Measuring House Price Bubbles

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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 as they are forming 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. as the bubble is forming
- 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, *JBF*, 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 six metropolitan areas in three 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 six simpler alternative methods with the present value method:
  - 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: $E(u_{mt}) = (1 - \tau_{mt})(i_{mt} + \lambda_m + \gamma_m) + \delta_m + \tau_{mt}\eta_m - \left(1 - \tau_{mt}^{g}\right)E(g_{mt})$

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 six methods is in identifying bubbles ex post
- We also conduct a recursive or 'real time' analysis:
  - We use the same six 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 use all of the data for each city, but focus on the last 10 years

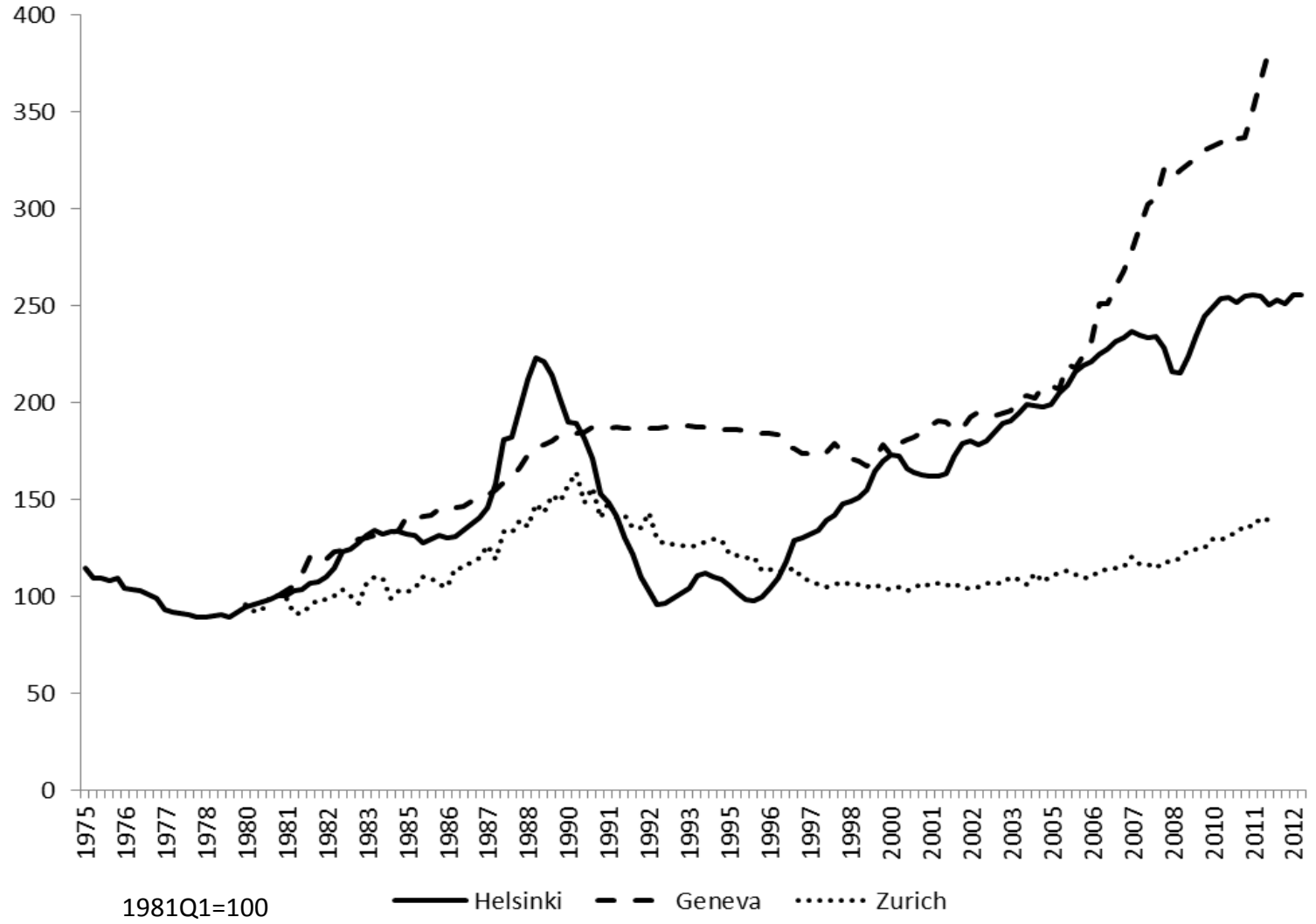
Research strategy

- 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(price) exceeds the log-linear trend by at least 20%
  - Robustness checks will apply different criteria
- We will focus here on % of correct signals as a measure of 'wellness' of a method

