Forecast of Municipal Housing Demand: An Introduction to the IOER-Online Program "Kommunale Wohnungsnachfrageprognose" and its Adoption Potential

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ABSTRACT:

Housing markets develop very heterogeneously, with some trends even running in opposite directions. It is vital to consider the local trend of each municipality in order to capture dynamic developments in the housing market. This paper presents a method of forecasting demand for municipal housing. It has discussed about the adoption potential of such method to the regional or even international level. Since 2002, the IOER has been operating a web-based program to forecast municipal housing demand called "Kommunale Wohnungsnachfrageprognose". This is an open access forecasting platform that supports individual module-based forecasts of population, household patterns, housing offer and housing demand. Potential users can customize the forecasting of housing demand according to three different types of households and up to seven categories of housing market. Individual forecasts can be simulated for multiple scenarios. After choosing a base year, the user is given estimates for five-year periods in each forecasting module, up to a final forecasting horizon of 15 years. Generally, the individual forecasting method can be implemented using local municipal statistics as input data. For the last 17 years, this open access online service has helped many municipalities in eastern Germany to draw up an integrated urban development concept in the context of the federal programme "Stadtumbau Ost". An extension of the online service includes specific regional parameters to forecast housing demand for municipalities in western Germany. The service provides support to perform simplified forecasting of trends in the housing market for Polish and Czech municipalities and for small municipalities at the national border. The method can also be transferred to other countries or regions. To realize this, an initial study must be performed to determine specific basic parameters such as birth rate, mortality rate, household trends or housing patterns for different spatial scales and dimensions. These then can easily be implemented within scope of the online program.

KEY WORDS

Housing market model; Forecasting platform; Forecast of housing demand, Adoption potential;

INTRODUCTION

The consequences of demographic change are now hard to ignore in Germany as well as in other European countries. At the level of municipalities, the impact of these trends on housing markets and urban development is rather diverse (Lindh and Malmberg, 2008). Currently, many municipalities are benefiting demographically from local and long-distance migration, whereby newcomers are helping to stabilize the population structure. However, an increased residential population needs additional land for housing, which can negatively impact land conservation. On the other hand, some municipalities face the challenge of a decreasing population, for which they are drawing up adaptation strategies and development concepts. Clearly, one of the most important tasks for local authorities is the careful monitoring of demographic change so that the potential consequences can be identified at an early stage by means of scenario-based analysis. Such analysis can then serve as a basis for the development of robust coping strategies. Furthermore, complex problems can arise due to unexpectedly high demand for housing or a higher than anticipated level of vacant housing stock if there is no sound assessment and forecasting of possible future developments.

The article presents a forecasting service developed by the Leibniz Institute of Ecological Urban and Regional Development (IOER), which has been running for the past 17 years. The online program can forecast municipal population, housing demand and the demand for land for residential development. It provides a useful open access platform to local authorities, allowing them to input their own municipal administrative and statistical dataset to create scenarios for sustainable urban development in a straightforward and simple way. The article also discusses the potential for this method to be adopted by other countries or regions.

BASIC PARAMETERS OF THE SCENARIO MODELS

Hitherto municipalities have preferred to use relatively simple forecasts of housing demand as a basis for setting targets on new housing units as well as to project demand for residential building land. However, these basic estimates are insufficiently precise to meet the challenges of growing and shrinking communities. It is vital that base data takes account of the changing context at the local municipal level as well as possible alternative options for action so that practical, goal-oriented and model-supported scenarios can be developed.

For many municipalities, it is no longer sufficient to report a forecast based on only one development alternative. Instead, local authorities wish to be given a range of developments options under various framework conditions as well as information on steps that can be taken to encourage/respond to certain desirable situations. All scenarios must be transparent and reproducible. Further, the assumptions behind each scenario must be based on solid base data. Municipal development scenarios are ultimately based on forecasts of population growth. Such forecasts, however, are particularly vulnerable to disparities between the assumed migration factors within the demographic scenario and the actual migration dynamics. Here, significant consideration should be given to population structures analysed by age and gender. In Germany, the population registers maintained by local statistical offices provide the base data for analyses and forecasts of small-scale demographic structures. These registers contain data on intra-municipal migration, spatial/building survey data as well construction related information. In this respect, the population registers – along with other administrative data –

provide most of the empirical data that can be utilized for the evidence-based forecasting of housing demand.

The IOER forecasting of municipal housing development encompass three basic components, namely demography, trends in housing construction as well as land for housing. Thereafter, scenarios can be compiled on the regional and sectoral housing submarkets, specifically to investigate: (i) demographic trends, focused on population and the development of private households; (ii) trends in the housing market, focused on changes in housing demand, the availability of housing units, construction of new residential units and the level of vacant housing; (iii) the demand for residential space as well as subcomponents relevant to demand for residential space and the availability of land for residential building construction. In addition, analyses in the form of an *ex post* temporal series are required to identify basic regional and municipal trends, which then form a basis for generating module-specific scenario assumptions.

The basic modules are available to users in the form of an interactive Internet platform (free open access: http://www2.ioer.de/wpg/). The user can easily define their own scenarios on population and the numbers of various types of households, on housing demand and trends in housing supply [fig.1]. Since 2002, the online program has been used by municipal authorities as well as planning offices on behalf of municipalities (Iwanow et al., 2011). The potential user must input their own municipal dataset. Most scenario assumptions are also selected by the user, who is free to create any number of individual scenarios and to realize municipal concepts for the development of the population structure. A few general scenario assumptions are specified by the program in addition to the user-generated scenario assumptions.

