

Measuring House Price Bubbles

Steven C. Bourassa, Florida Atlantic University,
USA

Martin Hoesli, University of Geneva, Switzerland
and University of Aberdeen

Elias Oikarinen, University of Turku, Finland

University of Reading, October 14, 2015

Motivation

- Excessive volatility in housing markets—formation and dissolution of price bubbles— is harmful
- Efforts to avoid the formation of bubbles would be sound policy (Crowe et al., *JFS*, 2013)
- Hence, reliable methods for measuring bubbles in real time could be helpful
- Of the various methods used to identify bubbles, most have been employed ex post, and none is generally accepted
- The commonly used methods are simplifications of the theoretically correct model with some restrictive assumptions

Aims of this study

- First to identify bubbles in six metropolitan areas ex post, using an empirical application of the theoretically correct model
- Investigate whether (some of) the simplified models are largely in line with the more complex asset pricing model ex post
- Examine if (some of) the simplified models can signal the identified bubble “in real time”, i.e. ex ante (out-of-sample)
- Make a recommendation regarding the use of the simplified models

What is a bubble?

- Two definitions:
 - Prices exhibit a sustained and substantial departure from fundamentals; e.g., prices reflect expected price growth rather than future rents (Stiglitz, *JEP*, 1990)
 - Rapid price growth followed by rapid decline (Lind, *IJHMA*, 2009)
- Most of the methods used in the literature are variations on the first idea
- Second idea has also influenced some empirical research

Ways to measure bubbles

- Ratios:
 - Price-to-rent
 - Price-to-income
 - Imputed-to-actual rents (or other ratios involving imputed rents, which are user costs multiplied by prices) (Himmelberg, Mayer and Sinai, *JEP*, 2005)

Ways to measure bubbles

- Regression models:
 - Based on one or more fundamentals, more or less based on theory, and using various estimation techniques (Case and Shiller, *BPEA*, 2003; Oikarinen, *JBFA*, 2009)
 - Based on present value concepts and using VAR models to relate future rents (or, in some cases, incomes) to current prices (Black, Fraser and Hoesli, *JBFA*, 2006)

Ways to measure bubbles

- Growth rates:
 - Exponential rates of growth are indicators of bubbles (Zhou and Sornette, *PA*, 2006)

Research strategy

- Focus on 6 metropolitan areas in 3 countries:
 - Helsinki, Finland; Geneva and Zurich, Switzerland; and Chicago, Miami, and San Francisco, USA
 - Some of these are thought to have experienced bubbles and some not
 - Over 30 years of quarterly data; Constant-quality housing price indices

Research strategy

- The first step is to apply the “optimal” asset pricing or present value approach that relates prices to rents (Campbell and Shiller, *RFS*, 1988; Black, Fraser, and Hoesli, *JBFA*, 2006) to identify bubbles ex post:
 - The dynamic Gordon growth model: time-varying risk premium and rental growth expectations
 - Bubble signal if observed price-rent is X% over the equilibrium price-rent implied by the model

Research strategy

- The “optimal”/“correct” asset pricing model is computationally complex
- Thus, we compare 6 simpler alternative methods with the present value method
- The methods are:
 - price-rent ratio
 - price-income ratio
 - imputed-actual rent ratio
 - parsimonious supply and demand model
 - multivariate supply and demand model
 - exponential growth rate (EGR) model

Research strategy

- Imputed rent is the price of a typical house times the user cost
- The user cost calculation varies somewhat across countries
- Finland: $E(u_{mt}) = (1 - \tau_{mt})i_{mt} + \delta_m - E(g_{mt})$
- U.S.: $E(u_{mt}) = (1 - \tau_{mt})(i_{mt} + \lambda_m) + \delta_m - E(g_{mt})$
- Switzerland: $E(u_{mt}) = (1 - \tau_{mt})(i_{mt} + \lambda_m + \gamma_m) + \delta_m + \tau_{mt}\eta_m - (1 - \tau_{mt}^g)E(g_{mt})$

Research strategy

- The multivariate regression models include real income, population, unemployment, real interest rates, real construction costs, real spreads between 10-year and 3-month government securities and consumer sentiment as fundamentals
- The parsimonious regression models only consider real aggregate income

