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Business Confidence and Forecasting of Housing Prices and Rents in Large German Cities

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Business confidence and forecasting of housing prices and rents in large German cities[¶]

Konstantin A. Kholodilin[*] Boriss Siliverstovs[§]

January 31, 2014

Abstract

In this paper, we evaluate the forecasting ability of 115 indicators to predict the housing prices and rents in 71 German cities. Above all, we are interested in whether the local business confidence indicators can allow substantially improving the forecasts, given the local nature of the real-estate markets. The forecast accuracy of different predictors is tested in a framework of a quasi out-of-sample forecasting. Its results are quite heterogeneous. No single indicator appears to dominate all the others for all cities and market segments. However, there are several predictors that are especially useful, namely the business confidence at the national level, consumer confidence, and price-to-rent ratios. Given the short sample size, the combinations of individual forecast do not improve the forecast accuracy. On average, the forecast improvements attain about 20%, measured by reduction in RMSFE, compared to the naïve model. In separate cases, however, the magnitude of improvement is about 50%.

Keywords: Housing prices; housing rents; forecasting; spatial dependence; German cities; confidence indicators; chambers of commerce and industry.

JEL classification: C21; C23; C53.

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1 Introduction

The role of the housing market in the everyday life of society is difficult to overestimate. Housing rents and prices directly affect the standard of living of every person. In Germany, the housing wealth (6.3 trillions euros at the end of 2012) accounts for more than a half of wealth of private households (about 12.3 trillions euros), see SVR (2013).

It is well known that speculative price bubbles on real-estate markets are likely to trigger financial crises, which can, in turn spill, over to the real economy by producing deep recessions accompanied by huge employment reductions.

Since the end of 2010, after more than a decade of falling real housing prices, strong rent and especially price increases have been observed in Germany. This raised doubts and fears in German society. On the one hand, it is feared that Germany can follow the path of Spain, Ireland, and other bubble countries that ended in a severe economic crisis[1]. On the other hand, the tenants that constitute a majority of German population are afraid of substantial rent increases that will erode their welfare. The tenants' discontent takes a form of massive protests and manifestations endangering political stability in the country. For this reason of the major issues debated in during recent elections and coalition negotiations among the two leading German parties CDU/CSU and SPD is the housing policy. Therefore, it is very important to be able to predict the dynamics of home rents and prices in the nearest future.

There exist very few studies on forecasting housing prices in Germany. an de Meulen et al. (2011) forecast German real estate prices for four different market segments (new and existing houses and apartments) using ARDL and VAR as well as forecast combination approaches. Their study is based on monthly data provided by Immobilienscout24 dating back to 2007. The benchmark is a simple AR model. The authors find that ARDL and VAR forecasts single-handedly can hardly improve upon the accuracy of AR forecasts, but find some substantial improvements when weighing the forecasts with the forecast errors of previous periods, especially for the existing houses segment. The VARs include 26 potential predictors of the real-estate market, namely: consumer confidence indicators of the European Commission, business confidence indicators of the ifo institute, and macroeconomic indicators (consumer prices, stock exchange index, mortgage interest rate as well as new

[1] Deutsche Bundesbank (2013) in its recent study stated that in several cities the house prices might be overvalued by 5-10%.

orders and building permits in construction).

Kholodilin and Mense (2012) use a panel-data model with spatial effects to forecast the monthly growth rates of the prices and rents for flats in 26 largest German cities. A big shortcoming of their approach is that their forecasts are based only on the past growth in the city and in the neighboring city and ignore other indicators that could contain useful informations about the future price and rent dynamics.

In this paper, we intend to fill this gap and to use alternative predictors in forecasting the housing prices and rents. In particular, we examine the forecasting performance of the macroeconomic variables, consumer confidence as well as business confidence indicators. The latter variables, unlike all other, are available not only at the national but also at the regional level. The regional business confidence indicators are produced by the local chambers of commerce and industry (CCI) for the whole economy of a region and for its separate branches, such as industry, construction, services, etc. Despite their potential usefulness, these indicators are neglected in the literature. To the best of our knowledge, the only paper that takes advantage of the CCI indices for forecasting purposes is that of Wenzel (2013), who uses business confidence indicators to forecast the economic growth of German Bundesländer. Such a neglect of these data for economic analysis and research can be, among other things, explained by a formidable task of collecting them from various institutions.

The paper has the following structure. Section 2 describes the data used in the paper. Section 3 introduces forecasting models and compares their out-of-sample forecast accuracy. Finally, section 4 concludes.

2 Data

This study forecasts four real-estate variables: square-meter prices and rents for the existing (secondary market) and newly built (primary market) housing. The data were provided by a Berlin-based research institute *empirica*[2] that computes the quarterly housing price/rent indices starting from the 1st quarter 2004 on. Both prices and rents were calculated using hedonic approach. The prices refer to the condominiums with upscale equipment and 100-150 m^2 total area, whereas the rents refer to the rental apartments with upscale equipment and 60-80 m^2 total area. Our data set includes prices and rents in 71 large German cities from 2004q1 through 2013q3. Thus, the dimensions of our dataset are $N = 71$ and $T = 39$. Figures 1 and 2 show the dynamics of

[2] http://www.empirica-institut.de/empi2007/startseite.html

the housing prices and rents at secondary market, respectively. Due to a high correlation between the primary and secondary market variables and in order to save space the graphs of prices and rents at primary markets are suppressed.

The set of potential predictors comprises both macroeconomic variables (15 variables) and confidence indices (100 variables). The macroeconomic variables include the housing lending rates and volumes at different loan maturities as well as the German stock exchange price and performance indices DAX and CDAX, see Table 1. All of them are available at the national level only and hence are identical for all cities. The macroeconomic time series were downloaded from the webpage of the Deutsche Bundesbank[3].

The sentiment indices are available both at the national level (business confidence indices of Ifo and consumer confidence indices of the European Commission) and at the regional level (business confidence indices for East Germany, Bundesländer or cities). Table 2 lists the national and regional business confidence indices. "Frequency" refers to the number of times the indicators are published a year. It varies from 2 (semiannual) to 12 (monthly). The vast majority of the CCIs produce their indices at triannual frequency. In some cases, the surveying and publication frequency has been increased, say, from semiannual to triannual (2-3), or reduced, say, from quarterly to triannual (4-3). The all-German chamber of commerce and industry (Deutsche Industrie- und Handelskammertag e.V., or shortly DIHK) collects the data from individual regions and constructs aggregated indicators for the whole country and four large regions (North, South, East, and West). In addition, Dresden branch of the Ifo institute conducts it own surveys for East Germany and Saxony. Moreover, the NRW.Bank does the same for the Bundesland Nordrhein-Westphalen. Furthermore, the sentiment indices of several regions from the same Bundesland are often aggregated at the Bundesland level (e.g., Niedersachsen and Rheinland-Pfalz).

Figure 3 depicts the publication schedule of housing prices/rents and business confidence indicators. t corresponds to the 1st quarter of the year, while $t-1$ stands for the last quarter of the previous year. It can be seen that the data on prices/rents are published several weeks later after the end of the reference quarter. The Ifo indices are typically published on 25th-26th of the reference month. Each quarter sees three Ifo publications: $\text{Ifo}_{t,1}$ is the first month of quarter t, $\text{Ifo}_{t,2}$ is the second month of quarter t, and $\text{Ifo}_{t,3}$ is the third month of quarter t. The same publication cycle is valid for the Dresden subsidiary of Ifo and NRW.Bank. Thus, before the reference quarter ends and much earlier than the price/rent data will be published, some information on the

[3] http://www.bundesbank.de/Navigation/DE/Statistiken/statistiken.html?nsc=true

state of the economy, which may be relevant for predicting the price/rent dynamics, is already available. By contrast, the DIHK publishes its indices only three times a year: in the beginning of the year (Jahresbeginn), in the early Summer (Frühsommer), and in the Fall (Herbst). Notice that no data are published in the second quarter. The exception to this rule are the CCI of Northern Germany (Hamburg, Bremen, and Niedersachsen) that publish their business sentiment indices quarterly, and Saarland that produces its indices at monthly frequency.

Given that the dependent variable has quarterly frequency, while predictors have in many cases a lower observational frequency, we interpolated such regressors to the monthly frequency by using a linear spline. The interpolated time series are then sampled at the quarterly frequency, such that March corresponds to the 1st quarter, June to the 2nd quarter, September to the 3rd quarter, and December to the 4th quarter.

In order to get the time series of the business confidence we contacted all the relevant chambers of commerce and industry. Unfortunately, we were unable to obtain the sentiment indicators for all the cities of interest. In some cases, the local CCIs did not respond to our data requests, in other cases, they promised but never sent the data (like the CCI Nürnberg für Mittelfranken). Therefore, we are very grateful to those CCIs that supplied us with their indicators. Sometimes we managed to recover the time series from the archives of the past publications of the business survey indicators. When the business confidence indicators for a city itself are not available, we are using those of a larger region, to which the city belongs. The latter indicator can sometimes be even better than the former one. It is known from the anecdotal evidence that in large cities, such as Berlin and Hamburg, the local construction firms due to their higher costs cannot compete with the firms coming from the neighbor regions. Hence, the local firms may display lower or even declining business confidence, in spite of the booming building activity. Thus, using the indices that are based on the opinions of the local firms can sometimes be misleading.

The business confidence indices used here typically represent the differences between the percentage share of the positive answers (e.g., the economic situation is good or is going to improve) and the that of the negative answers (e.g., the economic situation is bad or is going to deteriorate):

$$B_{it} = 100 \times \frac{A_{it}^{+} - A_{it}^{-}}{A_{it}^{+} + A_{it}^{-} + A_{it}^{0}} \tag{1}$$

where A_{it}^{+} is the number of positive answers given by the firms in the region i in the period t, A_{it}^{-} is the number of negative answers, and A_{it}^{0} is the number of neutral answers. The index varies between -100 (all firms believe that the situation is bad) and 100 (all firms believe that the situation is good).

In this study, we utilize four business sentiment indices for forecasting purposes: current situation, future situation (next 12 months), investment plans, and employment plans. When possible those are reported for the whole economy and for construction industry in particular. Thus, for each region we could have at most 8 different local business confidence indices.

The indices of the current and the future economic situation can be employed to construct a so-called **business climate index**:

$$BCI = \sqrt{(B_{it}^{current} + 100)(B_{it}^{future} + 100)} \tag{2}$$

where $B_{it}^{current}$ is the current economic situation index and B_{it}^{future} is the future economic situation index. By construction, the BCI can take values between 0 indicating extremely bad business climate and 200 pointing to the excellent business climate.

For some cities only the business climate index is available. Therefore, we computed it also for those cities, for which we have its components. The BCI is used in the forecasts along with 8 other business confidence indices.

3 Forecasting

In this section, we describe details of how forecasts of real-estate price indices were made. The four-quarter-ahead forecasts of the quarterly year-on-year growth rates of the real-estate variables were obtained using a direct forecasting approach (Marcellino et al., 2006). The forecasts are based on three different specifications of the forecasting model with gradually increasing information set. Observe that for each city we allow only one auxiliary indicator to enter the forecasting regression at a time. The first specification contains a single indicator as the only explanatory variable:

$$y_t^{(j)} = \mu_i^{(j)} + \beta_i^{(j)} x_{i,t-4}^{(j)} + \epsilon_{it}^{(j)}, \tag{3}$$

where $y_t^{(j)}$ denotes the quarterly year-on-year growth rate of one of the four real-estate price indices in question that is specific to a city (j). The auxiliary indicators are denoted by $x_{i,t}^{(j)}$, where the super-script (j) allows for a possibility that some of the indicators are specific to a particular city. Naturally, for national indicators this super-script can be suppressed.

The second specification of the forecasting model adds own lag of the dependent variable $y_{t-4}^{(j)}$ as an additional explanatory variable:

$$y_t^{(j)} = \mu_i^{(j)} + \alpha_i^{(j)} y_{t-4}^{(j)} + \beta_i^{(j)} x_{i,t-4}^{(j)} + \epsilon_{it}^{(j)}. \tag{4}$$

The third specification of the forecasting model adds a distance-weighted spatial lag of the dependent variable $y_{t-4}^{(W)}$ accounts for spatial correlation between price indices:

$$y_t^{(j)} = \mu_i^{(j)} + \alpha_i^{(j)} y_{t-4}^{(j)} + \beta_i^{(j)} x_{i,t-4}^{(j)} + \gamma_i^{(j)} y_{t-4}^{(W)} + \epsilon_{it}^{(j)}. \tag{5}$$

The spatial lag of the dependent variable $y_t^{(W)}$ was calculated using a spatial weights matrix W such that:

$$y_t^{(W)} = \sum_{j=1}^{N} w_{ij} y_t^{(j)}$$

A typical element of W is defined as:

$$w_{ij} = \frac{I_{ij} d_{ij}^{-2}}{\sum_{k=1}^{N} I_{ik} d_{ik}^{-2}} \tag{6}$$

where I_{ij} is the indicator function such that:

$$I_{ij} = \begin{cases} 1, \text{ if } d_{ij} \leq d_{0.25} \\ \\ 0, \text{ otherwise} \end{cases}$$

where d_{ij} is the distance between city i and city j and $d_{0.25}$ is the first quartile of pairwise distances between all 71 cities.

