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Abstract

This paper provides evidence that some aggregate and regional U.S. real house price indices exhibited a bubble in the last few years according to the Phillips et al. (2007) unit root test. We subsequently investigate whether house price acceleration (deceleration) had a significant impact on consumption in an error correction mechanism implied by a wide class of optimizing models. Our results support the argument that real house prices have their major effect on consumption only during the bubble period.

Keywords: Bubble, House prices, Consumption

JEL Classification: C22, E21, G1

1 Introduction

Movements in house prices in the last few years have sparked considerable debate about the presence of bubbles in the housing market. For example, Smith and Smith (2006), Himmelberg et al. (2005), Krainer and Wei (2004) and McCarthy and Peach (2004) examine the price of houses in the U.S. relative to various fundamentals, such as per capita personal income, historical prices, population density and long-term interest rates. Their analyses suggest there was no overall evidence of bubbles except, possibly, in a few coastal states. These results indicate that fundamentals can explain both the patterns and the geographical dispersion of U.S. house prices, as well as why some areas seem more likely to experience house price booms than others. Other studies have disputed this view and argued that a bubble was present. McCarthy and Peach (2005) hinted that a bubble at the aggregate level may not be ruled out as "*a continued surge[...] probably would put prices significantly above levels consistent with their fundamentals*". Shiller warned in 2005 that "*the [housing] market is in the throes of a bubble of unprecedented proportions that probably will end ugly.*" Krugman (2005) also argued that there was definitely a housing bubble on the coasts and that, indeed, the air had already begun leaking out of the bubble.

The presence of a bubble and its implied boom and bust behavior might concern policymakers, among other things, due to its impact on consumption, the largest component of aggregate demand. We address this issue by augmenting the consumption model of Lettau and Ludvigson (2001, and 2004) with a variable that captures the acceleration(deceleration) in house prices. In order to analyze such effect this paper proceeds sequentially. First, we test for bubbles in house prices and second, we examine their effect on consumption.

2 Bubbles in House Prices?

There are different ways to test for bubbles in asset prices (see Gurkaynak, 2005, for a comprehensive review). We follow the more recent methodology of Phillips et al. (2007) because it enables us to identify the starting and finishing date of the bubble, if it exists. This will be useful when trying to relate the effect of house prices on consumption with the bubble process. In the Phillips et al.(op.cit.) test the house price is classified as a bubble when the null of a unit root can be rejected against the alternative of an explosive series using the following regression

$$s_t = \mu + \phi s_{t-1} + \sum_{j=1}^{J} \xi_j \Delta s_{t-j} + \varepsilon_{s,t}, \quad \varepsilon_{s,t} \sim NID(0, \sigma_s^2), \tag{1}$$

where s_t is the asset price, the null hypothesis is $H_0 : \phi = 1$, and the alternative $H_1 : \phi > 1$. Phillips et al. (2007) propose two tests, a right-side and a sup Augmented Dickey–Fuller (ADF) test based on the recursive estimation of (1).[1] Under the null, the corresponding test statistics, denoted by ADF_r and $\sup_{r \in [r_0,1]} ADF_r$, are

$$ADF_r \Rightarrow \frac{\int_0^r W dW}{\int_0^r W^2}, \tag{2}$$

$$\sup_{r \in [r_0,1]} ADF_r \Rightarrow \sup_{r \in [r_0,1]} \frac{\int_0^r W dW}{\int_0^r W^2}, \tag{3}$$

where W denotes a Brownian motion, and $r \in [r_0, 1]$ a fraction of the sample.[2] We apply these tests to twenty U.S. metropolitan area and two aggregate monthly S&P/Case-Shiller house price indices over the period January 1987 to

[1] Recursive estimation is implemented by fitting (1) to a fraction of the sample, r_0, and sequentially increasing this fraction by including successive observations. Phiilips et al. (2007) claim that their test can detect bubbles à la Evans with a π as low as 0.25.

[2] The lag length J in Equation (1) is selected on the basis of the Akaike Information Criterion and r_0 is set to 0.25. If the null hypothesis is rejected then confidence intervals for the parameter ϕ can be constructed on the basis of the work by Phillips and Magdalinos (2007) regarding the asymptotic distribution theory for mildly explosive processes.