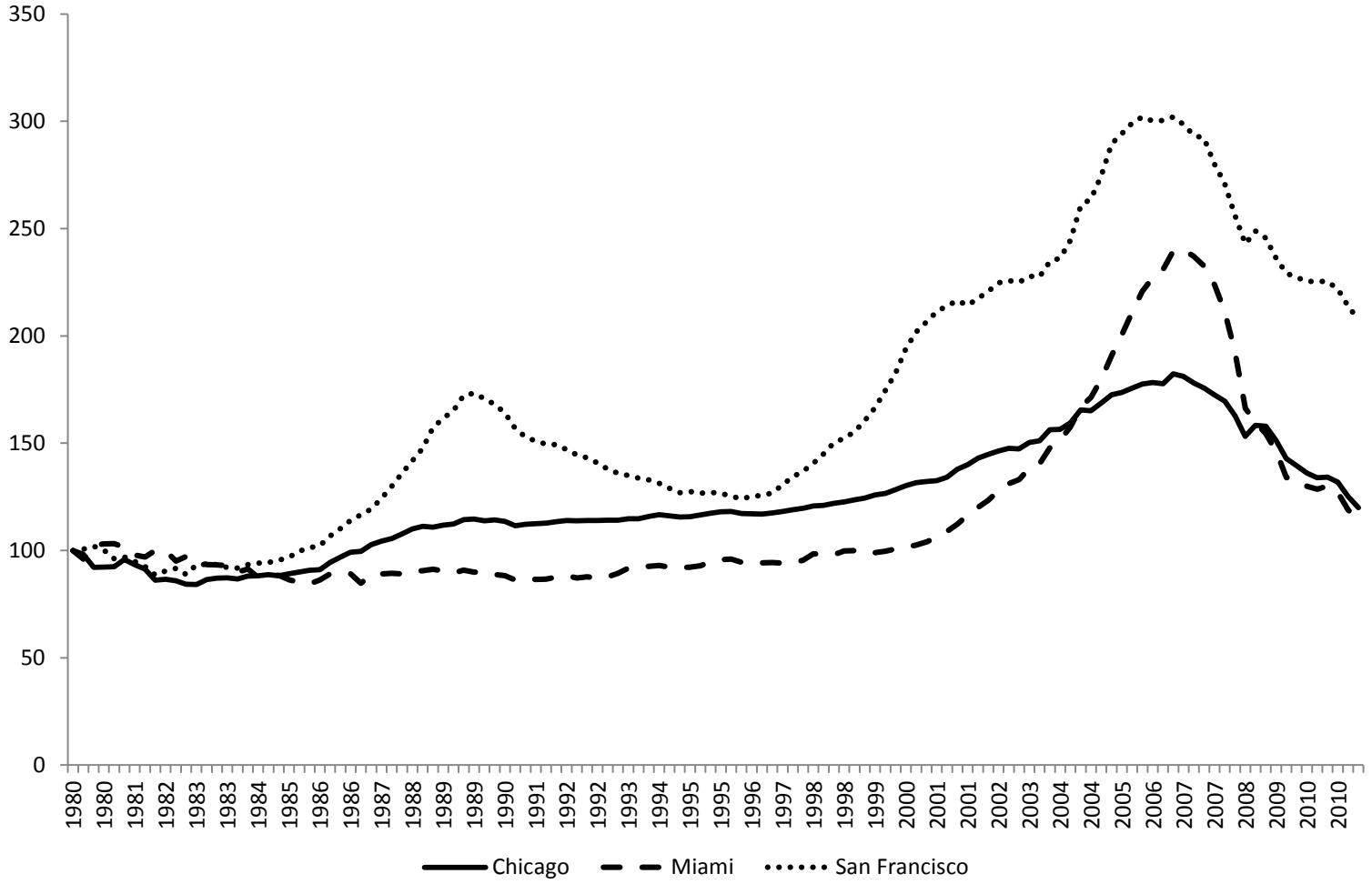
The benchmark model results

- 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 indicating that 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)