Research strategy

- We assess how effective each of the 6 methods is in identifying bubbles ex post
- We also conduct an ex ante or “real time” analysis:
 - We use the same 6 alternative methods, but applied recursively
 - Aim here is to determine whether any of the methods measures a bubble consistently with our ex post benchmark (the PV method)
 - We focus on the last ten years of data in each city

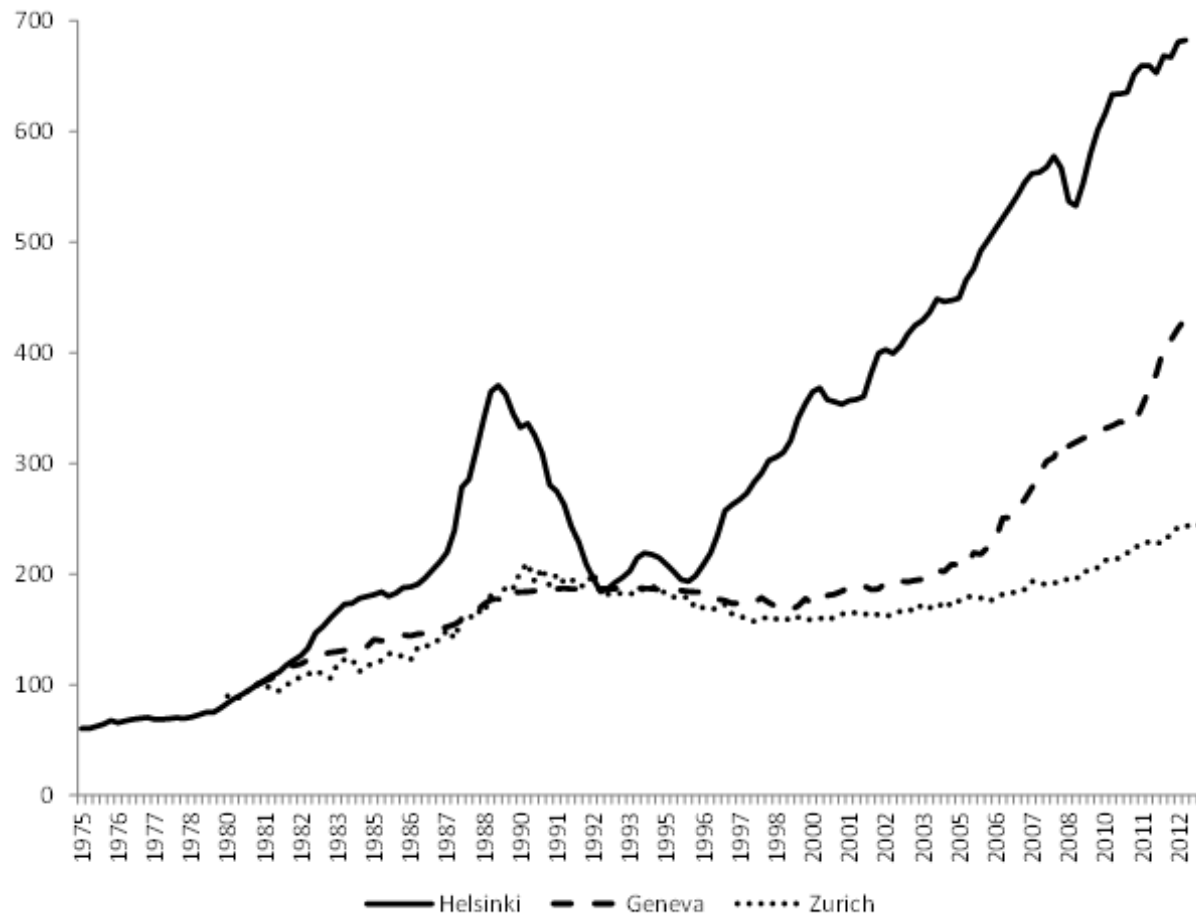
Research strategy

- Baseline bubble criterion:
 - For the ratio measures, a bubble occurs whenever the long-term average is exceeded by at least 20%
 - Similarly, for the present value and supply and demand approaches, a bubble occurs whenever the actual price level exceeds the equilibrium level by at least 20%
 - For the EGR analysis, $\ln(\text{price})$ exceeds the log-linear trend by at least 20%
 - Robustness checks apply different criteria
- We will focus here on % of correct signals as a measure of 'wellness' of a method (working on other methods)