We elicit the informational content of the auxiliary indicators for the future development of the real-estate price indices by comparing out-of-sample forecast accuracy of the forecasts models in Equations (3)—(5) with that of the benchmark models. Correspondingly, for those indicators that are informative about future price

dynamics we should observe substantial increase in forecast accuracy compared to the forecasting performance of the benchmark models void of this additional information. To this end, we use two benchmark models. The first benchmark model is a so-called random walk model that uses a historical mean of observed growth rate of the real-estate price indices as a forecast. This model is nested within each of the three specifications of the forecasting model as it imposes zero restrictions on the slope coefficients in Equations (3)—(5), i.e., $\alpha_i^{(j)} = \beta_i^{(j)} = \gamma_i^{(j)} = 0$ for all i and j, whenever appropriate. The second benchmark model allows for the lagged dependent variable to enter the regression. This benchmark model is nested within the models in Equations (4) and (5) with the restrictions $\beta_i^{(j)} = 0$ and $\beta_i^{(j)} = \gamma_i^{(j)} = 0$ for all i and j, respectively. Observe that the model specification in Equation (3) does not nest the autoregressive benchmark model.

The (non-)nested structure of the forecasting and benchmark models has implications on the choice of the statistical tests for comparing predictive ability of the competing models. In the case of non-nested models we use the Diebold-Mariano test with the small sample correction proposed in Harvey et al. (1997). When comparing forecasting accuracy of the nested models we use the test of Clark and West (2007). In both cases we pairwise tested the null hypothesis of equal predictive accuracy of an indicator-augmented and benchmark models against an one-sided alternative that the former model produces more accurate forecasts than the latter model.

In addition, we investigated forecasting performance of various forecast combination schemes (Timmermann, 2006). These include a simple average of all available forecasts (Mean), forecast combinations using weights from in-sample model fit measured by the Bayesian Information Criterion (BIC), and forecast combinations using weights derived from the recursively calculated measures of the past forecast performance. In the last group of forecast combinations the weights are derived from inverse of recursively computed discounted mean squared forecast errors (MSFE(δ)), where δ denotes a value of chosen discount factor $\delta = \{1, 0.75, 0.50, 0.25\}$ (Watson and Stock, 2004). We also derived forecast weights by taking average of remaining forecasts after trimming a certain number of models with the worst forecasting performance (TRIM(τ)), where $\tau = \{0.75, 0.50, 0.25, 0.10\}$ denotes a quantile in distribution of model-specific MSFEs used as a threshold for discarding models with the MSFE surpassing this threshold. Last but not least we considered forecast combination based on ranks, i.e. the forecast weights were computed inversely proportional to model ranking based on the past forecasting

performance in terms of MSFE.

An important aspect of computing forecast combinations, derived from the past forecasting performance, is that we calculated combination weights based on the information set available at the forecast origin, that is allowing for an appropriate information lag of the target variable when the out-of-sample forecast accuracy of the models can be evaluated. That is, we simulated information flow to a forecaster under pseudo-real time conditions. As a result of this setup, forecast combination weights are time-varying as these were re-calculated every quarter. For the first few iterations, when the out-of-sample information on forecast accuracy was not available, we used the equal weighting scheme.

We are interested in forecasting dynamics of real-estate price indices four quarters ahead. At the moment of writing, these prices indices end in 2013Q3, implying that we will produce forecasts of the quarterly year-on-year growth rate for 2014Q3. In order to do so, we proceeded in two steps. In the first step, we used a training period in order to select the best city-specific forecasting model for the chosen forecast horizon. In the second step, we utilized the identified top-ranked model for producing forecast for 2014Q3 for each city.

The training period is from 2009Q1 until 2013Q3. For each quarter in this period we computed four-quarter ahead forecasts by appropriately truncating the data set. Due to the fact that after the transformation of the price indices into the year-on-year growth rates the earliest available observation is for 2005Q1, which leaves us with a rather small estimation sample in order to initialize our forecasting procedure, we used an expanding estimation window allowing us to use all available observations for estimation of regression coefficients. For example, the forecast for 2009:1 was produced using estimated coefficients of one of the models in Equations (3), (4) or (5) as well as two benchmark models for the sample from 2006Q1 until 2008Q1.[4] The next forecast for 2009Q2 was produced using estimation results for the 2006Q1 until 2008Q2, etc.

The results of out-of-sample forecasting using the training period are reported in Table 3 and in Figure 6. Given a rather large number of alternative models, which makes their pairwise comparison a formidable task, we summarize the predictive ability of various indicators and their combinations by counting the number of cities, for which a given indicator was selected among the top five models with the largest forecast accuracy. In such a comparison we have to distinguish between national and regional indicators. Naturally, all the national

[4]Four additional observations were lost due to incorporating the fourth-order lag of the dependent variables in the forecasting equation.

indicators are pertinent to each city in our sample, whereas regional indicators are only relevant for cities in this particular region. Observe that, even if we make a correction for the smaller number of cities, for which regional indicators are available, the tentative conclusion is that these regional indicators are of a relatively minor importance compared to national indicators. The regional indicators are selected most often only once or twice in the group of top five best indicators. Among the regional indicators, the indicator Region_BauGL, reflecting business climate in the regional construction industry, scores the best, especially in predicting rent in the primary and secondary housing market segment.

It is interesting to observe that between two benchmark models, the random walk model is selected into the top-five group much more often than the autoregressive model, reflecting a rather weak informational content of distant own lags of the growth rates of the price indices at this forecast horizon. Having said this, we observe that the variables P2R_Neubau and P2R_Bestand, reflecting the ratio of prices to rents in the primary and secondary housing segments, appropriately lagged, have the highest selection frequency than any other indicator for predicting future price dynamics (purchasing prices at primary and secondary markets) four periods ahead. This finding implies that for predicting future price dynamics the current discrepancy between prices and rents is more informative than the current growth rates of purchasing prices alone.

Among other indicators, business confidence in construction BUIL.Q2.F6S (Q2: Main factors currently limiting your building activity, F6S: Other factors) of the European Commission, the index of economic situation in construction of Ifo, Ifo_BauGL and of the Association of German Chambers of Commerce and Industry, DIHK_BauGL, have a relatively high selection frequency. A similar performance is also recorded for selected indicators from the consumer survey of the European Commission. The highest selection frequency is recorded for the following indicators based on the corresponding questions CONS.Q1 (Financial situation over last 12 months), CONS.Q2 (Financial situation over next 12 months), CONS.Q6 (Price trends over next 12 months), CONS.Q10 (Savings at present), and CONS.Q12 (Statement on financial situation of household). It is interesting to observe that survey question directly asking about intentions about purchasing or building a home within the next 12 months (CONS.Q14) and home improvements over the next 12 months (CONS.Q15) are not selected as often as the other above mentioned surveys.

Last but not least, we observe a relatively meager performance of forecast combinations methods. Among

all forecast combinations, the one based on the in-sample Bayesian Information Criterion (BIC) has the highest selection frequency. This conclusion is at odds with the results of an de Meulen et al. (2011), which state the opposite, emphasizing the important role of forecast combinations in considerable enhancement of predictive power.

Figure 6 depicts the conditional frequencies of being the best indicator in terms of RMSFE, given that indicator belongs to one of six groups: business confidence at regional level, business confidence at national level, consumer confidence, macroeconomic variables, price-to-rent ratios, and forecast combinations. Computing conditional frequencies allows accounting for a large variation of the number of indicators belonging to each group: from 2 indicators in the group "price-to-rent ratios" to 63 indicators in the group "business confidence at regional level". There are no variable groups that allow a uniform forecast accuracy improvement at all four market segments. In the housing for sale market, the best indicators are the consumer confidence and price-to-rent indicators. In the housing for rent market, the first place is occupied by the regional business confidence at the level of Bundesländer.

Tables 4—7 contain summary of forecasting performance of the best models selected for each city. We report the root mean squared forecast error (RMSFE), ratio of RMSFE to that of the benchmark models (random walk, RW, and autoregressive model, AR), the p-values of the Clark and West (2007) test of equal predictive ability of the best model and each of the benchmark models. In column *Forecast 2014Q3*, forecast values of the quarterly year-on-year growth rates of the price indices for 2014:3 are reported. In columns *Mean* and *St. dev.*, means and standard deviations of actual values of the rent and price growth rates for the period 2010:1-2013:3 are reported.

The summary of forecast and actual values is provided in Table 8, which draws a quite heterogeneous picture on future price dynamics. On average, we expect that the growth rates will be positive for each price index. The reported mean growth rate varies from about 2% to 4%, subject, however, to substantial uncertainty across individual cities that is reflected in values of the reported standard deviations of the forecasts. The forecasts of prices are more volatile that those of rents with the reported standard deviations of price forecasts are about twice as large as the standard deviations of rent forecasts, 2.6 (rents at primary market) and 2.3 (rents at secondary market) versus 5.3 (prices at primary market) and 5.8 (prices at secondary market). The reported

correlation between forecasts and past actual values is about 0.6. This indicates that it is very likely that those cities, for which we observed high growth rates in prices in the past, will continue the trend and in those cities with stagnating or slowly growing prices the current situation is likely to persist in the near future.

The summary of the forecast accuracy of the best models in the training period is presented in Table 9. The relative forecast accuracy is measured by the ratio of model-specific RMSFE to that of the RW model.[5] The descriptive statistics is calculated using only those models, for which reported RMSFE was numerically smaller than the RMSFE of the benchmark RW model. The corresponding number of observations is reported in the row *Obs.* In parentheses the number of cities, for which the null hypothesis of equal forecast accuracy with the benchmark random-walk model, was rejected at the 10% significance level by the test of Clark and West (2007). The number of cities, for which forecast accuracy of the best forecasting model was better than that of the benchmark RW model, varies from 53 (reported for rent in the primary market) to 62 (reported for price in the secondary market). According to the results of the Clark and West (2007) test, the null hypothesis of equal forecasting accuracy of the best model and the benchmark RW model is rejected in 46 out of 53 and 53 out of 59 cases for rent in the primary and secondary markets, respectively, and in 54 out of 57 and 56 out of 62 cases for price in the primary and secondary markets, respectively. The average decline in RMSFE over the random-walk model is about 20%, which is of about the same magnitude for all real-estate indices. The maximum decrease in RMSFE is about 50%, that is again similar across the real-estate indices. The number of cities for which the benchmark random-walk model produces most accurate forecasts is reported in the row *Obs. (RW)*. The number of cities, for which no other model was able to produce more accurate forecasts than the random-walk model, is the largest for rent in the primary market (18), which is about a quarter of cities in our sample, and the lowest for the price in the secondary market (9).

4 Conclusion

In this paper, we evaluate the forecasting ability of 115 indicators to predict the housing prices and rents in 71 German cities. Above all, we are interested in whether the local business confidence indicators can allow

[5] As reported in Tables 4—7 the forecasting performance of the benchmark autoregressive benchmark model was always inferior to that of the RW model. For example, the AR model was never selected as the best forecasting model. As a result, the RW model provides the benchmark that is more difficult to improve upon. This is the reason why we compare forecasting performance of the indicator-augmented models with the RW model.

substantially improving the forecasts, given the local nature of the real-estate markets.

In order to test the forecast accuracy of different predictors a four-quarters-ahead out-of-sample forecasting exercise is undertaken. Its results are quite heterogeneous. No single indicator appears to dominate all the others. However, there are several predictors that are especially useful, namely the business confidence at the Länder level, price-to-rent ratios, and consumer confidence. On average, the forecast improvements attain about 20%, measured by reduction in RMSFE, compared to the naïve model. In separate cases, however, the magnitude of improvement is about 50%. Given the short sample size, the combinations of individual forecast do not improve the forecast accuracy.

The present analysis utilizes information from national and regional indicators for short-term predicting real-estate price dynamics. In the future research, the scope of regional or city-specific indicators needs to be enlarged by collecting local information on factors influencing demand-supply conditions in the real-estate market such as in-/out-migration, unemployment level, percentage of empty housing, etc.

References

an de Meulen, P., M. Micheli, and T. Schmidt (2011). Forecasting house prices in Germany. Ruhr Economic Papers 0294, Rheinisch-Westfälisches Institut für Wirtschaftsforschung, Ruhr-Universität Bochum, Universität Dortmund, Universität Duisburg-Essen.

Clark, T. E. and K. D. West (2007). Approximately normal tests for equal predictive accuracy in nested models. *Journal of Econometrics 138*(1), 291–311.

Deutsche Bundesbank (2013). Monatsbericht Oktober 2013.

Harvey, D., S. Leybourne, and P. Newbold (1997). Testing the equality of prediction mean squared errors. *International Journal of Forecasting 13*(2), 281–291.

Kholodilin, K. A. and A. Mense (2012). Forecasting the prices and rents for flats in large German cities. Discussion Papers of DIW Berlin 1207, DIW Berlin, German Institute for Economic Research.

Marcellino, M., J. H. Stock, and M. W. Watson (2006). A comparison of direct and iterated multistep AR methods for forecasting macroeconomic time series. *Journal of Econometrics 135*(1-2), 499–526.

SVR (2013). Gegen eine rückwärtsgewandte Wirtschaftspolitik. Jahresgutachten 2013/14. Sachverständigenrat zur Begutachtung der gesamtwirtschaftlichen Entwicklung.

Timmermann, A. (2006). *Forecast Combinations*, Volume 1 of *Handbook of Economic Forecasting*, Chapter 4, pp. 135–196. Elsevier.

Watson, M. W. and J. H. Stock (2004). Combination forecasts of output growth in a seven-country data set. *Journal of Forecasting 23*(6), 405–430.

Wenzel, L. (2013). Forecasting regional growth in Germany: A panel approach using business survey data. HWWI Research Papers 133, Hamburg Institute of International Economics (HWWI).