June 2008. We also examine the quarterly house price index from the Office of Federal Housing Enterprise Oversight (OFHEO) from 1980.Q1 to 2007.Q4, which we will denote by HPI.[3]

The results in Table 1 show rejection of the null hypothesis of a unit root, suggestive of a bubble, in the case of 9 metropolitan areas house price indices, the Composite-20 index, and the HPI. Figure 1 plots the recursive $supADF_r$ statistic and suggests that a bubble originated in 2003, and burst at the end of 2006 and 2007 for the Case-Schiller Composite-20 and HPI aggregate indices, respectively. At the regional level, bubbles originating between late 1990s and 2001 and ending around 2005 can be found for Atlanta, Chicago, Detroit, Las Vegas, Miami, Minneapolis, Phoenix and Seattle. Whilst the presence of a house price bubble in the Miami and Tampa areas has also been documented in Mikhed and Zemcik (2006) and Lai and VanOrder (2009), our results, with an extended sample, suggest that a larger number of areas exhibited bubbles.

3 The Impact of House Prices on Consumption

Lettau and Ludvigson (2001) demonstrate and provide empirical evidence that a wide class of optimal models of consumer behavior imply that the log of real non-durable consumption, c, is cointegrated with the log of real wealth, w, and the log of real labour income, y. In order to investigate the possible impact of real house price inflation on real consumption, we estimate an error correction model employing updated data from Lettau and Ludvigson supplemented with real house prices. We apply a "general to specific" model selection procedure and end up with the following specification

[3] All series are deflated by the consumer price index, obtained from the International Financial Statistics database. Note that some of the Case-Shiller indices do not cover the whole period from January 1987 to June 2008. For a more detailed description of the data see www.homeprice.standardpoors.com and www.fhfa.gov.

$$\Delta c_t = \beta_0 + \sum_{i=1}^{3} \beta_i \Delta c_{t-i} + \beta_4 \Delta w_{t-1} + \beta_5 \Delta y_{t-1} + \beta_6 (\Delta rhp_{t-1} - \Delta rhp_{t-2}) + \epsilon_t \quad (4)$$

where Δ represents first difference, and rhp the log of real house prices (HPI).[4] The term that distinguishes our specification from the general form estimated by Lettau and Ludvigson is $\Delta rhp_{t-1} - \Delta rhp_{t-2}$, which measures the acceleration (deceleration) in real house prices.

Table 2 reports the results of our estimation of the error correction mechanism over the full sample period, 1975.Q1 to 2007.Q4, and for various subsamples suggested by the findings regarding the presence and timing of a house price bubble discussed above. Since the Jarque-Bera test of the OLS regressions indicates non-normality, we complement the OLS estimates with Least Absolute Deviations, LAD, estimates.[5] The acceleration (deceleration) in the rate of change of real house prices is significant and this finding is robust to the estimation method used.[6] Furthermore, the coefficient of the real house price acceleration (deceleration) term in the consumption equation exhibits only a small variation in value across the samples considered, ranging between 0.070 and 0.097 for the OLS estimates and between 0.098 and 0.122 for the LAD ones. As illustrated by model (3) in Table 2, omission of this term results in a drop

[4] The data for c, w, and y is the updated version of that used in Lettau and Ludvigson (2004) available at: http://www.econ.nyu.edu/user/ludvigsons/. House prices are represented by HPI. Wealth is defined as asset wealth, including housing wealth together with financial wealth and consumer durables.

[5] In Table 2, column one, we also report the result including the cointegrating residual from the consumption, wealth, and labour income relationship, denoted by cay_{t-1}, which is insignificant for the full sample, 1975Q1-2007Q4. A similar result was obtained by Lettau and Ludvigson.