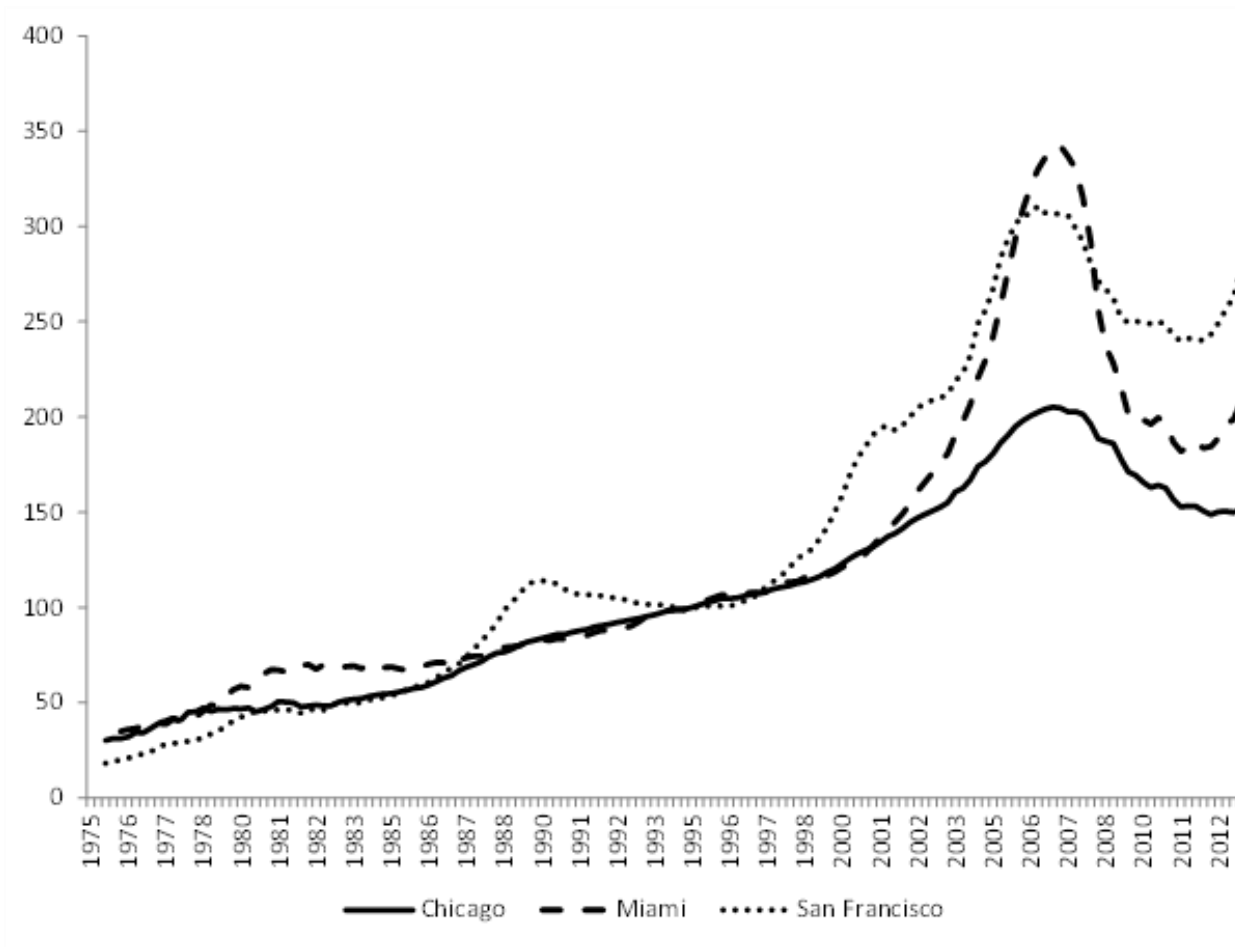
The benchmark model results

- In each case, a bubble signal has been followed by a substantial drop even in the nominal price level
- No such price drops without bubble signals => the model works as desired and expected
- An exception to the general rule is the late 1970s bubble signal in Helsinki which is due to low rental growth expectations (real rental prices dropped notably)