Appendix

Table 1: List of variables

Code	Description	Source	Frequency
Rent_Neubau	Housing rent at primary market	empirica	4
Rent_Bestand	Housing rent at secondary market	empirica	4
Price_Neubau	Housing price at primary market	empirica	4
Price_Bestand	Housing price at secondary market	empirica	4
P2R_Neubau	Price-to-rent ratio at primary market	own calculation	4
P2R_Bestand	Price-to-rent ratio at secondary market	own calculation	4
BauGL	Current situation in local construction	local CCIs	2 to 12
BauGE	Future situation in local construction	local CCIs	2 to 12
BauGK	Business climate in local construction	local CCIs	2 to 12
BauBeP	Employment plans in local construction	local CCIs	2 to 12
BauInv	Investment plans in local construction	local CCIs	2 to 12
GL	Current situation in whole local economy	local CCIs	2 to 12
GE	Future situation in whole local economy	local CCIs	2 to 12
GK	Business climate in whole local economy	local CCIs	2 to 12
BeP	Employment plans in whole local economy	local CCIs	2 to 12
Inv	Investment plans in whole local economy	local CCIs	2 to 12
Ifo_BauGL	Current situation in German construction	Ifo	12
Ifo_BauGE	Future situation in German construction	Ifo	12
Ifo_BauGK	Business climate in German construction	Ifo	12
Ifo_GL	Current situation in whole German economy	Ifo	12
Ifo_GE	Future situation in whole German economy	Ifo	12
Ifo_GK	Business climate in whole German economy	Ifo	12
DIHK_BauGL	Current situation in German construction	DIHK	3
DIHK_BauGE	Future situation in German construction	DIHK	3
DIHK_BauGK	Business climate in German construction	DIHK	3
DIHK_BauBeP	Employment plans in German construction	DIHK	3
DIHK_BauInv	Investment plans in German construction	DIHK	3
DIHK_GL	Current situation in whole German economy	DIHK	3
DIHK_GE	Future situation in whole German economy	DIHK	3
DIHK_GK	Business climate in whole German economy	DIHK	3
DIHK_BeP	Employment plans in whole German economy	DIHK	3
DIHK_Inv	Investment plans in whole German economy	DIHK	3
Region_BauGL	Current situation in big region's construction	DIHK	3
Region_BauGE	Future situation in big region's construction	DIHK	3
Region_BauGK	Business climate in big region's construction	DIHK	3
Region_BauBeP	Emploment plans in big region's construction	DIHK	3

Table 1: List of variables (continued)

Code	Description	Source	Frequency
Region_BauInv	Investment plans in big region's construction	DIHK	3
Region_GL	Current situation in whole big region's economy	DIHK	3
Region_GE	Future situation in whole big region's economy	DIHK	3
Region_GK	Business climate in whole big region's economy	DIHK	3
Region_BeP	Emplomente plans in whole big region's economy	DIHK	3
Region_Inv	Investment plans in whole big region's economy	DIHK	3
NRW_GL	Current situation in whole North Rhine-Westphalia's economy	NRW.Bank	12
NRW_GE	Future situation in whole North Rhine-Westphalia's economy	NRW.Bank	12
NRW_GK	Business climate in whole North Rhine-Westphalia's economy	NRW.Bank	12
Sachsen_BauGL	Current situation in Saxony's construction	Ifo Dresden	12
Sachsen_BauGE	Future situation in Saxony's construction	Ifo Dresden	12
Sachsen_BauGK	Business climate in Saxony's construction	Ifo Dresden	12
Sachsen_GL	Current situation in whole Saxony's economy	Ifo Dresden	12
Sachsen_GE	Future situation in whole Saxony's economy	Ifo Dresden	12
Sachsen_GK	Business climate in whole Saxony's economy	Ifo Dresden	13
Ostdeutschland_BauGL	Current situation in East German construction	Ifo Dresden	12
Ostdeutschland_BauGE	Future situation in East German construction	Ifo Dresden	12
Ostdeutschland_BauGK	Business climate in East German construction	Ifo Dresden	12
Ostdeutschland_GL	Current situation in whole East German economy	Ifo Dresden	12
Ostdeutschland_GE	Future situation in whole East German economy	Ifo Dresden	12
Ostdeutschland_GK	Business climate in whole East German economy	Ifo Dresden	12
Niedersachsen_BauGL	Current situation in Lower Saxony's construction	CCI Lüneburg-Wolfsburg	4
Niedersachsen_BauGE	Future situation in Lower Saxony's construction	CCI Lüneburg-Wolfsburg	4
Niedersachsen_BauGK	Business climate in Lower Saxony's construction	CCI Lüneburg-Wolfsburg	4
Niedersachsen_BauBeP	Emplomente plans in Lower Saxony's construction	CCI Lüneburg-Wolfsburg	4
Niedersachsen_BauInv	Investment plans in Lower Saxony's construction	CCI Lüneburg-Wolfsburg	4
Niedersachsen_GL	Current situation in whole Lower Saxony's economy	CCI Lüneburg-Wolfsburg	4
Niedersachsen_GE	Future situation in whole Lower Saxony's economy	CCI Lüneburg-Wolfsburg	4
Niedersachsen_GK	Business climate in whole Lower Saxony's economy	CCI Lüneburg-Wolfsburg	4
Niedersachsen_BeP	Emplomente plans in whole Lower Saxony's economy	CCI Lüneburg-Wolfsburg	4
Niedersachsen_Inv	Investment plans in whole Lower Saxony's economy	CCI Lüneburg-Wolfsburg	4
RLP_BauGL	Current situation in Rhineland-Palatinate's construction	CCI Koblenz	3
RLP_BauGE	Future situation in Rhineland-Palatinate's construction	CCI Koblenz	3
RLP_BauGK	Business climate in Rhineland-Palatinate's construction	CCI Koblenz	4
RLP_BauBeP	Emplomente plans in Rhineland-Palatinate's construction	CCI Koblenz	3
RLP_BauInv	Investment plans in Rhineland-Palatinate's construction	CCI Koblenz	3
RLP_GL	Current situation in whole Rhineland-Palatinate's economy	CCI Koblenz	3
RLP_GE	Future situation in whole Rhineland-Palatinate's economy	CCI Koblenz	3

Table 1: List of variables (continued)

Code	Description	Source	Frequency
RLP_GK	Business climate in whole Rhineland-Palatinate's economy	CCI Koblenz	3
RLP_BeP	Emploment plans in whole Rhineland-Palatinate's economy	CCI Koblenz	3
RLP_Inv	Investment plans in whole Rhineland-Palatinate's economy	CCI Koblenz	3
Lend.HH.1year.EIR	Effective interest rates of German banks / New business / Housing loans to households with an initial rate fixation, floating rate or up to 1 year	Deutsche Bundesbank	12
Lend.HH.1year.Vol	New business (volumes) of German banks / Housing loans to households with an initial rate fixation, floating rate or up to 1 year	Deutsche Bundesbank	12
Lend.HH.1.5year.EIR	Effective interest rates of German banks / New business / Housing loans to households with an initial rate fixation of over 1 year and up to 5 years	Deutsche Bundesbank	12
Lend.HH.1.5year.Vol	New business (volumes) of German banks / Housing loans to households with an initial rate fixation of over 1 year and up to 5 years	Deutsche Bundesbank	12
Lend.HH.5.10year.EIR	Effective interest rates of German banks / New business / Housing loans to households with an initial rate fixation of over 5 years and up to 10 years	Deutsche Bundesbank	12
Lend.HH.5.10year.Vol	New business (volumes) of German banks / Housing loans to households with an initial rate fixation of over 5 years and up to 10 years	Deutsche Bundesbank	12
Lend.HH.over10year.EIR	Effective interest rates of German banks / New business / Housing loans to households with an initial rate fixation of over 10 years	Deutsche Bundesbank	12
Lend.HH.over10year.Vol	New business (volumes) of German banks / Housing loans to households with an initial rate fixation of over 10 years	Deutsche Bundesbank	12
Lend.HH.EIR	Effective interest rates of German banks / New business / Housing loans to households	Deutsche Bundesbank	12
Lend.HH.Vol	New business (volumes) of German banks / Housing loans to households	Deutsche Bundesbank	12
Lend.HH.Cost	Effective interest rates of German banks / New business / Housing loans to households (annual percentage rate of charge, total cost of loan)	Deutsche Bundesbank	12
DAX_price	DAX price index / End 1987 = 1000 / End of month	Deutsche Bundesbank	12
DAX_performance	DAX performance index / End 1987 = 1000 / End of month	Deutsche Bundesbank	12
CDAX_price	CDAX price index / End 1987 = 100 / End of month	Deutsche Bundesbank	12
CDAX_performance	CDAX performance index / End 1987 = 100 / End of month	Deutsche Bundesbank	12
BUIL.COF	Construction confidence indicator (Q3 + Q4) / 2	European Commission	12
BUIL.Q1	Building activity development over the past 3 months	European Commission	12
BUIL.Q2.F1S	Factors limiting activity: None	European Commission	12
BUIL.Q2.F2S	Factors limiting activity: Insufficient demand	European Commission	12
BUIL.Q2.F3S	Factors limiting activity: Weather conditions	European Commission	12
BUIL.Q2.F4S	Factors limiting activity: Shortage of labour force	European Commission	12
BUIL.Q2.F5S	Factors limiting activity: Shortage of material and/or equipment	European Commission	12
BUIL.Q2.F6S	Factors limiting activity: Other factors	European Commission	12
BUIL.Q2.F7S	Factors limiting activity: Financial constraints	European Commission	12

Table 1: List of variables (continued)

Code	Description	Source	Frequency
BUIL.Q3	Evolution of your current overall order books	European Commission	12
BUIL.Q4	Employment expectations over the next 3 months	European Commission	12
BUIL.Q5	Prices expectations over the next 3 months	European Commission	12
BUIL.Q6	Operating time ensured by current backlog (in months)	European Commission	12
CONS.COF	Consumer confidence indicator (Q2 + Q4 - Q7 + Q11) / 4	European Commission	12
CONS.Q1	Financial situation over last 12 months	European Commission	12
CONS.Q2	Financial situation over next 12 months	European Commission	12
CONS.Q3	General economic situation over last 12 months	European Commission	12
CONS.Q4	General economic situation over next 12 months	European Commission	12
CONS.Q5	Price trends over last 12 months	European Commission	12
CONS.Q6	Price trends over next 12 months	European Commission	12
CONS.Q7	Unemployment expectations over next 12 months	European Commission	12
CONS.Q8	Major purchases at present	European Commission	12
CONS.Q9	Major purchases over next 12 months	European Commission	12
CONS.Q10	Savings at present	European Commission	12
CONS.Q11	Savings over next 12 months	European Commission	12
CONS.Q12	Statement on financial situation of household	European Commission	12
CONS.Q13	Intention to buy a car within the next 12 months	European Commission	12
CONS.Q14	Purchase or build a home within the next 12 months	European Commission	12
CONS.Q15	Home improvements over the next 12 months	European Commission	12

Table 2: Business confidence indicators

City	Region	Frequency	Source
Augsburg	IHK-Bezirk Bayerisch-Schwaben	3	IHK Schwaben
Berlin	Berlin	3	IHK Berlin
Bielefeld	Ostwestfalen	2	IHK Ostwestfalen zu Bielefeld
Bochum	Mittleres Ruhrgebiet	2	IHK Mittleres Ruhrgebiet
Bonn	Bonn/Rhein-Sieg	3	IHK Bonn/Rhein-Sieg
Bottrop	Nord Westfalen	2	IHK Nord Westfalen
Braunschweig	Braunschweig (only industry)	4	IHK Braunschweig
Bremen	HK Bremen	4	HK Bremen
Bremerhaven	Bremerhaven	2-4	IHK Bremerhaven
Chemnitz	IHK Südwestsachsen	2-3	IHK Chemnitz
Cottbus	Südbrandenburg	3	IHK zu Cottbus
Dortmund	Ruhrgebiet	2	IHK zu Essen
Dresden	Kammerbezirk Dresden	2-3	IHK Dresden
Duisburg	Ruhrgebiet	2	IHK zu Essen
Düsseldorf	Düsseldorf und Mittlerer Niederrhein	2-3	IHK zu Düsseldorf
Erfurt	Region Nord- und Mittelthüringen	3	IHK Erfurt
Erlangen	Mittelfranken	3	IHK Nürnberg für Mittelfranken
Essen	Ruhrgebiet	2	IHK zu Essen
Frankfurt am Main	Frankfurt (all) and IHK-Bezirk Frankfurt (construction)	3	IHK Frankfurt am Main
Fürth	Mittelfranken	3	IHK Nürnberg für Mittelfranken
Gelsenkirchen	IHK Nord Westfalen	2	IHK Nord Westfalen
Halle (Saale)	IHK Bezirk Halle-Dessau	4	IHK Halle-Dessau
Hamburg	Hamburg	4	IHK Hamburg
Hannover	IHK-Bezirk Hannover	4	IHK Hannover
Heilbronn	IHK Bezirk Heilbronn-Franken	4	IHK Heilbronn-Franken
Jena	Region Nord- und Mittelthüringen	3	IHK Erfurt
Karlsruhe	TechnologieRegion Karlsruhe	4-3	IHK Karlsruhe
Kassel	Nordhessen (only business climate)	3	IHK Kassel-Marburg
Kiel	Schleswig-Holstein	4	IHK zu Kiel
Koblenz	Bezirk der IHK Koblenz	4-3	IHK Koblenz
Köln	Stadt Köln	3	IHK Köln
Leipzig	Kammerbezirk Leipzig	2-3	IHK Leipzig
Ludwigshafen	Pfalz	3	IHK für die Pfalz in Ludwigshafen am Rhein
Lübeck	Schleswig-Holstein	4	IHK zu Kiel
Magdeburg	Sachsen-Anhalt	4	IHK Magdeburg
Mainz	Rheinhessen	3	IHK für Rheinhessen
München	Region München	3	IHK München und Oberbayern
Münster	Nord Westfalen	2	IHK Nord Westfalen
Nürnberg	Mittelfranken	3	IHK Nürnberg für Mittelfranken
Oldenburg	Oldenburger Land	4	Oldenburgische IHK
Osnabrück	Osnabrück - Emsland - Grafschaft Bentheim	4	IHK Osnabrück - Emsland - Grafschaft Bentheim
Pforzheim	Nordschwarzwald	2	IHK Nordschwarzwald
Potsdam	Westbrandenburg	2	IHK Potsdam
Regensburg	Region Oberpfalz-Kelheim	3	IHK Regensburg für Oberpfalz/Kelheim
Rostock	IHK-Bezirk Rostock	3	IHK zu Rostock
Saarbrücken	Saarland	12	IHK des Saarlandes
Trier	Region Trier	3	IHK Trier
Ulm	IHK-Region Ulm	4-3	IHK Ulm
Wiesbaden	Rhein-Main-Gebiet	3	IHK Wiesbaden
Wolfsburg	Lüneburg-Wolfsburg (all), Niedersachsen (construction)	4	IHK Lüneburg-Wolfsburg
Wuppertal	IHK-Bezirk Wuppertal-Solingen-Remscheid	2-3	IHK Wuppertal-Solingen-Remscheid
Würzburg	Mainfranken	3	IHK Würzburg-Schweinfurt
Germany and big regions (North, South, West, East)		3	DIHK
Saxony and East Germany		12	Ifo Dresden
North Rhine-Westphalia		12	NRW.Bank
Niedersachsen		4	IHK Lüneburg-Wolfsburg
Rheinland-Pfalz		4-3	IHK Koblenz