Real house prices: European cities

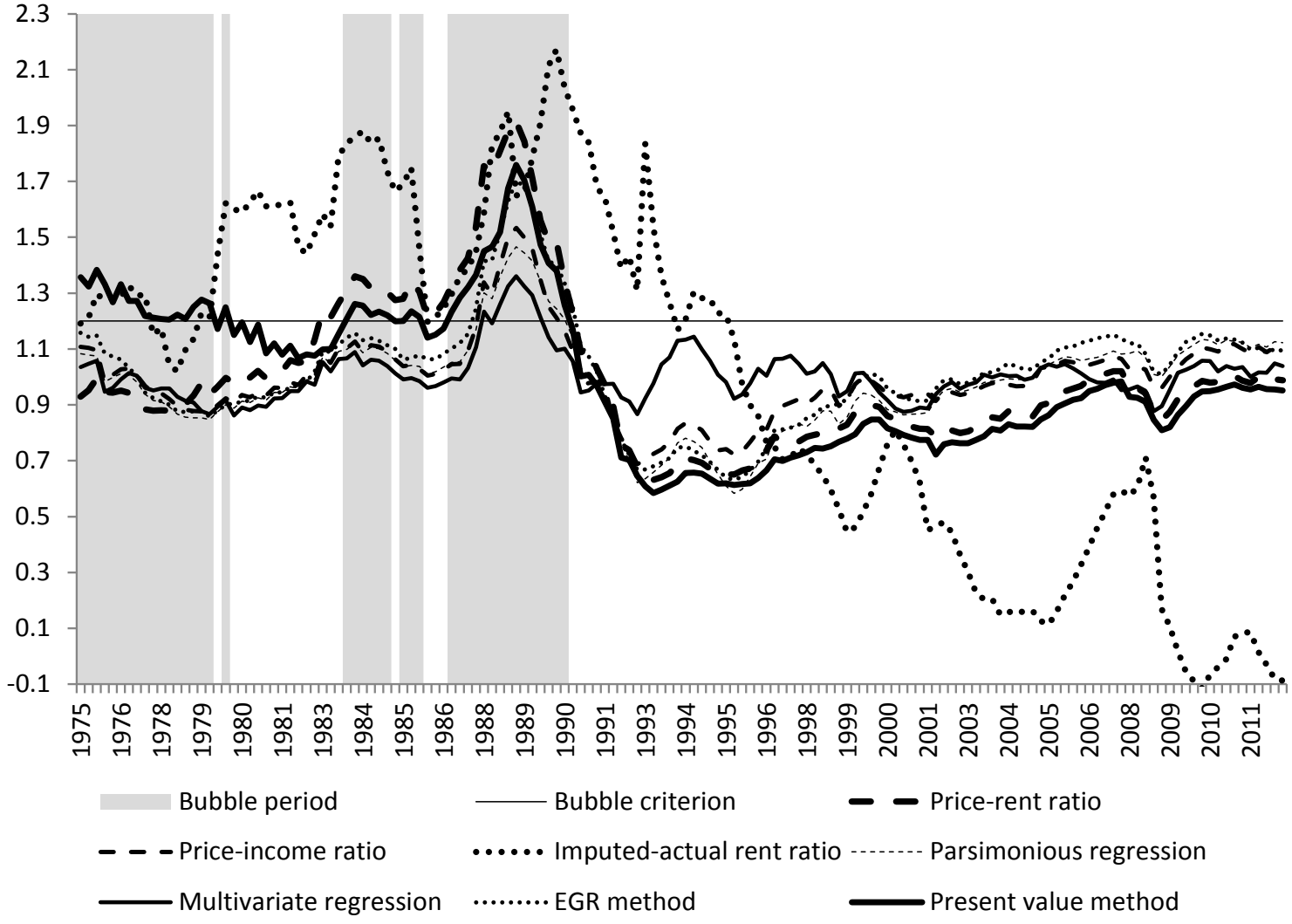


Real house prices: U.S. cities

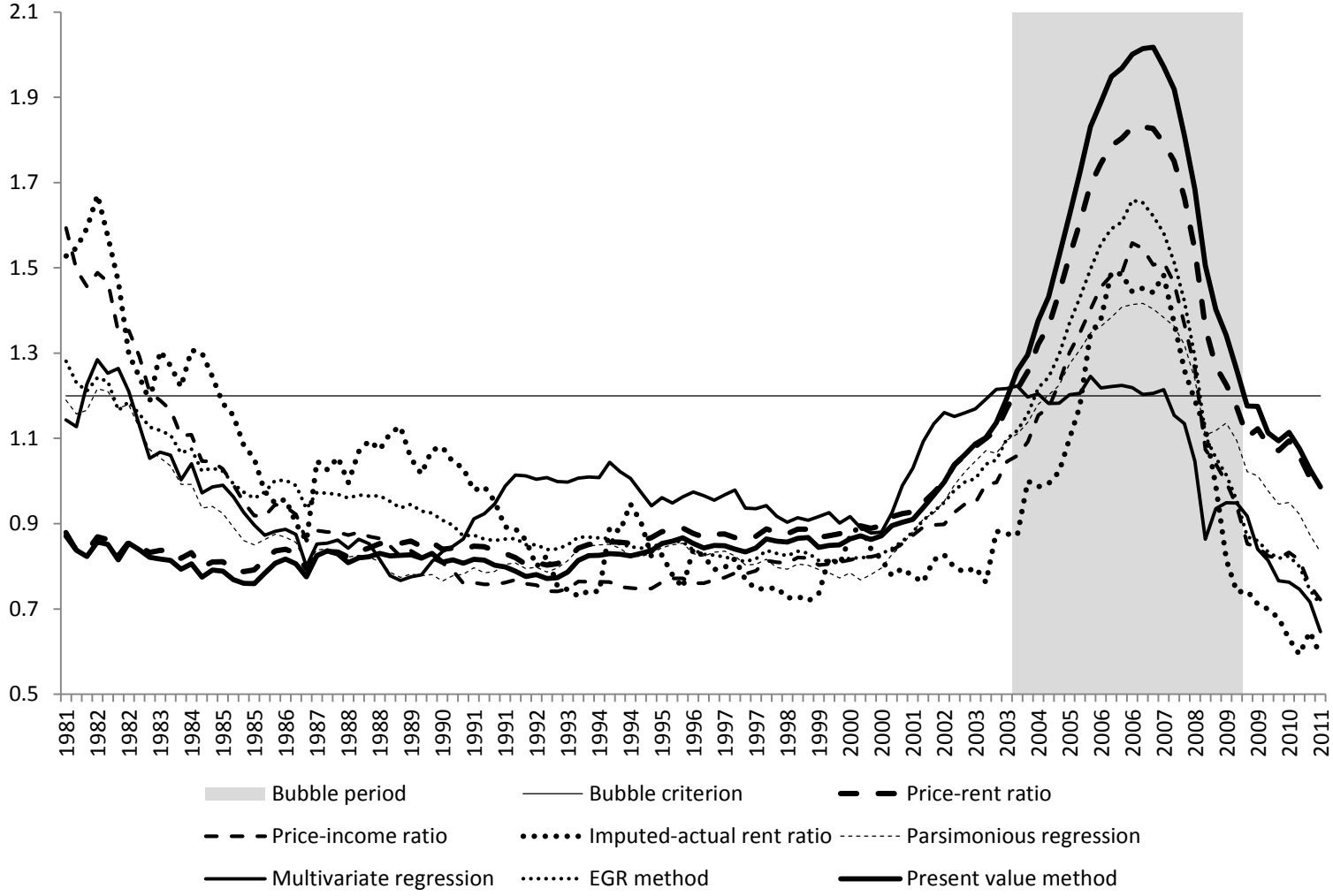


1980Q1=100

Ex post measures: Helsinki



Ex post measures: Miami



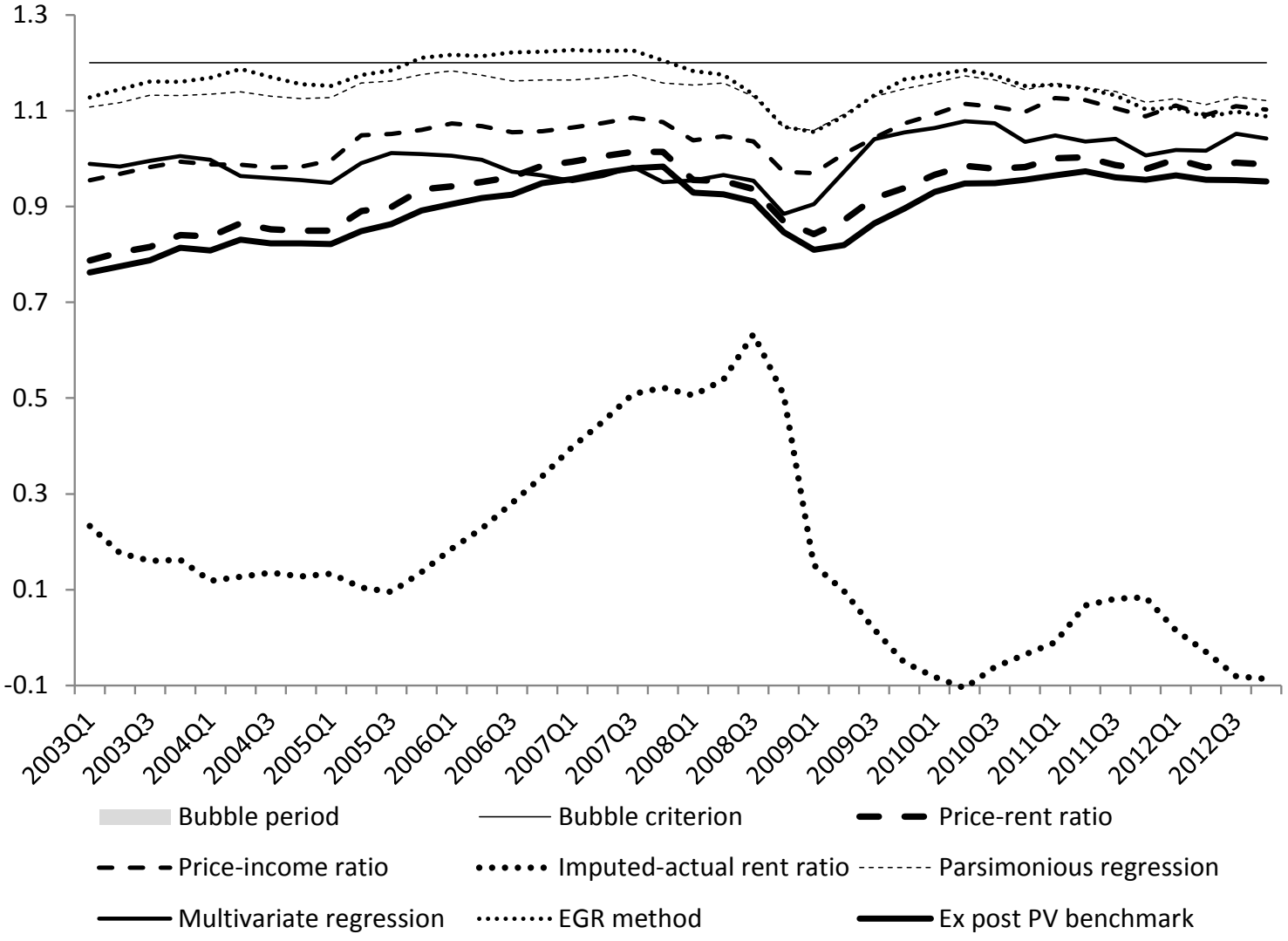
Ex post measures

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