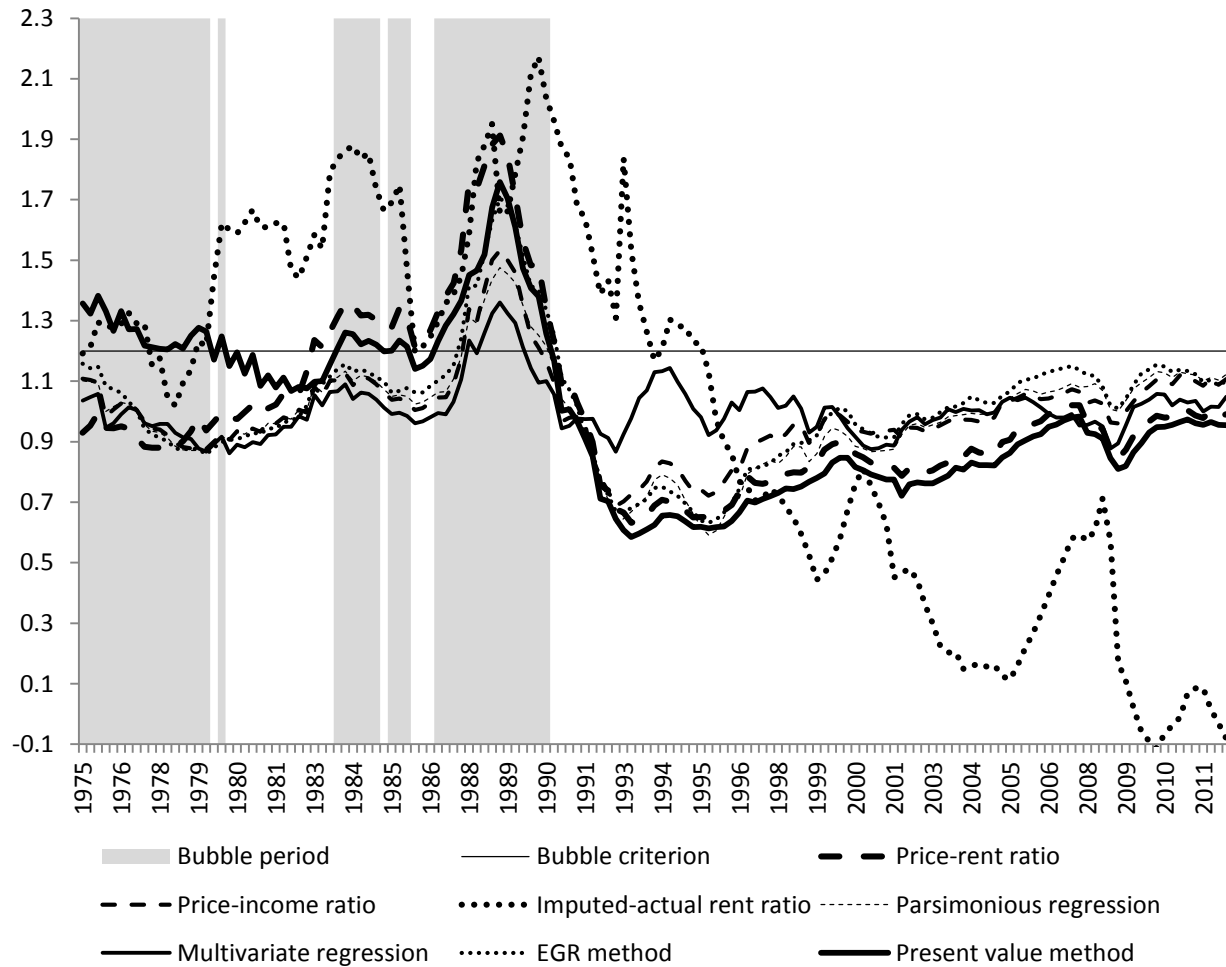
Nominal prices: European cities



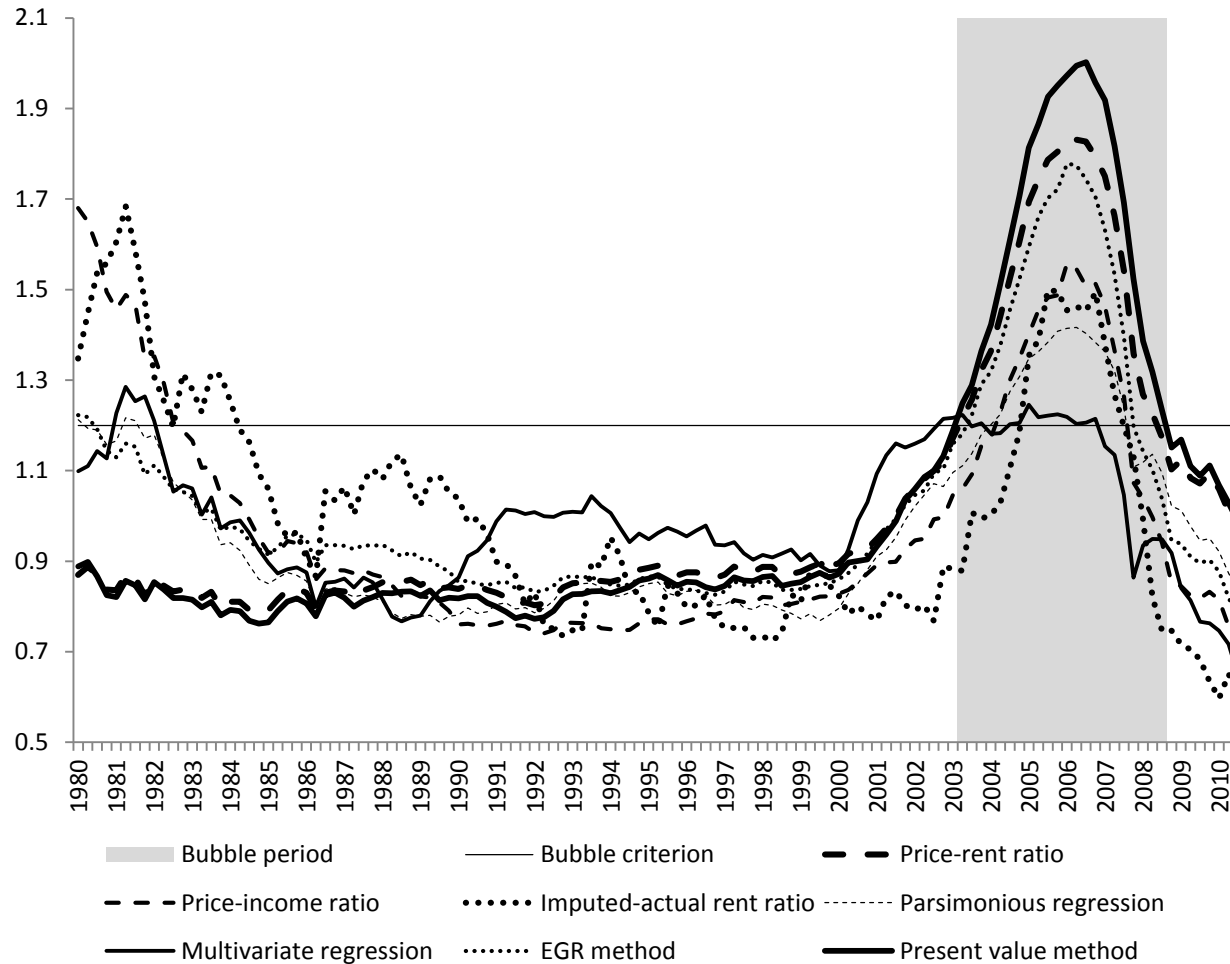