Table 3: Selection frequency of indicator models into top five forecasting models for each city

Indicator	RN%	RB%	PB%	PN%	Obs.	Indicator	RN%	RB%	PB%	PN%	Obs.	Indicator	RN%	RB%	PB%	PN%	Obs.
Ifo_GL	2	2	0	2	71	RLP_GK	0	0	0	0	3	D1DAX_performance	1	3	3	0	71
Ifo_GE	1	1	1	1	71	RLP_BauGL	0	0	0	0	3	D4DAX_performance	2	5	5	2	71
Ifo_GK	3	4	1	1	71	RLP_BauGE	1	0	0	0	3	CDAX_price	3	4	4	5	71
Ifo_BauGL	11	10	15	9	71	RLP_BauInv	0	0	0	0	3	D1CDAX_price	1	1	1	1	71
Ifo_BauGE	0	0	0	0	71	RLP_BauBeP	0	0	0	0	3	D4CDAX_price	2	5	4	4	71
Ifo_BauGK	6	9	2	2	71	RLP_BauGK	0	0	0	0	3	CDAX_performance	3	1	2	1	71
DIHK_GL	3	3	0	0	71	BauGL	2	3	1	0	26	D1CDAX_performance	2	3	1	0	71
DIHK_GE	4	6	0	3	71	BauGE	3	0	0	1	26	D4CDAX_performance	2	5	2	3	71
DIHK_Inv	1	2	1	1	71	BauInv	1	1	0	1	17	BUIL.COF	6	3	3	4	71
DIHK_BeP	2	1	1	0	71	BauBeP	0	1	0	0	18	BUIL.Q1	1	3	0	0	71
DIHK_GK	0	0	0	1	71	BauGK	0	0	0	0	27	BUIL.Q2.F1S	3	4	3	1	71
DIHK_BauGL	7	11	7	6	71	GL	0	0	0	1	39	BUIL.Q2.F2S	4	5	4	5	71
DIHK_BauGE	0	2	0	0	71	GE	2	2	1	1	39	BUIL.Q2.F3S	4	4	5	3	71
DIHK_BauInv	2	1	0	0	71	Inv	2	2	0	0	23	BUIL.Q2.F4S	2	2	5	2	71
DIHK_BauBeP	5	5	0	0	71	BeP	0	0	1	0	25	BUIL.Q2.F5S	1	2	0	3	71
DIHK_BauGK	3	4	1	1	71	GK	2	2	0	0	42	BUIL.Q2.F6S	5	4	18	10	71
Region_GL	3	1	0	0	71	Ostdeutschland_GL	0	0	0	0	11	BUIL.Q2.F7S	6	6	0	0	71
Region_GE	4	3	0	5	71	Ostdeutschland_GE	0	0	0	0	11	BUIL.Q3	2	2	5	6	71
Region_Inv	1	5	1	1	71	Ostdeutschland_GK	0	0	0	0	11	BUIL.Q4	2	3	1	1	71
Region_BeP	2	1	1	2	71	Ostdeutschland_BauGL	0	0	1	2	11	BUIL.Q5	2	4	1	1	71
Region_GK	0	2	0	1	71	Ostdeutschland_BauGE	0	0	0	1	11	BUIL.Q6	3	0	5	5	71
Region_BauGL	9	9	6	5	71	Ostdeutschland_BauGK	0	0	0	0	11	CONS.COF	2	2	0	1	71
Region_BauGE	2	2	0	0	71	P2R_Neubau	1	2	19	27	71	CONS.Q1	7	7	12	15	71
Region_BauInv	1	0	1	1	71	P2R_Bestand	9	8	25	31	71	CONS.Q2	12	7	13	15	71
Region_BauBeP	2	4	0	0	71	Lend.HH.1year.EIR	8	5	5	4	71	CONS.Q3	5	6	0	1	71
Region_BauGK	1	2	1	1	71	Lend.HH.1year.Vol	7	2	3	6	71	CONS.Q4	3	4	0	0	71
Sachsen_GL	0	0	0	0	3	D1Lend.HH.1year.Vol	1	0	0	1	71	CONS.Q5	4	2	1	1	71
Sachsen_GE	0	0	0	0	3	D4Lend.HH.1year.Vol	6	5	5	3	71	CONS.Q6	11	8	2	6	71
Sachsen_GK	0	0	0	0	3	Lend.HH.1.5year.EIR	5	4	8	7	71	CONS.Q7	2	2	1	1	71
Sachsen_BauGL	0	0	1	1	3	Lend.HH.1.5year.Vol	7	5	1	0	71	CONS.Q8	6	5	5	4	71
Sachsen_BauGE	0	1	0	0	3	D1Lend.HH.1.5year.Vol	0	0	1	1	71	CONS.Q9	3	3	1	3	71
Sachsen_BauGK	0	0	1	1	3	D4Lend.HH.1.5year.Vol	5	4	4	2	71	CONS.Q10	4	4	12	7	71
Niedersachsen_GL	0	0	0	0	9	Lend.HH.5.10year.EIR	1	2	7	6	71	CONS.Q11	4	3	3	7	71
Niedersachsen_GE	1	0	0	1	9	Lend.HH.5.10year.Vol	0	2	3	2	71	CONS.Q12	7	2	15	10	71
Niedersachsen_Inv	0	0	0	0	9	D1Lend.HH.5.10year.Vol	1	1	1	1	71	CONS.Q13	5	4	2	5	71
Niedersachsen_BeP	0	0	0	0	9	D4Lend.HH.5.10year.Vol	1	1	3	2	71	CONS.Q14	3	1	3	4	71
Niedersachsen_GK	0	0	0	0	9	Lend.HH.over10year.EIR	1	1	3	4	71	CONS.Q15	2	4	1	1	71
Niedersachsen_BauGL	1	1	1	0	9	Lend.HH.over10year.Vol	1	1	1	1	71	Mean	2	3	0	0	71
Niedersachsen_BauGE	0	0	0	0	9	D1Lend.HH.over10year.Vol	1	3	1	2	71	BIC	1	0	3	4	71
Niedersachsen_BauInv	0	0	0	0	9	D4Lend.HH.over10year.Vol	7	12	2	5	71	MSFE(1)	1	1	0	0	71
Niedersachsen_BauBeP	0	1	0	0	9	Lend.HH.EIR	3	5	7	5	71	MSFE(0.75)	1	1	0	0	71
Niedersachsen_BauGK	0	0	0	0	9	Lend.HH.Cost	3	5	7	3	71	MSFE(0.50)	1	1	0	0	71
NRW_GL	1	0	1	1	25	Lend.HH.Vol	1	0	5	4	71	MSFE(0.25)	2	1	0	0	71
NRW_GE	1	0	1	0	25	D1Lend.HH.Vol	1	1	2	2	71	TRIM(75)	1	1	0	0	71
NRW_GK	1	2	0	0	25	D4Lend.HH.Vol	1	0	4	1	71	TRIM(50)	0	0	0	0	71
RLP_GL	0	0	0	0	3	DAX_price	4	3	4	4	71	TRIM(25)	0	0	1	0	71
RLP_GE	1	1	1	1	3	D1DAX_price	1	2	2	2	71	TRIM(10)	0	0	1	0	71
RLP_Inv	0	0	0	0	3	D4DAX_price	3	6	6	4	71	RW	32	24	26	26	71
RLP_BeP	0	0	0	0	3	DAX_performance	3	2	2	1	71	AR	1	1	1	1	71

The entries are selection frequency of each indicator model into top five forecasting models. The column *Obs.* reports the number of cities for which a given indicator is available.