[6] To check the robustness of our results, we obtained significance levels based on the wild bootstrap suggested, inter alia, by Davidson and Flachaire (2008), which replicates any heteroskedasticity and non-normality in the residuals of the estimated regression. The results, not reported here for brevity, are available upon request from the authors and are consistent with the results reported.

of four percent in the explanatory power of the consumption model considered for the full sample.[7]

In order to investigate further the effect of the possibly identified bubble part of house prices on consumption we estimate the error correction mechanism recursively. We start with an initial sample of ten years, 1975.Q1 to 1985.Q4, and iteratively add an extra observation until the end of the sample. Figure 2 shows the way in which the value of the t-statistic of the coefficient of the house price acceleration term, β_6, evolves. This suggests that the significance of the acceleration term is largely driven by the period in which a bubble may have occurred as indicated by the Phillips et al. test. Figure 3 illustrates the recursive estimate of β_6 which displays an upward trend over the period. This suggests that the sensitivity of consumption to real house price changes is highest in the bubble period (2003.Q4 to 2007.Q4). Our findings are consistent with the analysis of Buiter (2008) who demonstrates that a pure wealth effect on consumption from a change in house prices can only exist if it reflects a bubble.[8]

3.1 The Impact of the Bubble

To gain more insight on the impact of a house price bubble on consumption, we consider the extreme values of the acceleration(deceleration) in real house prices for the period before and that after prices peaked (that is, before and after 2006.Q4). By multiplying these values by the point estimate of the coefficient linking the rate of change of consumption to the rate of change of real house inflation (with a value of 0.083 for the full sample period considered), we can deter-

[7] We also note that our results corroborate the argument in Piazzesi and Schneider (2009).

[8] Alternative rationales for the impact of house prices could include relaxtion of borrowing constraints, as argued by Campbell and Cocco (2007); arguments from behavioural economics, such as those presented in Shefrin and Thaler (1988); but also by empirical evidence as in De Veirman and Dunstan (2008), who suggest that transitory changes in housing wealth tend to restore the long-run relationship between wealth and consumption.

mine, *ceteris paribus*, the maximum impact that the acceleration(deceleration) in real house inflation has exerted upon the rate of change of consumption before and after the bubble burst.

Our calculations indicate that this impact reached a maximum value of 0.188% before the bubble burst and 0.186% after that. This may be considered as further evidence in support of our assertion in line with Buiter (2008). A pure wealth effect of changes in house prices on consumption can be unveiled if it represents a manifestation of a bubble, with consumption (almost) returning to the level before the origination of the bubble after its collapse.

4 Conclusion

We apply the Phillips et al. (2007) test for bubbles to a number of regional and aggregate house price indices in the U.S. for the last twenty three years. Our results indicate that a number of U.S. cities experienced a bubble in their housing market as well as the country as a whole. To analyze their impact on aggregate consumption we extend the Lettau and Ludvigson (2001, and 2004) model and find evidence that real house price acceleration(deceleration) affect consumption only when they display explosive behavior.

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Table 1. Test for bubbles. Phillips et al. (2006) statistics (2) and (3)

City	sup ADF_r	ADF_1	City	sup ADF_r	ADF_1
Phoenix	2.07**	-2.656	Minneapolis	1.52**	-2.97
Los Angeles	-1.21	-4.412	Charlotte	1.14	-0.79
San Diego	0.30	-3.289	Las Vegas	2.66***	-2.87
San Francisco	0.19	-2.521	New York	-0.90	-3.28
Denver	0.09	-2.406	Cleveland	0.15	-1.05
Washington	-0.27	-4.682	Portland	0.41	-2.19
Miami	1.51**	-5.292	Dallas	0.49	0.49**
Tampa	1.23*	-4.262	Seattle	1.75**	-2.02
Atlanta	1.67**	-2.347	Aggregate Index		
Chicago	1.50**	-1.906	Composite–10	-0.30	-4.76
Boston	-1.37	-2.637	Composite–20	2.80***	-2.43
Detroit	2.56***	-1.178	HPI	1.32*	-1.26

Notes: ***,**and *indicate significance at 1%, 5% and 10% significance levels

Table 2: The impact of real house prices on consumption.
Regression (4) where the dependent variable is real consumption growth ($\Delta cons_t$)