Nominal prices: U.S. cities



Ex post measures: Helsinki



Ex post measures: Miami



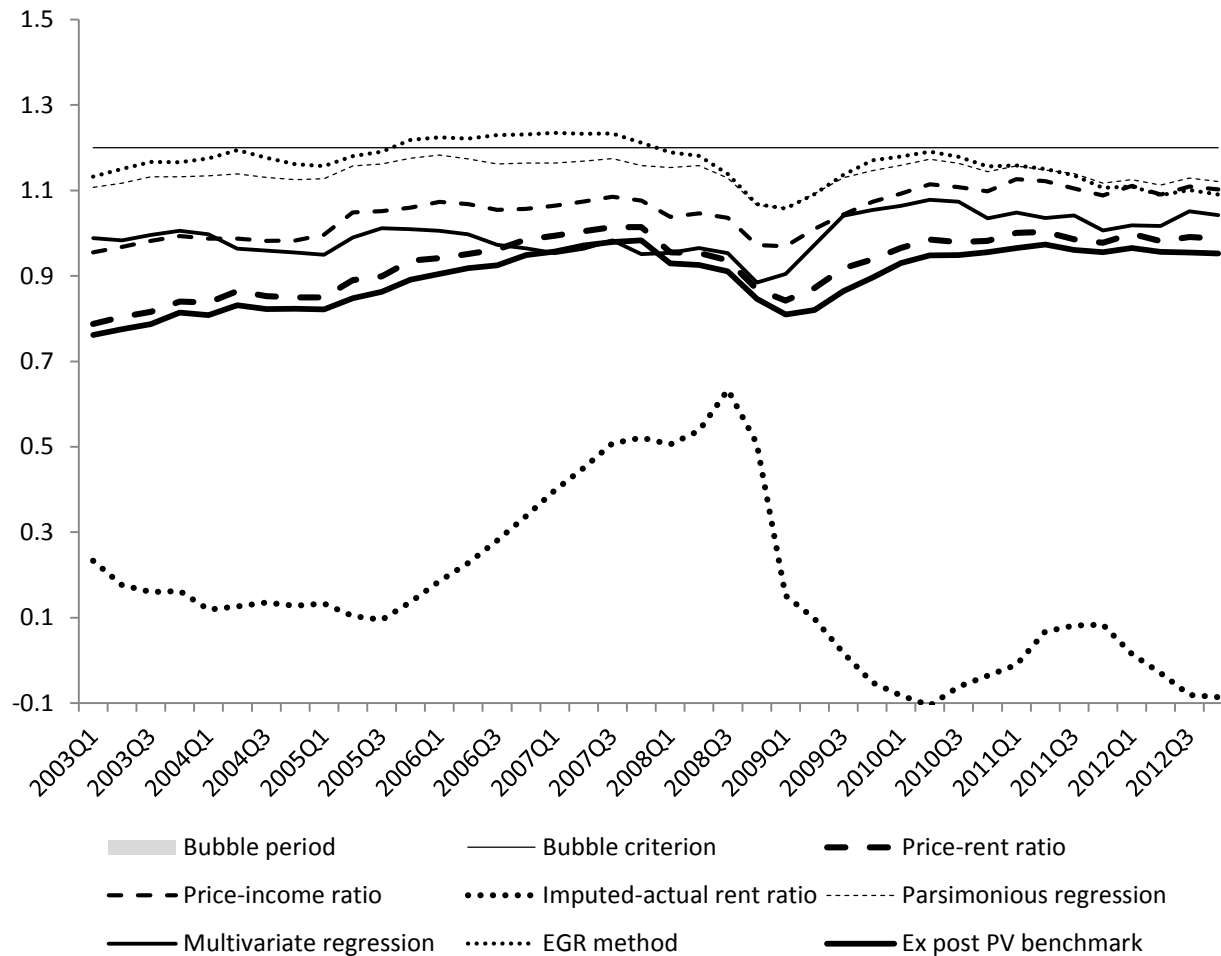
Ex post measures

Agreement of ex post measures with present value benchmark measure (%)

