Box 3

A model-based valuation metric for residential property markets

Reliable valuation metrics are key for monitoring residential property market developments from a financial stability perspective. Due to the heterogeneity and complexity of housing markets, no single metric of housing valuation at the macro level is sufficient to capture all relevant factors. Statistical indicators for measuring residential property price valuations offer intuitive appeal and ease of construction, but may fail to capture important fundamental factors.[14] By contrast, model-based approaches offer the advantage that they can explore a wider set of fundamental factors in a

[14] For further details, see Box 3 in *Financial Stability Review*, ECB, May 2015.

multivariate regression framework, but still can only go so far in capturing the symbiotic relationship between housing, rental and mortgage markets.

One such model-based approach is to adopt a textbook model where the supply of houses is given in the short run and prices are determined by the inverted demand curve.[15] The benefit of using a commonly applied model is that priors are available for the key long-run elasticities. The inverted demand equation can be formulated as follows:

$$\log \mathrm{rhp}_t = \frac{[a_0 + a_1 \log y_t - \log hs_t - a_3 \, int_t]}{a_2} + \varepsilon_t$$

where rhp_t denotes real house prices, y_t is real disposable income per household, hs_t is the real housing stock per capita, int_t is the real average mortgage interest rate variable (as a proxy for the user cost of housing) and ε_t is a residual. In terms of expected signs, higher income is expected to exert upward pressure on house prices, while a higher housing stock and/or higher real interest rates should both dampen house prices. The residuals in the equation are then interpreted as misalignments of actual house prices from fundamentals.

The inverted demand equation is estimated for each individual country using Bayesian techniques to alleviate potential short sample issues.[16] The Bayesian estimator combines the information in the data with the prior beliefs of the econometrician concerning the value of the parameters. The prior distributions of the model coefficients are centred at the values typically found in the literature.[17] The same prior means are used for all euro area countries. The intensity with which the prior beliefs are enforced, referred to as the prior tightness, is obtained by maximising the marginal likelihood of the model. The prior distribution of the constant term is centred at zero and is flat.

The estimated misalignment can be embedded in a vector autoregressive (VAR) model. Given the symbiosis between housing and mortgage markets, developments in mortgage credit to households are also included as an additional variable in the VAR model. This model can then be used to produce conditional forecasts for house prices and for scenario analysis. An out-of-sample forecast assessment is performed in order to determine the optimal model for each country based on the root mean squared forecast error. On the basis of this assessment, country models would typically either include house prices, income, interest rates and the housing stock or all except the housing stock, with the latter model close in spirit to a housing affordability model.

15 See, for example, Muellbauer, J., "When is a housing market overheated enough to threaten stability?", *Department of Economics Discussion Paper Series*, No 623, University of Oxford, 2012.

16 See Koop, G., *Bayesian Econometrics*, Wiley, 2003. Although panel estimation could also help to cope with short time series, it may not adequately accommodate the inherent cross-country heterogeneity in the structure of housing markets. Therefore, a Bayesian country-by-country approach is preferred.

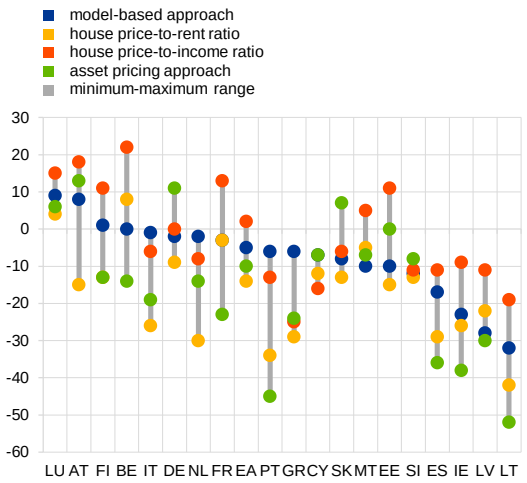
17 The prior means for the model coefficients are -0.015 for interest rates, 1.6 for income and -2.5 for the housing stock. For example, an increase in real disposable income of 1% gives rise to a 1.6% increase in real house prices. See Meen, G., *Modelling spatial housing markets: theory, analysis and policy*, Norwell, MA: Kluwer Academic Publishers, 2001. Also, normal-gamma prior distributions are assumed, because they are a natural conjugate of this framework, having the same functional form as the likelihood. This is an algebraic convenience as analytical results are available.

Chart A

House price valuation metrics are surrounded by a large degree of uncertainty

Residential property price valuations for euro area countries

(Q2 2015, percentages; deviation from long-term averages or model-based equilibria of indicators)



Sources: Eurostat and ECB calculations.
Notes: Last observations refer to Q2 2015, except for Belgium and Finland (Q4 2014). Euro area valuations are estimated directly based on euro area aggregate data. There is no estimate for Estonia based on the asset pricing approach. Countries are ranked according to the results of the model-based approach. The sample size for all measures starts in the mid-1990s or later for all countries. For methodological details on the two statistical indicators, i.e. the house price-to-rent and the house price-to-income ratio, as well as the asset pricing approach, see Box 3 in *Financial Stability Review*, ECB, June 2011.

The new model-based valuation indicator suggests that house prices were slightly below equilibrium levels in the euro area as a whole in the second quarter of 2015. However, it also suggests significant heterogeneity at the country level (see Chart A). According to the model metric, house prices in Luxembourg and Austria exhibit modest overvaluation, whereas those in the Baltic States, Ireland and Spain may be undervalued. Although generally preferable to statistical house price valuation metrics, the model-based measure is surrounded by a large degree of uncertainty. This reflects the challenge of adequately capturing in a similar fashion across countries the complex interaction of housing, rental and mortgage markets. Moreover, measurement issues can distort the picture, while the Bayesian approach may only partially offset any small sample bias.

In view of these limitations, other valuation measures need to be taken into consideration, the precise extent of which may differ given country specificities. In fact, the range across different valuation estimates can be quite wide for some countries (see Chart A), although the new model metric lies in the middle of the range for the euro area and a significant number of euro area countries. Moreover, these country-wide results do not preclude the possibility of strong overvaluations at the regional level within certain euro area countries. In a euro area context, estimates such as those presented offer a guide to prospective (over/under)valuations, but need to be cross-checked with a variety of other information to ensure the right balance between cross-country consistency and national relevance.