Table 4: Rent in primary market: Best forecasting model

N	City	Predictor	RMSFE	$\frac{RMSFE}{RMSFE_{RW}}$	CW	$\frac{RMSFE}{RMSFE_{AR}}$	CW	**Forecast**	Actual, 2010Q1-2013Q3	
					p-value		*p*-value	**2014Q3**	Mean	St. dev.
1	Aachen	D4DAX_price	3.88	0.95	0.12	0.71	0.02	**0.57**	3.32	2.52
2	Augsburg	CONS.Q1	1.63	0.52	0.00	0.42	0.00	**3.58**	3.79	2.38
3	Berlin	D4Lend.HH.1.5year.Vol	6.55	0.93	0.00	0.80	0.00	**6.41**	8.76	3.94
4	Bielefeld	CDAX_price	2.59	0.73	0.04	0.72	0.05	**0.08**	3.33	1.84
5	Bochum	D4Lend.HH.1.5year.Vol	2.52	0.87	0.04	0.79	0.01	**1.11**	1.70	2.56
6	Bonn	CONS.Q10	4.64	0.94	0.17	0.91	0.09	**12.42**	4.47	4.06
7	Bottrop	CONS.Q6	1.56	0.62	0.03	0.60	0.02	**0.86**	1.85	2.34
8	Braunschweig	P2R_Bestand	2.95	0.91	0.06	0.81	0.00	**-2.53**	3.80	2.56
9	Bremen	D4Lend.HH.1.5year.Vol	4.46	0.87	0.13	0.81	0.07	**2.79**	4.08	3.64
10	Bremerhaven	Lend.HH.1year.Vol	5.50	0.97	0.15	0.72	0.03	**4.09**	6.46	3.88
11	Chemnitz	RW	2.25	1.00	.NaN	0.96	.NaN	**0.77**	1.69	1.91
12	Cottbus	CONS.Q3	2.17	0.74	0.02	0.68	0.00	**1.46**	1.90	2.90
13	Darmstadt	RW	3.28	1.00	.NaN	0.79	.NaN	**1.74**	2.76	2.73
14	Dortmund	RW	2.49	1.00	.NaN	0.86	.NaN	**1.62**	2.52	2.15
15	Dresden	CONS.Q12	3.35	0.78	0.01	0.81	0.01	**4.72**	4.93	0.77
16	Duesseldorf	RW	4.85	1.00	.NaN	0.58	.NaN	**2.55**	3.81	3.50
17	Duisburg	RW	3.01	1.00	.NaN	0.86	.NaN	**0.16**	-0.69	2.92
18	Erfurt	Lend.HH.1year.EIR	5.16	0.90	0.00	0.79	0.00	**8.98**	7.84	2.65
19	Erlangen	CONS.Q9	1.92	0.84	0.02	0.92	0.00	**4.07**	4.65	1.70
20	Essen	D4Lend.HH.over10year.Vol	2.14	0.83	0.00	0.81	0.01	**0.67**	0.65	2.52
21	Frankfurt	BauGL	2.29	0.76	0.04	0.65	0.00	**4.27**	3.92	2.54
22	Freiburg	D1CDAX_price	4.86	0.81	0.02	0.90	0.03	**3.82**	1.50	4.67
23	Fuerth	BUIL.Q2.F2S	2.13	0.86	0.00	0.82	0.00	**3.64**	4.10	1.47
24	Gelsenkirchen	RW	3.27	1.00	.NaN	0.69	.NaN	**-0.07**	-1.27	2.81
25	Hagen	BUIL.Q2.F7S	1.80	0.83	0.00	0.89	0.02	**-0.27**	0.59	2.12
26	Halle	CONS.Q11	1.93	0.84	0.01	0.80	0.00	**2.09**	2.65	1.77
27	Hamburg	RW	3.29	1.00	.NaN	0.56	.NaN	**3.77**	3.98	2.81
28	Hamm	D4Lend.HH.1year.Vol	4.57	0.94	0.07	0.87	0.00	**0.29**	0.83	4.85
29	Hannover	Region_GE	4.71	0.90	0.12	0.75	0.00	**3.72**	3.39	4.93
30	Heidelberg	CONS.Q14	1.46	0.82	0.01	0.96	0.04	**-0.15**	1.38	1.74
31	Heilbronn	CONS.Q1	2.34	0.71	0.00	0.73	0.00	**5.74**	4.62	1.80
32	Herne	CONS.Q6	3.17	0.71	0.02	0.62	0.01	**1.04**	2.92	4.11
33	Ingolstadt	D4Lend.HH.1.5year.Vol	4.21	0.94	0.00	0.89	0.04	**3.38**	4.52	4.49
34	Jena	CONS.Q6	3.51	0.89	0.08	0.82	0.04	**3.40**	4.79	2.39
35	Karlsruhe	CONS.Q1	2.46	0.77	0.03	0.67	0.01	**5.67**	4.06	2.54
36	Kassel	BIC	3.88	0.83	0.03	0.89	0.12	**6.38**	6.12	2.18
37	Kiel	Region_BauBeP	2.88	0.69	0.00	0.55	0.00	**-0.75**	1.20	3.68
38	Koblenz	RW	1.95	1.00	.NaN	0.78	.NaN	**0.58**	1.38	1.45
39	Koeln	Inv	3.93	0.79	0.02	0.64	0.01	**1.42**	3.05	4.27
40	Krefeld	DIHK_BauGL	2.10	0.68	0.02	0.61	0.00	**3.47**	2.74	1.80
41	Leipzig	Ifo_BauGK	1.79	0.84	0.07	0.82	0.08	**0.16**	1.18	2.06
42	Leverkusen	RW	3.11	1.00	.NaN	0.83	.NaN	**1.11**	2.54	1.99
43	Ludwigshafen	BauGE	1.93	0.89	0.07	0.76	0.02	**1.30**	2.04	1.60
44	Luebeck	RW	2.83	1.00	.NaN	0.87	.NaN	**2.50**	3.78	1.62
45	Magdeburg	CONS.Q3	3.66	0.84	0.06	0.76	0.01	**1.12**	1.79	4.21
46	Mainz	P2R_Bestand	2.59	0.72	0.05	0.73	0.04	**9.27**	3.53	3.38
47	Mannheim	Ifo_BauGL	1.46	0.86	0.08	0.80	0.03	**2.84**	1.87	1.16
48	Moenchengladbach	D4Lend.HH.over10year.Vol	2.02	0.92	0.00	0.88	0.00	**1.18**	1.80	1.85
49	Muelheim	RW	3.44	1.00	.NaN	0.92	.NaN	**1.73**	3.39	2.73
50	Muenchen	DIHK_BauGL	1.85	0.64	0.01	0.49	0.00	**4.85**	4.59	2.11
51	Muenster	D4Lend.HH.1year.Vol	3.27	0.98	0.19	0.94	0.09	**2.09**	3.10	3.01
52	Nuernberg	RW	2.36	1.00	.NaN	0.55	.NaN	**2.46**	3.00	1.58
53	Oberhausen	BUIL.Q2.F4S	1.60	0.76	0.03	0.75	0.03	**2.09**	1.13	1.98
54	Offenbach	Ifo_BauGL	1.66	0.80	0.02	0.79	0.03	**3.41**	2.77	1.56
55	Oldenburg	RW	5.55	1.00	.NaN	0.73	.NaN	**3.24**	4.97	4.75
56	Osnabrueck	Lend.HH.1.5year.EIR	2.29	0.72	0.00	0.69	0.00	**6.18**	3.75	2.67
57	Pforzheim	CONS.Q2	1.22	0.65	0.00	0.84	0.00	**3.45**	3.10	0.78
58	Potsdam	RW	3.82	1.00	.NaN	0.87	.NaN	**3.10**	5.11	2.58
59	Regensburg	CONS.Q8	0.94	0.78	0.00	0.66	0.00	**2.27**	2.44	0.61
60	Remscheid	RW	1.88	1.00	.NaN	0.92	.NaN	**1.12**	1.79	1.53
61	Rostock	CONS.Q6	4.66	0.91	0.11	0.76	0.03	**3.20**	4.77	3.87
62	Saarbruecken	CONS.Q10	2.05	0.77	0.02	0.69	0.00	**5.10**	2.94	1.60
63	Salzgitter	RW	5.13	1.00	.NaN	0.73	.NaN	**1.30**	0.93	4.01
64	Solingen	Region_Inv	3.33	0.79	0.02	0.80	0.00	**-0.98**	1.58	4.02
65	Stuttgart	Ifo_BauGL	1.80	0.62	0.04	0.70	0.01	**6.03**	3.84	2.05
66	Trier	DAX_performance	1.88	0.87	0.00	0.93	0.02	**5.64**	3.17	2.15
67	Ulm	Lend.HH.1.5year.Vol	8.73	0.66	0.04	0.73	0.07	**9.18**	2.75	10.63
68	Wiesbaden	RW	4.02	1.00	.NaN	0.84	.NaN	**2.26**	4.20	3.05
69	Wolfsburg	RW	8.21	1.00	.NaN	0.90	.NaN	**0.75**	2.28	7.20
70	Wuerzburg	BUIL.Q1	4.31	0.93	0.09	0.81	0.11	**3.88**	3.06	3.49
71	Wuppertal	CONS.Q11	0.91	0.81	0.00	0.86	0.02	**0.04**	0.76	1.04

Table 5: Rent in secondary market: Best forecasting model

N	City	Predictor	RMSFE	$\frac{RMSFE}{RMSFE_{RW}}$	CW	$\frac{RMSFE}{RMSFE_{AR}}$	CW	**Forecast**	Actual, 2010Q1-2013Q3	
					p-value		p-value	**2014Q3**	Mean	St. dev.
1	Aachen	D4DAX_price	3.39	0.86	0.07	0.67	0.02	**0.29**	2.98	2.49
2	Augsburg	CONS.Q2	1.77	0.57	0.00	0.53	0.00	**1.47**	3.71	2.46
3	Berlin	D4Lend.HH.1.5year.Vol	4.09	0.72	0.02	0.70	0.00	**6.52**	7.31	3.15
4	Bielefeld	CDAX_price	2.07	0.67	0.03	0.63	0.03	**-0.75**	2.34	2.03
5	Bochum	D4Lend.HH.1.5year.Vol	2.08	0.81	0.02	0.75	0.01	**0.93**	1.37	2.33
6	Bonn	CDAX_price	4.34	0.83	0.01	0.84	0.00	**0.57**	3.34	4.98
7	Bottrop	CONS.Q3	1.05	0.52	0.00	0.50	0.00	**0.29**	0.68	1.89
8	Braunschweig	P2R_Bestand	2.93	0.88	0.04	0.79	0.00	**-3.75**	3.71	2.84
9	Bremen	D4Lend.HH.1.5year.Vol	4.91	0.83	0.11	0.78	0.06	**3.06**	4.30	4.23
10	Bremerhaven	CONS.Q8	1.68	0.84	0.01	0.89	0.02	**1.15**	2.01	1.71
11	Chemnitz	BUIL.Q2.F6S	1.36	0.98	0.06	0.95	0.06	**1.14**	1.00	1.13
12	Cottbus	CONS.Q3	1.42	0.60	0.00	0.57	0.00	**0.77**	0.57	2.32
13	Darmstadt	BUIL.Q2.F7S	2.01	0.87	0.00	0.63	0.08	**-1.65**	2.01	2.05
14	Dortmund	D4Lend.HH.1year.Vol	3.35	0.96	0.00	0.91	0.01	**1.36**	1.89	3.45
15	Dresden	CONS.Q12	2.42	0.63	0.01	0.64	0.01	**4.91**	4.13	1.21
16	Duesseldorf	RW	4.79	1.00	.NaN	0.64	.NaN	**1.76**	2.27	4.13
17	Duisburg	CONS.Q2	2.11	0.96	0.18	0.86	0.06	**-0.78**	0.07	2.15
18	Erfurt	Lend.HH.1.5year.EIR	2.33	0.77	0.00	0.66	0.00	**7.72**	4.70	1.22
19	Erlangen	CONS.Q15	2.46	0.82	0.08	0.76	0.01	**3.59**	3.37	2.12
20	Essen	D4Lend.HH.over10year.Vol	2.19	0.89	0.00	0.79	0.01	**0.93**	0.93	2.12
21	Frankfurt	BauGL	2.41	0.76	0.04	0.64	0.01	**4.42**	4.37	2.54
22	Freiburg	D1CDAX_price	5.56	0.83	0.03	0.90	0.03	**4.10**	2.19	5.20
23	Fuerth	Ifo_BauGL	1.80	0.75	0.01	0.75	0.02	**4.55**	4.14	1.40
24	Gelsenkirchen	RW	3.08	1.00	.NaN	0.68	.NaN	**0.09**	-0.95	2.73
25	Hagen	BUIL.Q2.F7S	1.11	0.64	0.00	0.91	0.01	**0.88**	0.91	1.58
26	Halle	Region_BauBeP	1.72	0.93	0.02	0.84	0.01	**1.07**	1.90	1.57
27	Hamburg	RW	3.54	1.00	.NaN	0.54	.NaN	**3.82**	3.62	3.02
28	Hamm	Region_BauGE	1.71	0.67	0.00	0.54	0.04	**0.72**	1.05	1.73
29	Hannover	CONS.Q4	3.23	0.93	0.12	0.85	0.02	**1.82**	3.28	3.15
30	Heidelberg	P2R_Bestand	1.80	0.80	0.00	0.96	0.00	**3.19**	0.93	2.16
31	Heilbronn	Ifo_BauGL	1.89	0.73	0.04	0.69	0.03	**4.41**	3.33	1.84
32	Herne	CONS.Q6	1.85	0.57	0.02	0.59	0.01	**-0.05**	1.42	3.23
33	Ingolstadt	D4Lend.HH.1.5year.Vol	3.98	0.93	0.00	0.90	0.03	**3.09**	4.14	4.36
34	Jena	CONS.Q6	2.91	0.83	0.02	0.84	0.04	**2.97**	4.14	2.28
35	Karlsruhe	BUIL.Q2.F2S	1.72	0.79	0.01	0.72	0.00	**4.64**	3.48	1.72
36	Kassel	P2R_Bestand	2.47	0.70	0.00	0.89	0.02	**3.64**	5.08	1.49
37	Kiel	RW	3.29	1.00	.NaN	0.78	.NaN	**1.48**	3.16	2.31
38	Koblenz	RW	2.03	1.00	.NaN	0.78	.NaN	**0.80**	1.90	1.14
39	Koeln	Inv	4.07	0.72	0.00	0.58	0.01	**1.02**	2.72	5.12
40	Krefeld	RW	2.41	1.00	.NaN	0.80	.NaN	**0.63**	2.07	1.05
41	Leipzig	Ifo_BauGL	1.64	0.81	0.07	0.76	0.04	**1.16**	1.96	1.55
42	Leverkusen	D4DAX_price	2.41	0.89	0.01	0.75	0.02	**-0.62**	1.78	2.03
43	Ludwigshafen	RW	2.24	1.00	.NaN	0.90	.NaN	**0.97**	1.68	1.86
44	Luebeck	D4DAX_price	1.59	0.81	0.00	0.74	0.00	**0.28**	1.59	1.55
45	Magdeburg	CONS.Q1	1.32	0.97	0.08	0.81	0.04	**3.02**	2.47	1.20
46	Mainz	P2R_Bestand	2.55	0.66	0.04	0.68	0.03	**9.66**	3.14	3.78
47	Mannheim	Ifo_BauGL	1.52	0.75	0.06	0.70	0.04	**3.05**	2.12	1.51
48	Moenchengladbach	D4Lend.HH.over10year.Vol	1.94	0.86	0.00	0.89	0.00	**0.90**	1.66	2.00
49	Muelheim	D4CDAX_price	2.13	0.86	0.00	0.76	0.02	**-0.07**	1.20	2.37
50	Muenchen	DIHK_BauBeP	2.37	0.75	0.00	0.57	0.02	**3.76**	4.21	2.64
51	Muenster	CONS.Q6	2.96	0.99	0.24	0.97	0.16	**2.47**	3.68	2.34
52	Nuernberg	RW	2.76	1.00	.NaN	0.55	.NaN	**3.24**	4.35	1.49
53	Oberhausen	BUIL.Q2.F3S	1.25	0.77	0.00	0.77	0.00	**-0.88**	0.51	1.37
54	Offenbach	Ifo_BauGL	1.70	0.89	0.04	0.86	0.03	**3.40**	2.96	1.31
55	Oldenburg	RW	4.12	1.00	.NaN	0.79	.NaN	**3.27**	5.09	3.04
56	Osnabrueck	Lend.HH.1year.EIR	1.92	0.70	0.01	0.72	0.00	**4.43**	3.40	2.30
57	Pforzheim	Ifo_BauGK	1.17	0.77	0.08	0.77	0.06	**2.84**	1.97	1.39
58	Potsdam	RW	2.63	1.00	.NaN	0.88	.NaN	**2.38**	3.44	2.17
59	Regensburg	CONS.Q8	1.27	0.82	0.00	0.68	0.00	**2.95**	3.12	0.63
60	Remscheid	CONS.Q13	1.57	0.84	0.00	0.90	0.00	**-0.07**	1.06	1.78
61	Rostock	CONS.Q6	2.73	0.72	0.03	0.78	0.07	**2.46**	2.06	3.56
62	Saarbruecken	CONS.Q10	1.57	0.67	0.02	0.68	0.01	**4.02**	2.27	1.78
63	Salzgitter	RW	5.55	1.00	.NaN	0.71	.NaN	**1.56**	1.55	4.25
64	Solingen	CONS.Q7	3.14	0.68	0.01	0.74	0.00	**-2.99**	0.98	4.60
65	Stuttgart	Ifo_BauGL	1.68	0.60	0.04	0.65	0.01	**5.91**	3.67	2.07
66	Trier	RLP_GE	2.17	0.81	0.00	0.88	0.05	**3.36**	3.21	2.48
67	Ulm	CONS.Q6	8.64	0.75	0.06	0.85	0.04	**4.65**	1.65	8.24
68	Wiesbaden	CONS.Q5	3.81	0.99	0.14	0.89	0.02	**1.82**	3.74	3.18
69	Wolfsburg	RW	10.17	1.00	.NaN	0.92	.NaN	**2.29**	5.71	8.09
70	Wuerzburg	DAX_performance	5.53	0.99	0.22	0.87	0.12	**5.26**	4.01	4.45
71	Wuppertal	CONS.Q6	1.06	0.85	0.01	0.91	0.10	**0.02**	0.69	1.26