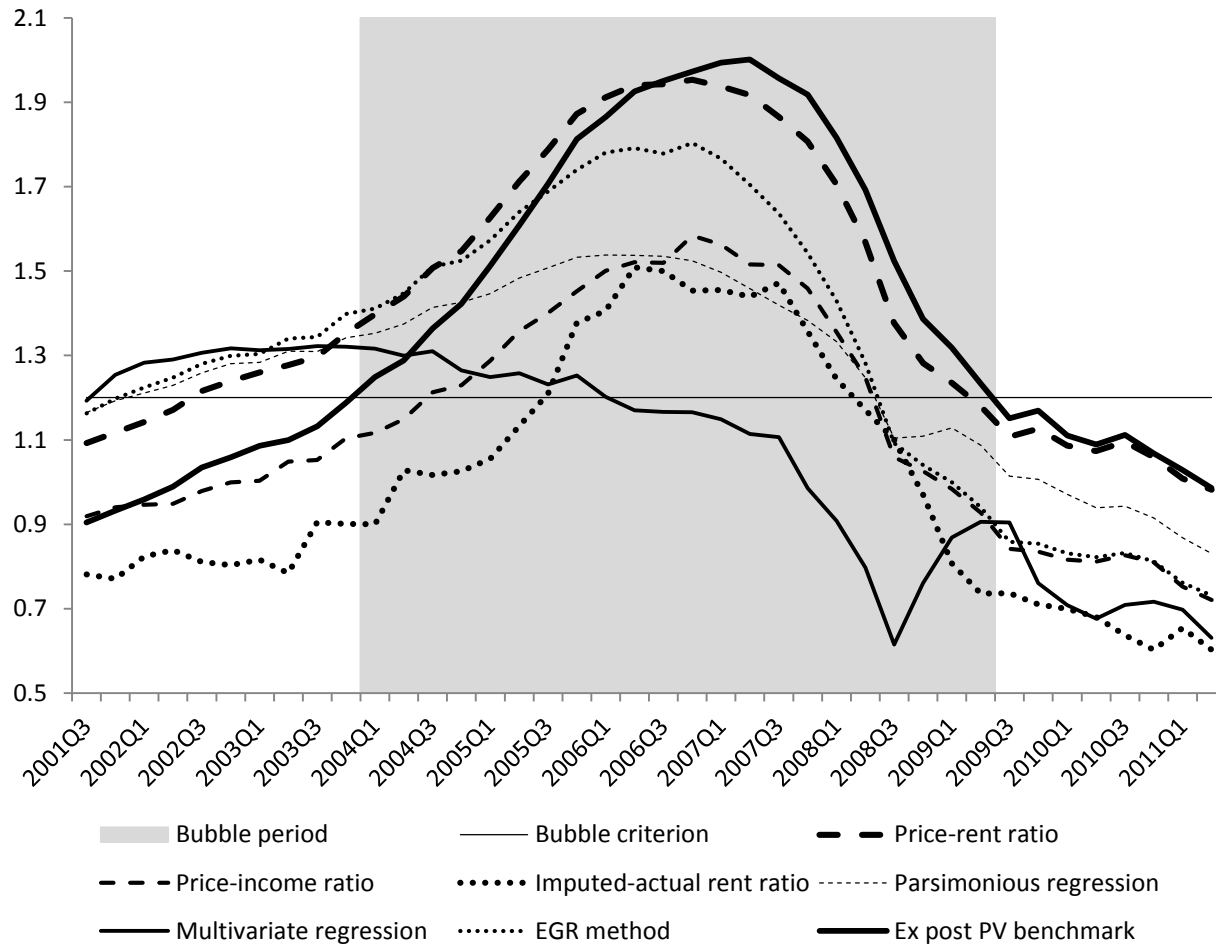
	Price-rent ratio	Price- income ratio	Imputed- actual rent ratio	Parsimonious regression	Multivariate regression	Exponential growth rate
Helsinki	74.9	61.9	74.5	63.1	58.3	63.8
Geneva	89.3	82.6	60.3	89.3	94.2	96.7
Zurich	88.8	95.2	76.8	88.8	96.0	88.0
Chicago	93.5	71.7	42.4	50.0	50.0	80.4
Miami	97.7	76.4	64.8	82.6	73.8	87.6
San Francisco	78.6	68.6	34.1	52.9	51.7	70.9
<i>Average</i>	<i>87.1</i>	<i>76.1</i>	<i>58.8</i>	<i>71.1</i>	<i>70.7</i>	<i>81.2</i>

Note: These figures give equal weight to sensitivity (percentage of bubble periods identified by the measure) and specificity (percentage of non-bubble periods identified by the measure). These percentages are based on the 20 percent criterion for identifying a bubble.