	1975.Q1-2007.Q4				1980.Q1-2007.Q4		1990.Q1-2007.Q4		2000.Q1-2007.Q4		1975.Q1-2000.Q4		1975.Q1-2005.Q4	
		OLS		LAD	OLS	LAD	OLS	LAD	OLS	LAD	OLS	LAD	OLS	LAD
	(1)	(2)	(3)											
β_0	0.002***	0.001***	0.001***	0.002***	0.001**	0.002***	0.001**	0.002**	0.002***	0.002***	0.001**	0.003***	0.001***	0.002***
	(3.119)	(2.867)	(2.768)	(3.820)	(2.513)	(2.638)	(2.239)	(3.223)	(2.911)	(1.816)	(2.345)	(3.965)	(2.770)	(4.230)
	[0.000]	[0.000]	[0.000]	[0.001]	[0.000]	[0.001]	[0.000]	[0.000]	[0.001]	[0.001]	[0.000]	[0.001]	[0.000]	[0.001]
β_1	0.201***	0.203***	0.209***	0.093	0.194**	0.111	0.083	-0.064	0.062	-0.094	0.206**	0.060	0.200***	0.071
	(2.874)	(2.842)	(2.568)	(1.195)	(2.604)	(1.246)	(0.632)	(-0.437)	(0.600)	(-0.379)	(2.345)	(0.664)	(2.721)	(0.910)
	[0.069]	[0.071]	[0.081]	[0.078]	[0.075]	[0.089]	[0.132]	[0.148]	[0.103]	[0.248]	[0.083]	[0.090]	[0.073]	[0.078]
β_2	0.061	0.065	-0.029	0.139	0.110	0.176*	0.149*	0.162	0.220**	0.289	0.276	0.129	0.055	0.131
	(0.664)	(0.704)	(-0.318)	(1.491)	(1.157)	(1.662)	(1.684)	(1.534)	(2.089)	(1.693)	(0.234)	(1.115)	(0.579)	(1.375)
	[0.092]	[0.092]	[0.091]	[0.093]	[0.095]	[0.106]	[0.089]	[0.105]	[0.105]	[0.171]	[0.118]	[0.116]	[0.095]	[0.095]
β_3	0.232***	0.237***	0.301***	0.229***	0.214***	0.218**	0.264***	0.208*	0.074	0.031	0.267***	0.216**	0.241***	0.246***
	(3.265)	(3.240)	(3.659)	(2.852)	(2.858)	(2.561)	(3.867)	(1.810)	(0.669)	(0.145)	(3.435)	(2.113)	(3.273)	(2.895)
	[0.071]	[0.073]	[0.082]	[0.080]	[0.075]	[0.085]	[0.068]	[0.115]	[0.111]	[0.216]	[0.078]	[0.102]	[0.073]	[0.084]
β_4	0.105***	0.117***	0.132***	0.089***	0.107***	0.078**	0.104***	0.090**	0.069**	0.090	0.144***	0.083*	0.126***	0.078**
	(3.580)	(3.772)	(4.105)	(2.577)	(3.644)	(2.198)	(3.081)	(2.043)	(2.213)	(1.289)	(3.270)	(1.840)	(3.684)	(2.197)
	[0.029]	[0.031]	[0.032]	[0.034]	[0.029]	[0.035]	[0.034]	[0.044]	[0.031]	[0.070]	[0.044]	[0.045]	[0.034]	[0.036]
β_5	0.033**	0.037***	0.040***	0.033***	0.039***	0.039**	0.043***	0.039***	0.040***	0.040**	0.030	0.030	0.038***	0.036**
	(2.553)	(2.917)	(3.027)	(2.053)	(3.036)	(2.344)	(3.765)	(2.768)	(3.977)	(2.216)	(1.433)	(1.150)	(2.884)	(2.069)
	[0.013]	[0.013]	[0.013]	[0.016]	[0.013]	[0.017]	[0.011]	[0.014]	[0.010]	[0.019]	[0.021]	[0.026]	[0.013]	[0.017]
β_6	0.085***	0.083***	-	0.108***	0.091***	0.106***	0/097***	0.130***	0.089***	0.098**	0.070	0.122***	0.085***	0.104***
	(2.968)	(2.889)		(3.986)	(2.833)	(3.444)	(3.076)	(2.966)	(4.356)	(2.282)	(1.637)	(2.897)	(2.655)	(3.382)
	[0.028]	[0.028]		[0.027]	[0.032]	[0.031]	[0.031]	[0.044]	[0.020]	[0.043]	[0.043]	[0.042]	[0.032]	[0.031]
cay_{t-1}	-0.026	-	-	-	-	-	-	-	-	-	-	-	-	-
	(-1.568)													
	[0.120]													
$\overline{R^2}$	0.342	0.339	0.304	0.209	0.337	0.215	0.415	0.260	0.638	0.320	0.318	0.180	0.338	0.204
JB	26.747	25.735	27.437	36.698	30.939	43.010	13.976	35.094	0.683	0.072	16.358	24.384	21.617	37.318
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.710]	[0.965]	[0.000]	[0.000]	[0.000]	[0.000]
$ARCH(1)$	0.228	0.340	0.272		0.472		5.646		1.403		0.135		0.254	
	[0.634]	[0.561]	[0.603]		[0.493]		[0.020]		[0.246]		[0.715]		[0.615]	
$ARCH(4)$	0.239	0.277	0.248		0.138		4.965		0.388		0.280		0.257	
	[0.915]	[0.892]	[0.910]		[0.968]		[0.001]		[0.815]		[0.890]		[0.905]	