Table 6: Price in primary market: Best forecasting model

N	City	Predictor	RMSFE	$\frac{RMSFE}{RMSFE_{RW}}$	CW	$\frac{RMSFE}{RMSFE_{AR}}$	CW	**Forecast**	Actual, 2010Q1-2013Q3	
					p-value		p-value	**2014Q3**	Mean	St. dev.
1	Aachen	Ifo_BauGL	3.98	0.83	0.06	0.81	0.03	**6.32**	3.29	3.88
2	Augsburg	P2R_Neubau	3.86	0.78	0.03	0.79	0.01	**3.24**	3.80	3.79
3	Berlin	CONS.Q8	2.39	0.45	0.00	0.84	0.02	**9.87**	7.75	1.59
4	Bielefeld	D4DAX_price	2.87	0.99	0.11	0.87	0.07	**0.58**	1.91	1.63
5	Bochum	P2R_Bestand	1.08	0.82	0.01	0.81	0.00	**1.47**	0.17	1.00
6	Bonn	RW	4.16	1.00	.NaN	0.86	.NaN	**2.46**	5.05	1.99
7	Bottrop	D1Lend.HH.over10year.Vol	2.51	0.79	0.03	0.96	0.03	**-1.87**	-0.07	3.29
8	Braunschweig	P2R_Bestand	5.47	0.74	0.01	0.72	0.01	**2.80**	7.22	3.28
9	Bremen	BUIL.Q2.F6S	3.97	0.56	0.03	0.76	0.04	**19.77**	6.83	3.73
10	Bremerhaven	P2R_Bestand	6.18	1.00	0.16	0.76	0.05	**-4.17**	3.39	4.78
11	Chemnitz	P2R_Bestand	3.02	0.74	0.00	0.62	0.00	**1.76**	-0.54	3.51
12	Cottbus	P2R_Neubau	4.92	0.68	0.00	0.69	0.00	**-3.11**	3.11	5.98
13	Darmstadt	RW	7.81	1.00	.NaN	0.76	.NaN	**2.63**	5.61	6.50
14	Dortmund	CONS.Q15	3.77	0.91	0.04	0.80	0.01	**1.39**	0.61	3.84
15	Dresden	P2R_Neubau	2.02	0.44	0.00	0.40	0.00	**3.86**	5.34	2.13
16	Duesseldorf	BUIL.Q2.F6S	3.79	0.70	0.00	0.97	0.25	**12.58**	6.03	3.09
17	Duisburg	CONS.Q9	2.58	0.70	0.00	0.63	0.00	**2.24**	1.56	2.47
18	Erfurt	BauInv	3.09	0.90	0.04	0.91	0.05	**5.81**	2.93	3.28
19	Erlangen	CONS.Q10	7.23	1.00	0.02	0.77	0.01	**17.33**	8.64	3.94
20	Essen	RW	4.62	1.00	.NaN	0.63	.NaN	**0.86**	3.31	3.06
21	Frankfurt	RW	5.20	1.00	.NaN	0.93	.NaN	**3.27**	5.13	4.22
22	Freiburg	RW	10.29	1.00	.NaN	0.65	.NaN	**4.90**	9.58	8.26
23	Fuerth	RW	5.83	1.00	.NaN	0.77	.NaN	**3.73**	6.40	2.73
24	Gelsenkirchen	Lend.HH.1year.EIR	4.24	0.90	0.04	0.84	0.07	**4.51**	3.78	2.50
25	Hagen	BUIL.COF	2.38	0.88	0.04	0.87	0.06	**-3.19**	-0.58	2.58
26	Halle	RW	34.05	1.00	.NaN	0.89	.NaN	**7.67**	19.11	31.55
27	Hamburg	Lend.HH.1year.Vol	5.83	0.89	0.00	0.83	0.04	**5.94**	7.67	2.56
28	Hamm	Lend.HH.5.10year.EIR	3.40	0.69	0.01	0.53	0.00	**11.99**	3.86	3.70
29	Hannover	P2R_Neubau	4.78	0.76	0.02	0.81	0.05	**5.56**	5.64	2.84
30	Heidelberg	RW	3.51	1.00	.NaN	0.80	.NaN	**-0.02**	-0.05	3.71
31	Heilbronn	CONS.Q10	3.96	0.74	0.01	0.80	0.01	**10.52**	5.11	2.66
32	Herne	CONS.Q1	3.32	0.71	0.02	0.63	0.00	**-4.09**	-0.30	4.75
33	Ingolstadt	P2R_Bestand	4.69	0.76	0.04	0.77	0.07	**3.89**	7.92	2.03
34	Jena	D4DAX_price	4.82	0.87	0.06	0.75	0.03	**0.58**	4.55	4.24
35	Karlsruhe	RW	1.91	1.00	.NaN	0.83	.NaN	**1.37**	2.01	1.40
36	Kassel	RW	4.71	1.00	.NaN	0.58	.NaN	**1.09**	3.04	3.96
37	Kiel	RW	7.82	1.00	.NaN	0.75	.NaN	**2.48**	5.75	6.67
38	Koblenz	P2R_Bestand	1.97	0.62	0.00	0.60	0.00	**0.43**	0.56	2.26
39	Koeln	CONS.Q1	3.95	0.77	0.04	0.69	0.04	**6.79**	4.98	3.11
40	Krefeld	DIHK_Inv	2.96	0.71	0.01	0.58	0.02	**-0.35**	0.80	2.99
41	Leipzig	Lend.HH.5.10year.EIR	4.35	0.92	0.02	0.81	0.06	**8.79**	2.72	3.87
42	Leverkusen	P2R_Bestand	3.23	0.92	0.02	0.85	0.00	**2.18**	2.21	2.49
43	Ludwigshafen	DIHK_GE	4.96	0.89	0.01	0.66	0.03	**0.73**	1.99	5.00
44	Luebeck	P2R_Neubau	4.24	0.65	0.01	0.57	0.00	**-0.15**	4.66	5.25
45	Magdeburg	P2R_Bestand	4.95	0.89	0.03	0.89	0.02	**-4.43**	-1.44	4.42
46	Mainz	CONS.Q1	5.76	0.79	0.01	0.65	0.05	**9.18**	5.87	6.20
47	Mannheim	CONS.Q8	3.19	0.64	0.01	0.75	0.05	**6.46**	5.13	1.97
48	Moenchengladbach	CONS.Q2	4.05	0.90	0.02	0.71	0.07	**3.55**	2.84	3.44
49	Muelheim	P2R_Neubau	5.43	0.89	0.00	0.67	0.00	**4.54**	4.48	4.01
50	Muenchen	CONS.Q2	7.74	0.77	0.03	0.74	0.02	**11.63**	10.68	6.20
51	Muenster	CONS.Q1	6.28	0.96	0.21	0.71	0.05	**6.37**	5.18	4.44
52	Nuernberg	Lend.HH.1.5year.EIR	4.20	0.84	0.06	0.77	0.02	**10.43**	4.86	3.48
53	Oberhausen	Lend.HH.5.10year.Vol	1.80	0.88	0.00	0.89	0.01	**-0.69**	-0.17	1.67
54	Offenbach	P2R_Neubau	4.97	0.96	0.07	0.80	0.01	**-0.09**	3.63	4.22
55	Oldenburg	P2R_Neubau	4.04	0.67	0.00	0.63	0.00	**1.68**	6.57	1.75
56	Osnabrueck	Ifo_GE	5.35	0.86	0.00	0.85	0.00	**-2.49**	2.36	5.80
57	Pforzheim	Lend.HH.1year.Vol	3.77	0.74	0.00	0.75	0.02	**5.27**	4.65	2.08
58	Potsdam	RW	5.12	1.00	.NaN	0.74	.NaN	**2.51**	5.48	1.83
59	Regensburg	Region_BauGL	4.89	0.74	0.01	0.58	0.05	**8.77**	5.02	5.18
60	Remscheid	CONS.Q1	5.07	0.87	0.00	0.64	0.04	**6.15**	3.80	4.09
61	Rostock	P2R_Bestand	5.52	0.67	0.00	0.67	0.02	**-12.34**	6.59	6.26
62	Saarbruecken	RW	5.35	1.00	.NaN	0.83	.NaN	**0.90**	3.36	4.33
63	Salzgitter	CDAX_price	3.86	0.67	0.02	0.57	0.01	**-2.14**	2.70	3.21
64	Solingen	RW	3.21	1.00	.NaN	0.89	.NaN	**-0.59**	0.86	1.85
65	Stuttgart	P2R_Bestand	2.65	0.50	0.00	0.75	0.07	**10.61**	5.55	2.68
66	Trier	BUIL.Q2.F6S	3.00	0.92	0.00	0.80	0.02	**6.11**	4.49	2.75
67	Ulm	CONS.Q1	5.69	0.81	0.00	0.65	0.03	**10.03**	6.75	5.13
68	Wiesbaden	CONS.Q1	4.88	0.75	0.02	0.71	0.02	**7.28**	5.79	4.03
69	Wolfsburg	P2R_Neubau	5.96	0.90	0.01	0.83	0.01	**-5.09**	2.50	5.84
70	Wuerzburg	CONS.Q1	3.47	0.66	0.00	0.58	0.01	**6.17**	4.60	3.74
71	Wuppertal	P2R_Neubau	3.76	0.83	0.01	0.77	0.00	**-2.63**	1.52	3.96

