fan the flames, even if they do not start the fire.

The evidence presented in this paper also suggests that credit conditions, broadly defined, may play a larger role in house price booms than low interest rates *per se*. In market-oriented financial systems, like that of the U.S., a loosening of credit conditions plausibly resulted from financial innovation, such as securitization, and a relaxation of lending standards. In more bank-centric financial systems, like those present in many emerging market and transition economies, loose credit conditions have been associated with the rapid increase of quantitative monetary indicators, such as the monetary base. This suggests that it would be a mistake to focus narrowly on interest rates as the cause of asset price bubbles.

Data appendix

The following table lists the countries included in the analysis, details on the property price data, and the data used for the regressions reported in table 2.

Country	Region	Type	New/ existing	House price growth	Short-term rate	Lend-ing rate	Housing credit growth	Base growth
Austria	Capital	all	all	4.2	2.8	4.9	1.80	6.4
Australia	Big cities	all	existing	2.1	6.0	9.6	4.19	0.8
Belgium	Whole	all	existing	8.2	2.8	5.1	2.38	5.7
Canada[a]	Whole	all	existing	8.2	3.4	5.2	1.84	1.3
Switzerland	Whole	single family	all	0.9	1.0	3.3	1.71	-2.9
Colombia[b]	Whole	all	existing	7.0	7.3	15.3	-0.41	8.0
Czech Rep.	Whole	single family	existing		2.5	6.2	1.47	5.7
Germany[d]	Whole	all	new	-1.7	2.7	5.9	-0.33	5.1
Denmark	Whole	all	all	12.1	2.9	5.1	2.13	-1.3
Estonia	Whole	flats	all	25.3	3.1	5.7	6.70	15.1
Spain	Whole	all	all	8.2	2.7	3.9	6.30	8.2
Finland	Whole	all	existing	4.9	2.8	3.9	2.66	11.4
France	Whole	all	existing	9.9	2.8	5.0	2.58	8.9
Great Britain	Whole	all	all	6.0	5.0	4.9	3.55	10.8
Greece	Capital	flats	all	3.9	2.8	5.3	3.85	10.6
Hong Kong	Whole	all	all	11.6	2.8	7.0	-3.15	-0.6
Indonesia	Big cities	all	new	-5.3	7.4	15.8	0.25	4.0
Ireland	Whole	all	all	3.8	2.8	4.1	6.83	26.1
Israel	Whole	all	all	-1.3	5.1	7.6	-1.24	-9.9
Iceland	Capital	all	all	12.5	10.2	16.4		35.0
Italy[d]	Whole	all	all	4.1	2.8	4.9	1.49	9.3
Korea	Whole	all	all	1.1	4.1	6.3	0.90	3.4
Latvia	Whole	flats	existing	32.2	2.4	5.9		12.4
Lithuania	Whole	all	all	8.8	2.8	4.1	1.78	-4.0
Malaysia	Whole	all	all	0.3	3.2	6.6	1.21	4.8
Netherlands	Whole	all	existing	2.5	2.8	5.2	1.27	8.5
Norway	Whole	all	all	11.0	5.5	4.7	0.31	0.9
New Zealand	Whole	all	all	9.1	7.1	11.1	5.98	31.2
Poland	Big cities	flats	existing	20.6	5.3	7.3	1.47	8.2
Portugal	Whole	all	all	-1.1	2.8	4.3	3.56	-7.0
Russia	Urban areas	all	existing	22.7	3.5	11.6		18.4
Sweden	Whole	all	all	9.2	2.5		3.56	-0.6
Singapore[c]	Whole	all	all	6.8	2.4	5.7	-1.31	6.3
Slovenia	Whole	all	existing	13.7	4.2	7.5		23.8
Thailand[c]	Whole	townhouses	all	0.3	3.1	6.8	0.62	-1.0
United States[a]	Whole	single family	existing	3.4	3.5	6.7	3.69	-0.3
South Africa	Whole	single family	all	14.9	7.8	12.1	4.00	8.4

Notes: property price data are from the BIS except as noted: *a*, Haver; *b*, Datastream; *c*, CEIC. Interpolated series are denoted by *d*. Interest rates and growth rates are annualized averages over the 2003Q4 to 2007Q2, and expressed in real terms, adjusted using CPI inflation.

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