Notes: t-statistic in (),Newey-West robust standard errors in [ ].***,**and *indicate significance at 1%, 5% and 10% levels, $JB$is the Jarque-Bera test for normality. $ARCH(1)$and $ARCH(4)$are heteroskedasticity tests for residuals. For the JB, $ARCH(1)$and $ARCH(4)$statistics, p-values are reported in [].

Figure 1: SupADF$_r$ statistic of Phillips et al. (2006) for different city and aggregate U.S. real house prices

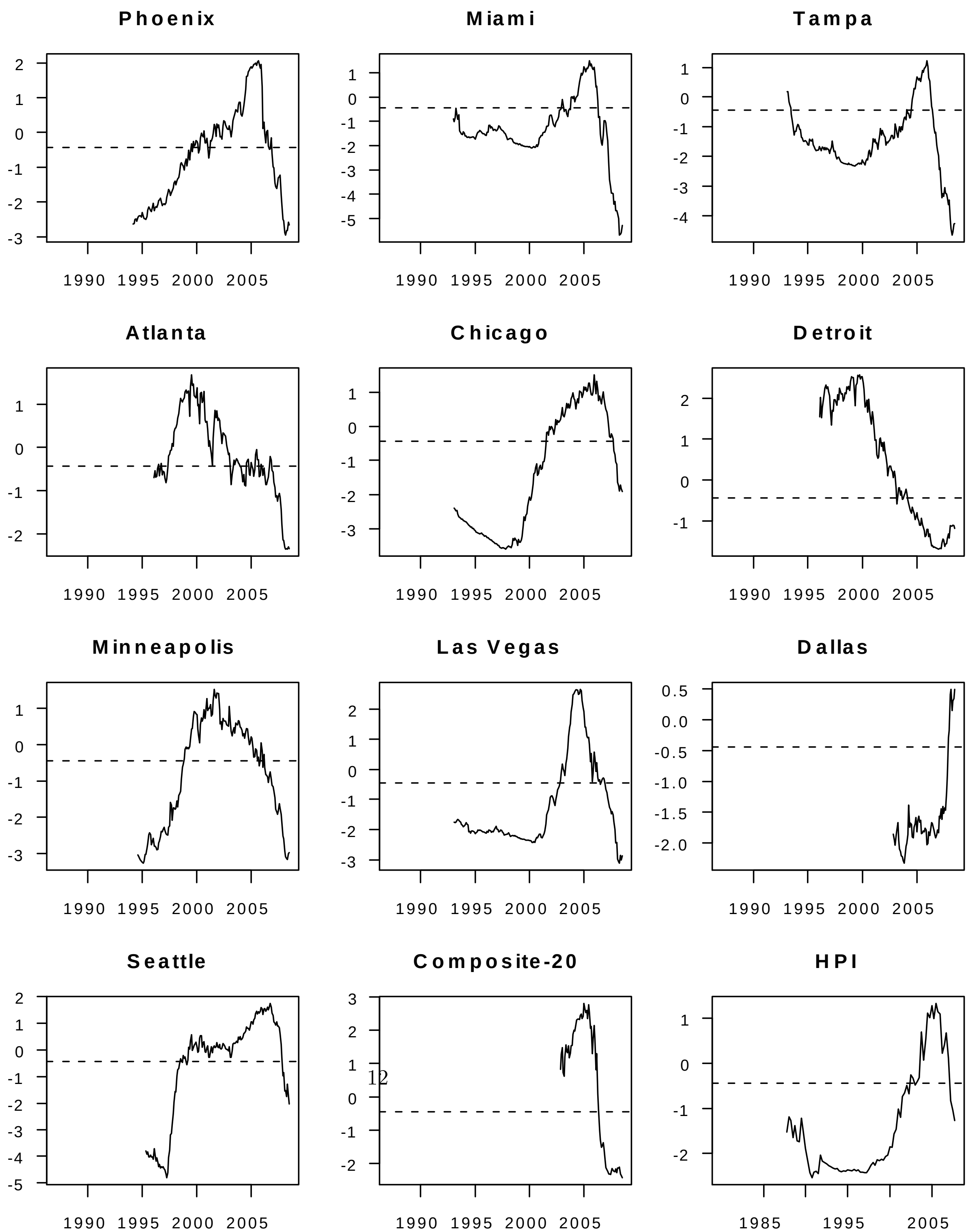