Table 7: Price in secondary market: Best forecasting model

N	City	Predictor	RMSFE	$\frac{RMSFE}{RMSFE_{RW}}$	CW	$\frac{RMSFE}{RMSFE_{AR}}$	CW	**Forecast**	Actual, 2010Q1-2013Q3	
					p-value		*p*-value	**2014Q3**	Mean	St. dev.
1	Aachen	P2R_Neubau	3.71	0.73	0.02	0.72	0.00	**2.28**	4.18	3.48
2	Augsburg	P2R_Neubau	4.66	0.67	0.03	0.81	0.01	**8.45**	6.75	4.37
3	Berlin	CONS.Q8	3.07	0.49	0.00	0.89	0.00	**11.61**	9.21	1.82
4	Bielefeld	RW	3.23	1.00	.NaN	0.86	.NaN	**0.44**	2.09	1.49
5	Bochum	P2R_Bestand	1.66	0.87	0.05	0.84	0.05	**1.67**	0.26	1.63
6	Bonn	RW	3.99	1.00	.NaN	0.77	.NaN	**2.22**	4.84	1.71
7	Bottrop	D1Lend.HH.over10year.Vol	2.75	0.78	0.04	0.97	0.04	**-3.23**	-0.28	3.60
8	Braunschweig	CONS.Q12	6.15	0.85	0.12	0.80	0.02	**6.03**	5.24	4.95
9	Bremen	BUIL.Q2.F6S	3.75	0.57	0.04	0.67	0.00	**16.30**	5.63	3.48
10	Bremerhaven	CONS.Q1	3.97	0.54	0.00	0.49	0.00	**1.54**	4.27	3.96
11	Chemnitz	P2R_Bestand	3.00	0.69	0.00	0.64	0.00	**1.37**	-1.47	3.55
12	Cottbus	CONS.Q12	7.61	0.82	0.05	0.65	0.03	**4.85**	5.16	7.56
13	Darmstadt	RW	7.63	1.00	.NaN	0.85	.NaN	**2.85**	6.06	5.89
14	Dortmund	CONS.Q15	2.51	0.86	0.03	0.77	0.01	**0.39**	-0.19	2.57
15	Dresden	P2R_Bestand	2.51	0.57	0.00	0.52	0.00	**3.76**	4.68	2.60
16	Duesseldorf	D4DAX_price	5.36	0.87	0.00	0.91	0.00	**7.73**	6.22	4.09
17	Duisburg	CONS.Q5	2.34	0.72	0.01	0.64	0.00	**0.13**	1.01	1.72
18	Erfurt	D4Lend.HH.1year.Vol	2.45	0.80	0.01	0.85	0.05	**3.34**	2.60	2.64
19	Erlangen	CONS.Q10	6.40	0.92	0.02	0.71	0.02	**15.36**	7.25	5.13
20	Essen	P2R_Bestand	2.70	0.80	0.01	0.78	0.01	**-2.81**	1.61	2.69
21	Frankfurt	P2R_Bestand	5.66	1.00	0.14	0.92	0.14	**1.23**	5.24	5.09
22	Freiburg	CONS.Q10	7.11	0.91	0.03	0.88	0.00	**19.12**	9.64	4.42
23	Fuerth	RW	7.36	1.00	.NaN	0.85	.NaN	**4.17**	7.44	4.96
24	Gelsenkirchen	CONS.Q1	3.10	0.82	0.00	0.72	0.03	**2.33**	0.66	3.18
25	Hagen	P2R_Neubau	2.94	0.85	0.00	0.80	0.00	**-0.14**	0.34	2.81
26	Halle	RW	8.63	1.00	.NaN	0.96	.NaN	**1.89**	6.62	5.43
27	Hamburg	Lend.HH.1year.Vol	7.10	0.91	0.02	0.80	0.05	**7.04**	9.24	2.67
28	Hamm	RW	3.39	1.00	.NaN	0.63	.NaN	**0.22**	1.88	2.21
29	Hannover	RW	10.80	1.00	.NaN	0.40	.NaN	**0.66**	4.37	10.33
30	Heidelberg	P2R_Bestand	3.79	0.89	0.00	0.70	0.01	**-5.97**	2.76	4.15
31	Heilbronn	CONS.Q10	3.25	0.61	0.01	0.70	0.00	**11.43**	4.67	2.75
32	Herne	P2R_Bestand	3.23	0.88	0.02	0.88	0.02	**-3.74**	-0.25	3.65
33	Ingolstadt	CONS.Q10	4.87	0.78	0.02	0.79	0.00	**15.06**	7.39	3.20
34	Jena	D4DAX_price	4.99	0.89	0.05	0.79	0.05	**1.13**	5.34	3.96
35	Karlsruhe	P2R_Neubau	2.84	0.97	0.10	0.77	0.04	**5.22**	3.88	1.72
36	Kassel	P2R_Neubau	3.75	0.65	0.04	0.64	0.02	**7.99**	4.43	4.32
37	Kiel	CONS.Q10	6.49	0.85	0.01	0.83	0.00	**15.83**	6.49	5.89
38	Koblenz	GE	2.61	0.61	0.01	0.56	0.03	**-0.28**	1.09	2.75
39	Koeln	CONS.Q1	4.30	0.80	0.06	0.72	0.02	**6.63**	5.38	3.23
40	Krefeld	DIHK_Inv	3.34	0.69	0.01	0.58	0.01	**-0.91**	0.40	3.50
41	Leipzig	BUIL.Q6	4.22	0.90	0.07	0.81	0.06	**3.44**	1.22	4.42
42	Leverkusen	P2R_Bestand	2.34	0.81	0.01	0.69	0.00	**1.33**	1.11	1.93
43	Ludwigshafen	P2R_Neubau	4.35	0.91	0.20	0.92	0.13	**4.85**	3.40	3.60
44	Luebeck	CONS.Q1	4.38	0.70	0.04	0.60	0.02	**5.97**	3.75	5.09
45	Magdeburg	RW	7.45	1.00	.NaN	0.94	.NaN	**1.61**	3.96	6.60
46	Mainz	CONS.Q1	3.62	0.79	0.02	0.71	0.03	**7.00**	4.84	3.66
47	Mannheim	DIHK_BeP	5.33	0.94	0.17	0.88	0.09	**8.20**	4.27	3.98
48	Moenchengladbach	CONS.Q2	2.73	0.84	0.01	0.70	0.03	**0.97**	1.33	2.31
49	Muelheim	P2R_Bestand	3.43	0.82	0.00	0.66	0.00	**4.82**	1.27	3.34
50	Muenchen	CONS.Q2	8.92	0.80	0.02	0.86	0.00	**13.17**	12.40	6.41
51	Muenster	Lend.HH.Cost	4.53	0.65	0.01	0.62	0.00	**14.52**	6.96	3.62
52	Nuernberg	Lend.HH.1.5year.EIR	4.86	0.76	0.04	0.77	0.00	**13.67**	6.87	4.02
53	Oberhausen	Lend.HH.1year.EIR	1.91	0.80	0.00	0.79	0.00	**1.12**	0.50	1.21
54	Offenbach	P2R_Bestand	3.35	0.81	0.00	0.73	0.00	**2.26**	3.33	2.71
55	Oldenburg	P2R_Bestand	4.63	0.76	0.00	0.66	0.00	**1.75**	6.07	2.17
56	Osnabrueck	CONS.Q10	4.21	0.77	0.07	0.63	0.02	**8.45**	4.17	4.21
57	Pforzheim	D4Lend.HH.1.5year.Vol	3.44	0.78	0.01	0.74	0.00	**6.64**	3.06	2.25
58	Potsdam	RW	6.00	1.00	.NaN	0.73	.NaN	**2.58**	5.42	3.27
59	Regensburg	Region_BauGL	5.44	0.65	0.02	0.55	0.02	**11.90**	8.23	5.13
60	Remscheid	CONS.Q1	2.74	0.63	0.00	0.50	0.02	**2.79**	1.41	3.38
61	Rostock	P2R_Bestand	8.02	0.80	0.00	0.95	0.15	**-13.60**	5.16	9.29
62	Saarbruecken	Ifo_BauGL	5.04	0.97	0.13	0.83	0.07	**5.91**	2.40	4.33
63	Salzgitter	DAX_price	3.90	0.78	0.01	0.71	0.01	**-3.35**	0.23	3.10
64	Solingen	CONS.Q12	1.87	0.73	0.01	0.67	0.00	**0.07**	-0.15	1.53
65	Stuttgart	D4DAX_price	4.36	0.75	0.00	0.78	0.00	**9.47**	5.47	3.52
66	Trier	Lend.HH.5.10year.Vol	4.27	0.92	0.00	0.93	0.02	**-1.21**	4.91	4.57
67	Ulm	CONS.Q1	6.06	0.87	0.00	0.64	0.02	**9.53**	7.64	4.57
68	Wiesbaden	CONS.Q1	5.08	0.76	0.04	0.75	0.01	**7.76**	5.87	4.39
69	Wolfsburg	P2R_Neubau	7.18	0.86	0.02	0.70	0.01	**-1.47**	4.36	6.61
70	Wuerzburg	CONS.Q1	4.59	0.83	0.01	0.76	0.01	**5.61**	6.14	3.08
71	Wuppertal	DIHK_BauGL	2.09	0.74	0.03	0.79	0.01	**-2.28**	-0.53	2.71

Table 8: Quarterly year-on-year growth rates in percent: Actual values (2010Q1-2013Q3) and forecasts for 2014Q3

	Rent				Price			
	primary market		secondary market		primary market		secondary market	
	actual	forecast	actual	forecast	actual	forecast	actual	forecast
Mean	3.0	2.8	2.6	2.1	4.2	3.5	4.0	4.3
St. dev.	1.7	2.6	1.5	2.3	3.1	5.3	2.9	5.8
Minimum	-1.3	-2.5	-1.0	-3.8	-1.4	-12.3	-1.5	-13.6
Maximum	8.8	12.4	7.3	9.7	19.1	19.8	12.4	19.1
Correlation	0.62		0.59		0.51		0.65	

Table 9: Forecast accuracy for the training period (2009Q1-2013Q3)

	Rent		Price	
	primary market	secondary market	primary market	secondary market
Mean	0.81	0.79	0.79	0.79
St. dev.	0.10	0.12	0.13	0.11
Minimum	0.52	0.52	0.44	0.49
Maximum	0.98	0.99	1.00	1.00
Obs.	53(46)	59(53)	57(54)	62(56)
Obs. (RW)	18	12	14	9

The entries in columns are descriptive statistics of the relative forecast accuracy of the best models achieved during the forecast training period from 2009Q1-2013Q3 at the four-quarter forecast horizon. The relative forecast accuracy is measured by the ratio of model-specific RMSFE to that of the random-walk model. The descriptive statistics is calculated using only those models for which reported RMSFE was numerically smaller than the RMSFE of the benchmark random-walk model. The corresponding number of observations is reported in the row *Obs.*. In parentheses the number of cities for which the null hypothesis of equal forecast accuracy with the benchmark random-walk model was rejected at the 10% significance level by the test of Clark and West (2007). The number of cities for which the benchmark random-walk model produces most accurate forecasts is reported in the row *Obs. (RW)*.

Figure 1: Secondary market price in large German cities (euros per m^2), 2004Q1-2013Q3

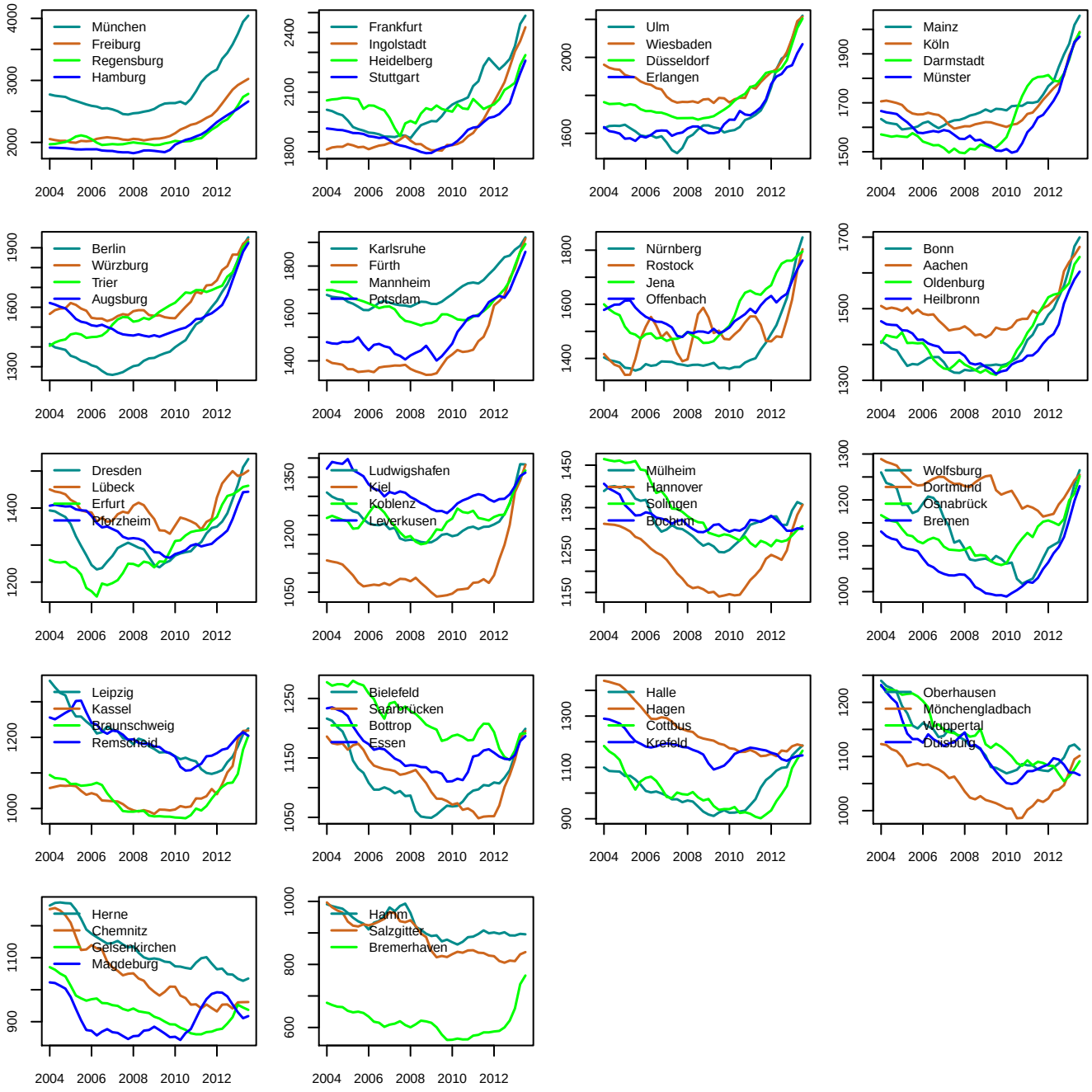

Figure 2: Secondary market rent for existing housing in large German cities (euros per m^2), 2004Q1-2013Q3

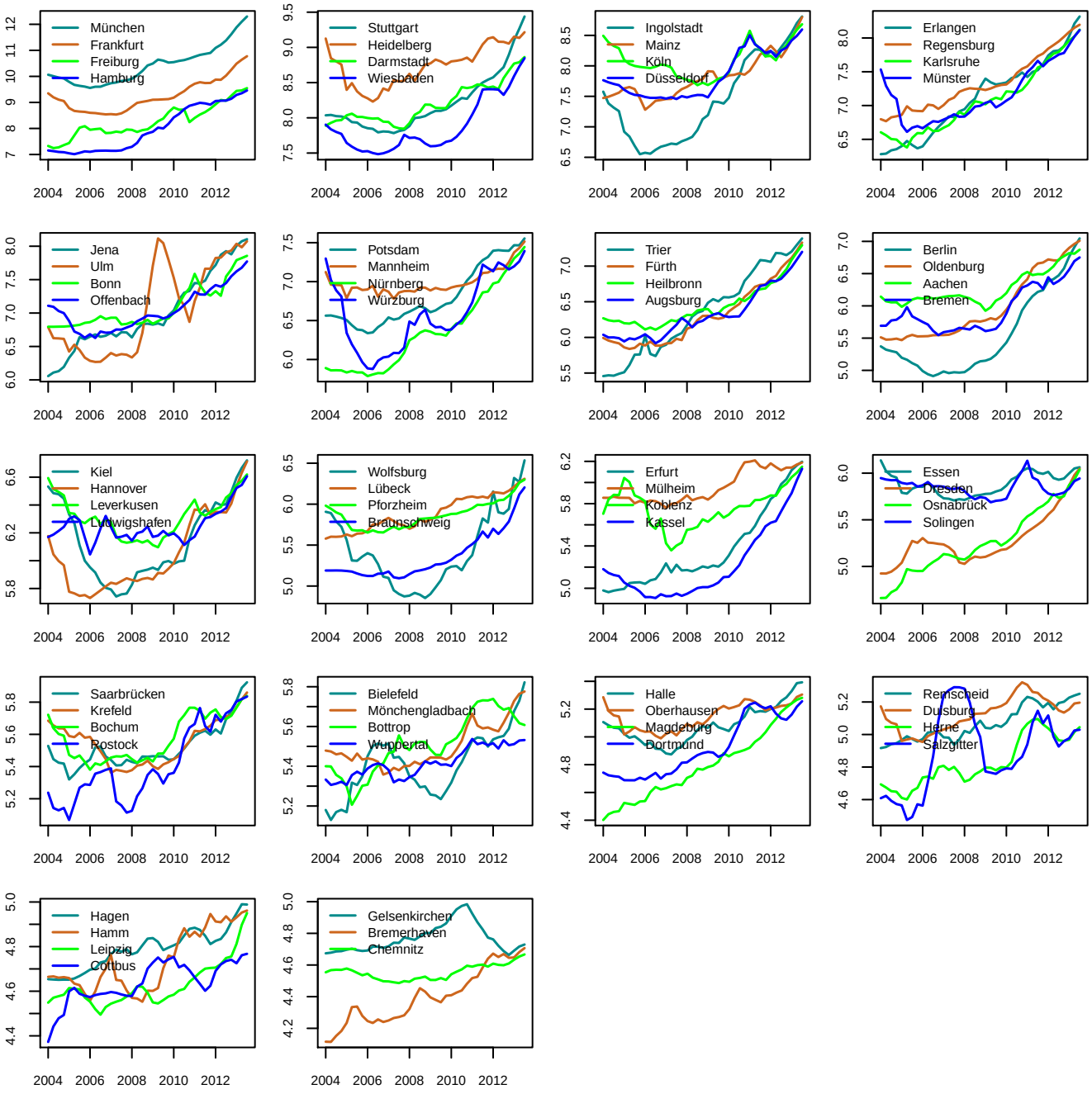

Figure 3: Publication schedule of housing prices/rents, DIHK and Ifo business confidence indices