Ex ante measures: Helsinki



Ex ante measures: Miami



Ex ante measures

Average correct ex ante identification of bubble and non-bubble periods (%)

	Price-rent ratio	Price- income ratio	Imputed- actual rent ratio	Parsimonious regression	Multivariate regression	Exponential growth rate
Helsinki	100.0	100.0	100.0	100.0	100.0	77.5
Geneva	60.0	37.5	95.0	55.0	55.0	45.0
Zurich	100.0	97.5	100.0	100.0	100.0	100.0
Chicago	89.0	80.4	50.0	50.0	50.0	60.9
Miami	81.1	86.4	75.0	68.7	45.5	68.7
San Francisco	73.7	71.0	50.0	54.8	50.0	66.1
<i>Average</i>	<i>84.0</i>	<i>78.8</i>	<i>78.3</i>	<i>71.4</i>	<i>66.7</i>	<i>69.7</i>

Note: These percentages are based on the 20 percent criterion for identifying a bubble.

Ex ante measures

Table 6. Correct ex ante identification of bubble periods (%)

	Number of bubble quarters	Price- rent ratio	Price- income ratio	Imputed- actual rent ratio	Parsimonious regression	Multivariate regression	Exponential growth rate
Helsinki	0	—	—	—	—	—	—
Geneva	0	—	—	—	—	—	—
Zurich	0	—	—	—	—	—	—
Chicago	20	100.0	70.0	0.0	0.0	0.0	25.0
Miami	22	95.5	72.7	50.0	81.8	40.9	81.8
San Francisco	31	80.6	41.9	0.0	9.7	0.0	32.3
<i>Average</i>		<i>92.0</i>	<i>61.6</i>	<i>16.7</i>	<i>30.5</i>	<i>13.6</i>	<i>46.4</i>

Note: These figures are the percentage of the most recent 40 quarters that each ex ante method identifies a bubble when the ex post benchmark identifies a bubble (i.e., sensitivity or one minus the probability of a Type I error). The number of bubble quarters is the number identified by the ex post benchmark. These percentages are based on the 20 percent criterion for identifying a bubble.

Ex ante measures

Table 7. Correct ex ante identification of non-bubble periods (%)

	Number of non- bubble quarters	Price- rent ratio	Price- income ratio	Imputed- actual rent ratio	Parsimonious regression	Multivariate regression	Exponential growth rate
Helsinki	40	100.0	100.0	100.0	100.0	100.0	77.5
Geneva	40	60.0	37.5	95.0	55.0	55.0	45.0
Zurich	40	100.0	97.5	100.0	100.0	100.0	100.0
Chicago	20	75.0	100.0	100.0	100.0	100.0	100.0
Miami	18	66.7	100.0	100.0	55.6	50.0	55.6
San Francisco	9	66.7	100.0	100.0	100.0	100.0	100.0
<i>Average</i>		<i>78.1</i>	<i>89.2</i>	<i>99.2</i>	<i>85.1</i>	<i>84.2</i>	<i>79.7</i>

Note: These figures are the percentage of the most recent 40 quarters that each ex ante measure does not identify a bubble when the ex post benchmark does not identify a bubble (i.e., specificity or one minus the probability of a Type II error). The number of non-bubble quarters is the number identified by the ex post benchmark. These percentages are based on the 20 percent criterion for identifying a bubble.

Conclusions

- The price-rent ratio works best and well (as an alternative to the present value method) at identifying bubbles both ex post (87% of correct signals) and ex ante (84% of correct signals), regardless of the 'bubble threshold'
- It tends to trigger the bubble signal a bit before the actual bubble
- This method is appealing because it is simple to implement
- Most methods are highly positively correlated (similar signals)

Conclusions

- Multiple variable regression constantly works worse than a parsimonious regression (with aggregate income): The inclusion of (especially mean-reverting) variables makes the model fit actual price levels “too well”
- Results should be useful in guiding policy measures designed to mitigate house price volatility
- Data quality! (“garbage in garbage out”)

Further work

- Sensitivity of results to deleting some years at the beginning or end of period (changing the 'equilibrium')
- Some of our data are at the annual frequency and interpolation methods are used:
Sensitivity analysis using annual data