Figure 2: Recursive t-statistic of the sensitivity of changes in consupmtion to real house price acceleration, β_6. Shaded area denotes presence of bubble in HPI according to Phillips et al. (2006) test.

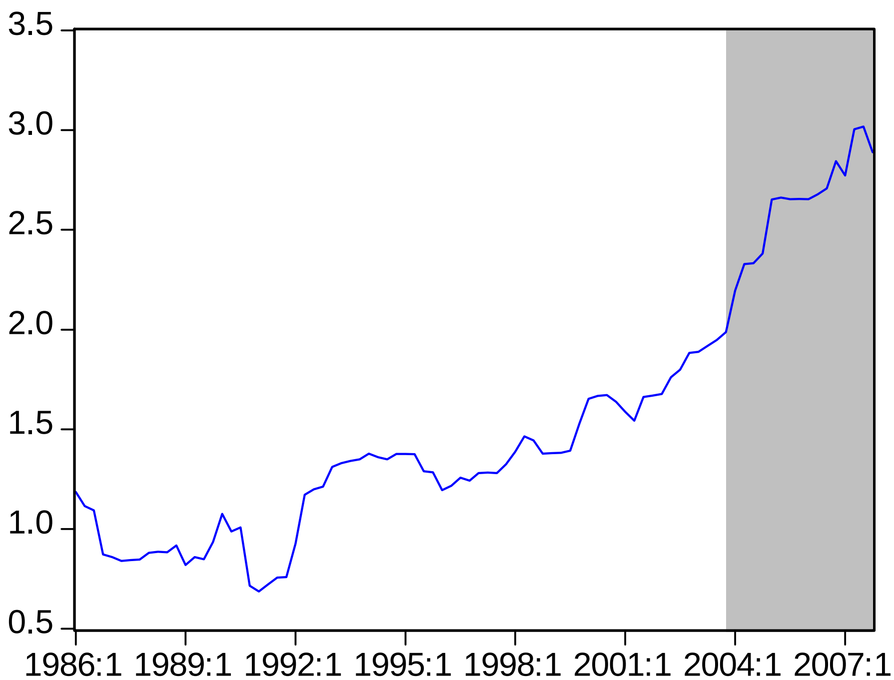

Figure 3: Recursive point estimate of the sensitivity of changes in consumption to real house price acceleration, β_6. Shaded area denotes presence of bubble in HPI according to Phillips et al. (2006) test.