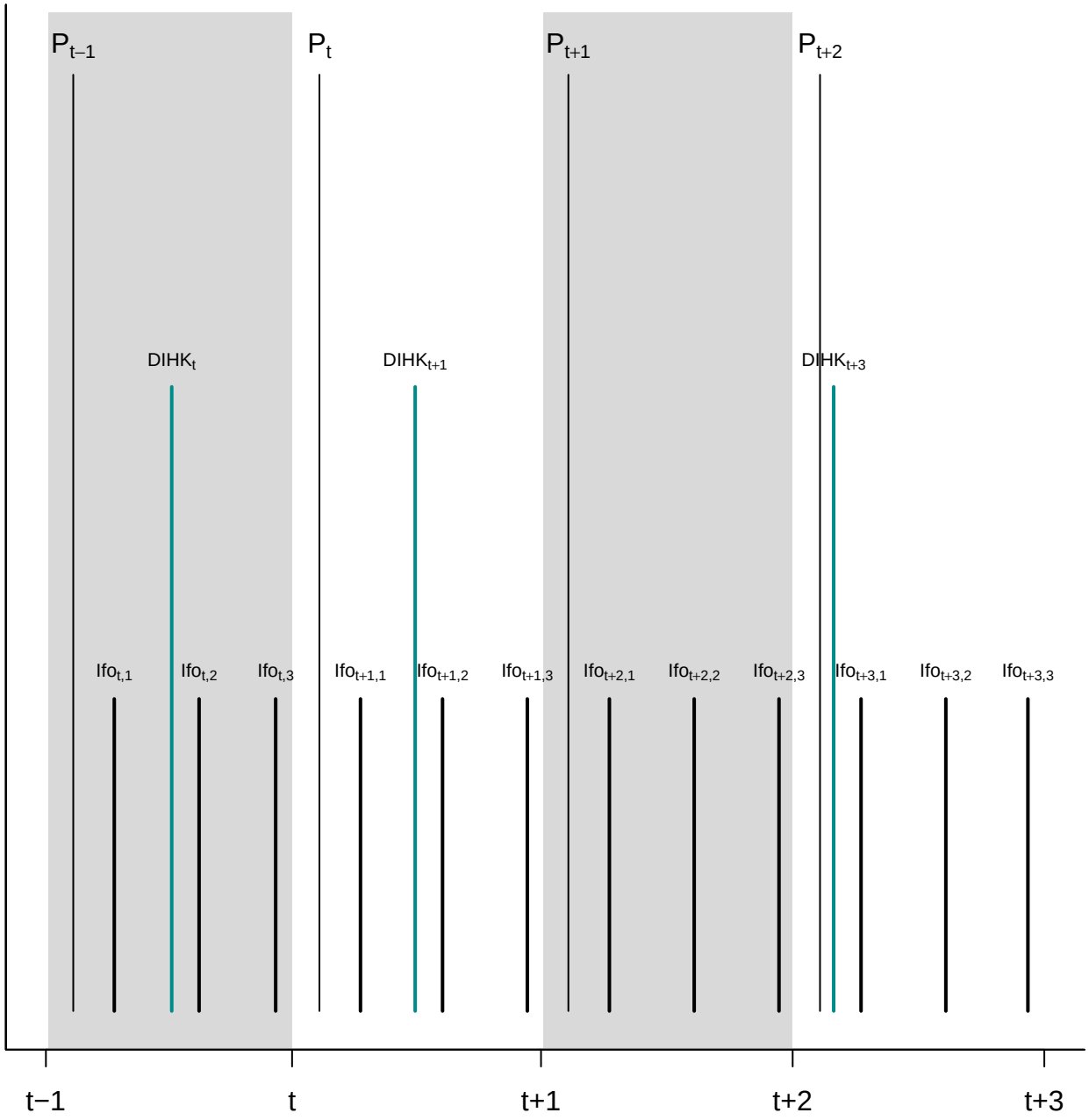

Figure 4: National and regional business climate indices for construction: Ifo vs. DIHK, 2001M1-2013M9

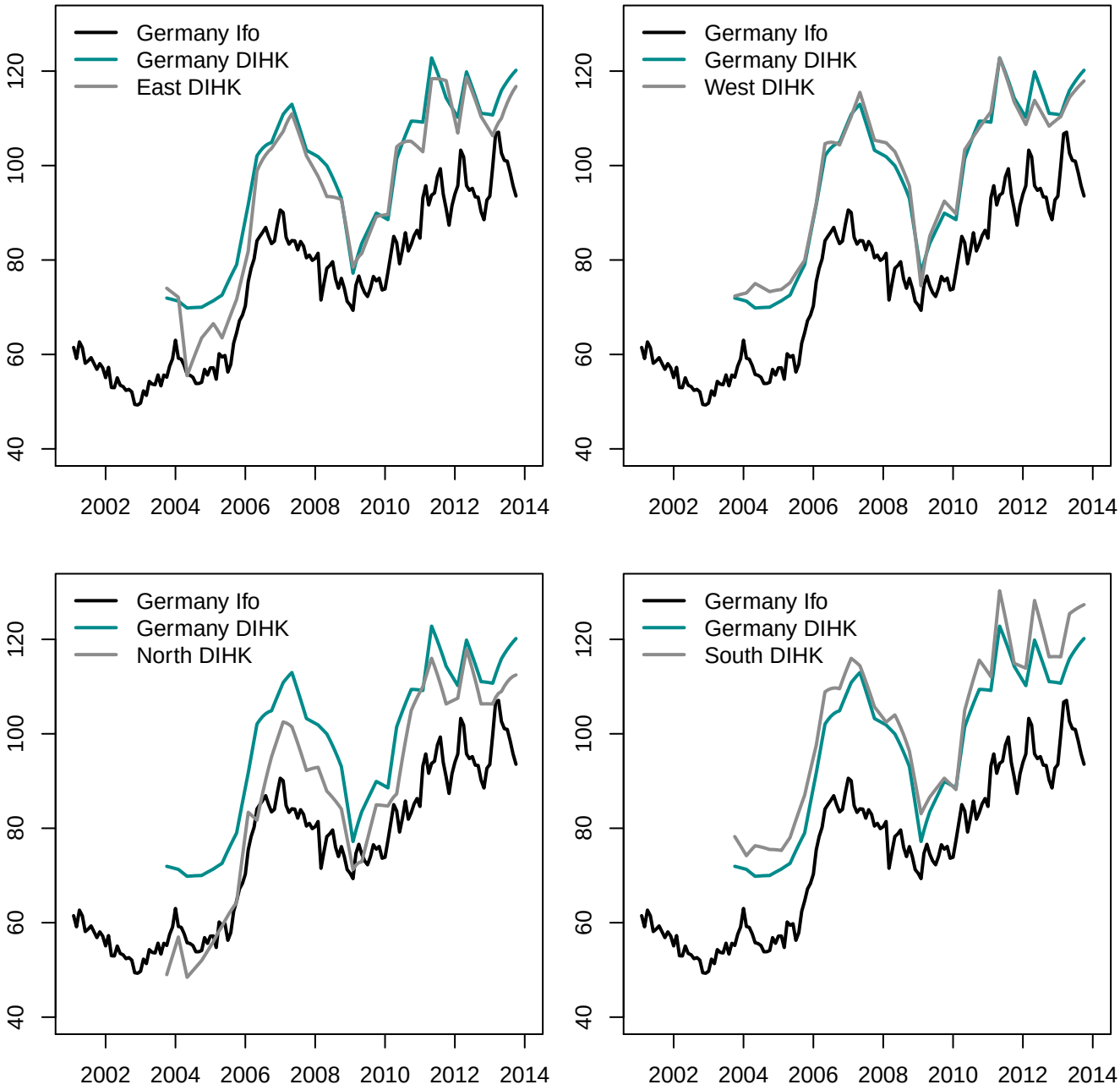

Figure 5: Business climate indices of individual cities for construction, 2001Q1-2013Q3

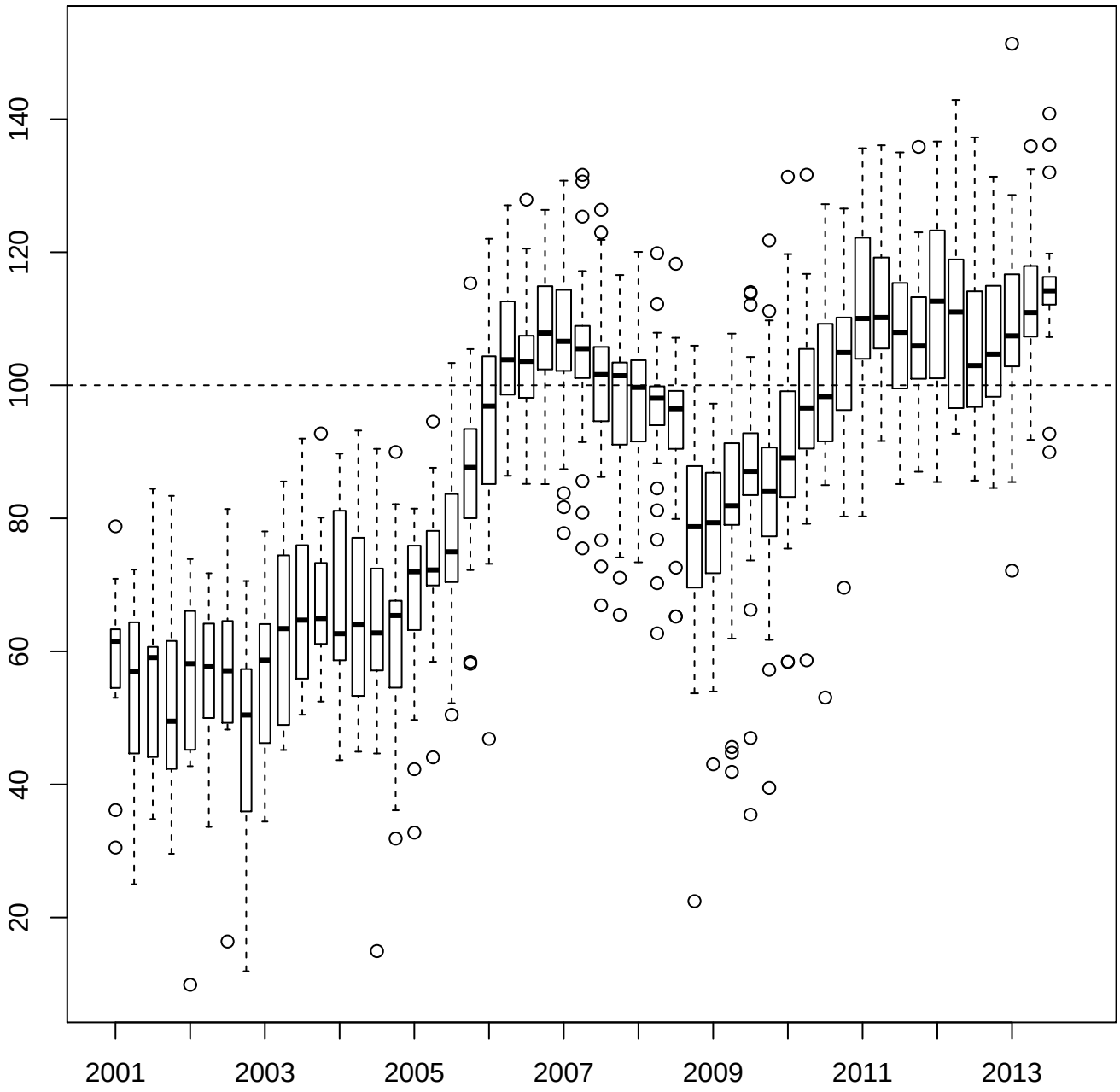

Figure 6: Distribution of the best-forecast indicators, %