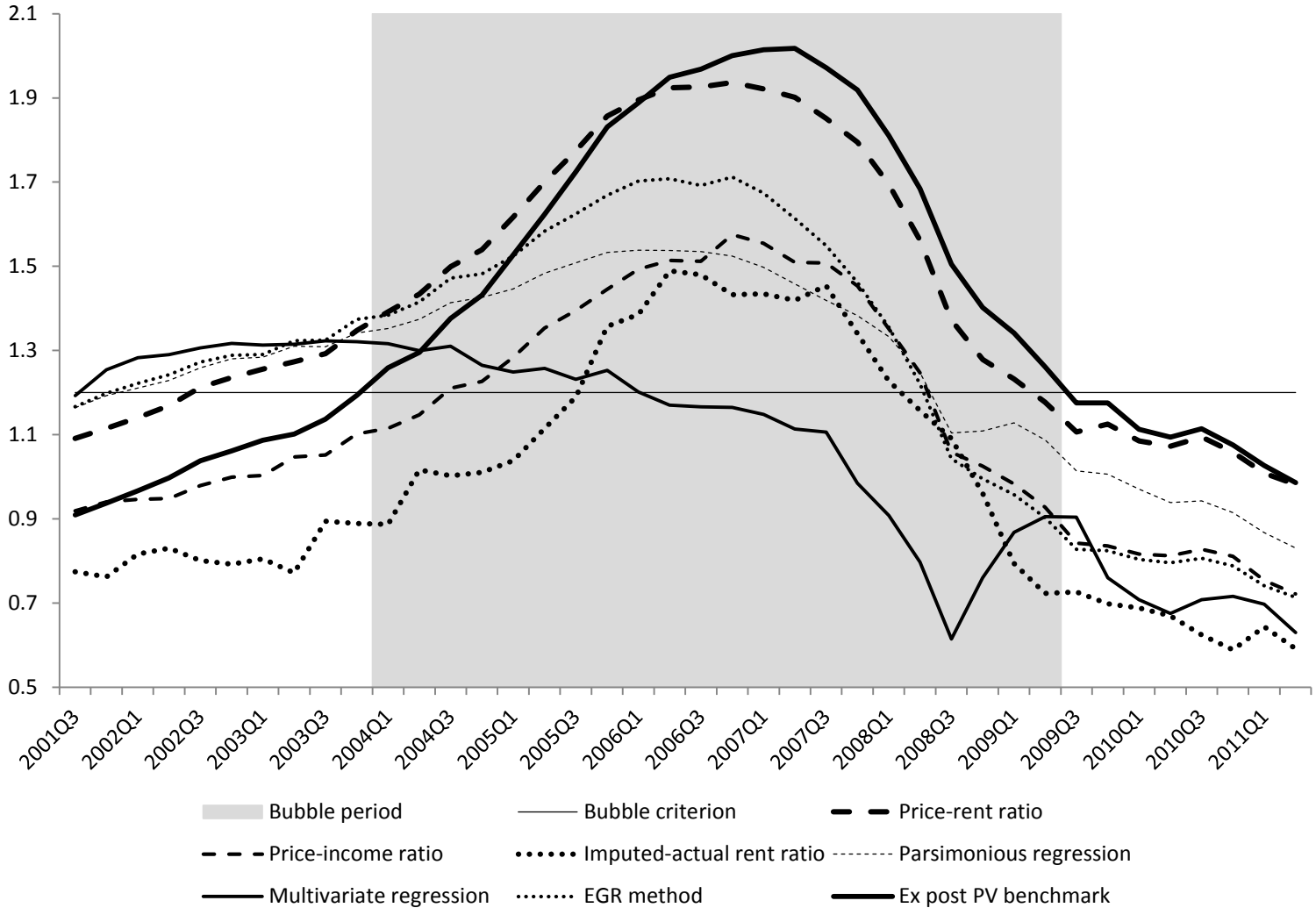
	Price-rent ratio		Price-income ratio		Imputed-actual rent ratio		Parsimonious regression		Multivariate regression		Exponential growth rate	
	Ex post	**Recur-sive**	**Ex post**	**Recur-sive**	**Ex post**	**Recur-sive**	**Ex post**	**Recur-sive**	**Ex post**	**Recur-sive**	**Ex post**	**Recur-sive**
Helsinki	74.9	100.0	61.9	100.0	74.5	100.0	63.1	100.0	58.3	100.0	63.8	77.5
Geneva	89.0	60.0	82.2	40.0	65.3	100.0	89.0	55.0	94.1	55.0	88.1	45.0
Zurich	94.4	100.0	98.6	100.0	94.9	100.0	94.9	100.0	53.2	100.0	99.1	100.0
Chicago	97.0	90.0	75.0	82.5	46.3	50.0	50.0	50.0	50.0	50.0	50.0	50.0
Miami	97.7	81.1	77.3	86.4	65.7	72.7	78.8	68.7	81.6	45.5	83.8	68.7
San Francisco	78.6	73.7	68.6	71.0	35.3	50.0	59.7	54.8	57.1	50.0	67.2	59.0
Average	*88.6*	*84.1*	*77.3*	*80.0*	*63.6*	*78.8*	*72.6*	*71.4*	*65.7*	*66.7*	*75.3*	*66.7*

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) except if there are no bubble periods, then the percentages are based solely on specificity. The percentages are based on the 20 percent criterion for identifying a bubble.

Recursive measures: Helsinki



Recursive measures: Miami



Recursive measures

Agreement of recursive measures with present value benchmark measure (%)

	Price-rent ratio		Price-income ratio		Imputed-actual rent ratio		Parsimonious regression		Multivariate regression		Exponential growth rate	
	Ex post	**Recur-sive**	**Ex post**	**Recur-sive**	**Ex post**	**Recur-sive**	**Ex post**	**Recur-sive**	**Ex post**	**Recur-sive**	**Ex post**	**Recur-sive**
Helsinki	74.9	100.0	61.9	100.0	74.5	100.0	63.1	100.0	58.3	100.0	63.8	77.5
Geneva	89.0	60.0	82.2	40.0	65.3	100.0	89.0	55.0	94.1	55.0	88.1	45.0
Zurich	94.4	100.0	98.6	100.0	94.9	100.0	94.9	100.0	53.2	100.0	99.1	100.0
Chicago	97.0	90.0	75.0	82.5	46.3	50.0	50.0	50.0	50.0	50.0	50.0	50.0
Miami	97.7	81.1	77.3	86.4	65.7	72.7	78.8	68.7	81.6	45.5	83.8	68.7
San Francisco	78.6	73.7	68.6	71.0	35.3	50.0	59.7	54.8	57.1	50.0	67.2	59.0
Average	*88.6*	*84.1*	*77.3*	*80.0*	*63.6*	*78.8*	*72.6*	*71.4*	*65.7*	*66.7*	*75.3*	*66.7*

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) except if there are no bubble periods, then the percentages are based solely on specificity. The percentages are based on the 20 percent criterion for identifying a bubble.

Sensitivity Analyses

- Modification of bubble threshold from 20%: 10% and 30% were also tested
- Deleting first five years of data
- Deleting last five years of data
- Using annual data (due to possible issues with interpolation of some of the quarterly data)

Sensitivity Analyses

Robustness checks for agreement of ex post and recursive measures with present value benchmark measure (%)

	Price-rent ratio		Price-income ratio		Imputed-actual rent ratio		Parsimonious regression		Multivariate regression		Exponential growth rate	
	Ex post	**Recur-sive**	**Ex post**	**Recur-sive**	**Ex post**	**Recur-sive**	**Ex post**	**Recur-sive**	**Ex post**	**Recur-sive**	**Ex post**	**Recur-sive**
20% bubble threshold	88.6	84.1	77.3	80.0	63.6	78.8	72.6	71.4	65.7	66.7	75.3	66.7
10% bubble threshold	91.5	82.8	81.5	80.2	59.4	71.0	78.0	59.6	75.6	69.5	79.3	55.4
30% bubble threshold	92.3	91.6	71.8	71.8	64.0	78.9	72.6	75.4	59.8	71.0	76.7	73.3
Without first 5 years	91.7	82.9	77.8	81.8	75.9	80.9	69.0	79.5	63.0	67.5	72.5	64.5
Without last 5 years	91.0	98.3	74.9	88.6	66.1	76.8	76.9	93.1	59.1	76.4	76.8	79.3
Annual	94.7	88.6	83.5	86.8	59.5	69.0	79.0	75.7	67.2	68.6	80.7	76.9

Note: These figures are averages across the six cities of the correct identification of bubble and non-bubble periods.

Conclusions

- The price-rent ratio works best and well (as an alternative to the present value method) at identifying bubbles both ex post (88.6% of correct signals) and recursively (84.1% 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); imputed-actual rent ratio is a frequent exception

Conclusions

- Multiple variable regression is less accurate than a parsimonious regression (with only aggregate income on RHS): the inclusion of additional (especially mean-reverting) variables makes the model fit actual price levels ‘too well’
- Sensitivity analyses are all consistent with baseline analysis
- Results should be useful in guiding policy measures designed to mitigate house price volatility

Zurich and Geneva: 1980-2015