[fig. 1] Screenshot of the IOER Online Platform: Forecast of Municipal Housing Demand ("Kommunale Wohnungsnachfrageprognose"); Source: http://www.ioer.de/wohnungsprognose

DEMOGRAPHIC FEATURES

The demographic component of the program consists of two modules: *population development* and *household development*. The methodological structure of the demographic scenarios basically follows the classical cohort-component approach (Bähr, 1997) employing dynamic scenario assumptions based on age classes in the areas of fertility, mortality and migration (these can be varied according to the needs of the user). The quantitative basis of the demographic scenarios is the population structure of inhabitants living in a municipal area and requiring residential space in the base year; this data is later updated to reflect births and deaths as well as migration inflows and outflows. To enable forecasting for small municipalities (larger than 1,000 inhabitants), population data is not subdivided by calendar age (i.e. 100 categories) but rather into 16 age groups of five years each. The age groups are summarized from the age of 75. As additional information, the user can input the number of women between the ages of 15 and 45 as well as the fertility rate in order to determine the number of expected births. Of particular importance are the selected age-group specific assumptions on population change due to migration.

Data on net migration (i.e. difference between in-flow and out-flow) for the base year, differentiated according to the 16 age groups, is needed for the detailed forecasting of population development. In order to set basic assumptions about future migration, the analysis has to be conducted on municipal trends regarding migration as well as assessments of future development. Assumptions must be made on the average annual net migration for each forecast period. These estimates can be made on the basis of the expected short and long-distance migration due to related push/pull factors such as jobs, family considerations at different life stages as well as the number of possible future asylum-seekers. After being supplied with all inputs, the *population development* module provides estimates of the population of each age class for the three forecast years (base year + 5, + 10 and + 15 years). To illustrate the individual scenario results, the interactive user interface provides a graphical presentation of future population trends. Such graphs are also offered in the other components.

The scenarios on population development also serve as inputs for corresponding scenarios of household development. Here a unique approach was developed while preparing for the *Stadtumbau Ost* competition, one which requires little municipal data but is still able to identify important trends in household structure. The projected household structure refers to three types, namely "younger 1-2 person households", "households with 3 or more persons" and "older 1-2 person households". These are the basic inputs for the *housing demand* module. The three household types follow a simple lifecycle concept that captures important differences in the housing needs of different household types. To create these types, the predicted population in private households is grouped into three age categories: (i) children up to 15 years, (ii) adults between 15 and 55 years and, (iii) adults aged 55 and over. This categorization enables the forecasting of household development in terms of younger and older households.

Average household size is the most important scenario assumption within the *household development* module. On the one hand this reflects age structure, as the formation of new households corresponds to specific age groups. On the other hand, the formation of households is affected by the personal values and lifestyles of inhabitants as well as general trends such as the increasing number of single households, patchwork families or the two-person households of senior citizens. Furthermore, the behaviour of household formation and the pattern of households may be dependent on local factors, which have to be carefully considered when drawing up scenarios.

TRENDS IN HOUSING CONSTRUCTION

The component of the program dealing with trends in housing construction aims to analyse the current and future state of the housing market. Consequently, the scenarios consider the expected demand for new housing and the developments in vacancy rates. The municipal housing market does not operate as a single entity but here is divided into various thematic and regional submarkets. Housing demand and supply do not always correspond in individual submarkets, so that diverging trends may be evident. A first important step is to classify the city according to its specific development structural types to allow more detailed analysis of demand development at a later stage. Therefore, building type should be linked to construction age, while for large cities a link should also be made to residential location. Building structure can be selected in the online program from between two and seven types. As urban structures can differ considerably from one another, the types of building structure are not predetermined; instead, the program allows the user to determine the number and description of the structural types. At least two building structural types must be selected. The simplest and most widely accepted typology is to distinguish between single- and two-family houses, on the one hand, and multi-family houses, on the other. Further differentiation of these types of buildings is quite possible and useful, as trends in demand can also vary within these two types, for example regarding building age, the size of the residential area or the residential location. In general, only a few clearly defined residential submarkets should be selected because scenario assumptions must be generated in the module *housing demand* regarding the future development of the housing requirements for all three household types with respect to each submarket. The program component dealing with trends in housing construction is divided into the five modules: (a) housing demand, (b) housing supply, (c) housing market, (d) demand potential for new housing, and (e) potential housing vacancy. Those sections of the population who create "demand" will, of course, differ in term of their personal values, their current household and familial situation as well as the age of the household members and their associated housing preferences. These preferences focus on the legal form of residency (ownership or tenancy) as well as on certain types of buildings and dwellings.

Housing demand is understood in a broad sense, i.e. inhabited dwellings are considered "in demand" (i.e. their residents' demand for housing) until the residents move out or a household is dissolved. The housing needs of households have been changing more radically in recent years than those of senior citizens. Changes in housing requirements are recorded in the scenario assumptions of the module *housing demand* by means of probabilities of relocation and continued residency. Since the housing requirements always refer to specific types of dwellings and buildings, they are directly linked to the selected residential submarkets. Within the module *housing supply*, inhabited dwellings are considered as contributing to the supply of housing stock. The situation is different in regard to holiday flats and housing for recreational purposes. These are not used permanently by households and therefore do not belong to the housing supply. Completed constructions, housing demolitions and other changes in the housing stock can lead to changes in the number of dwellings offered during the forecast period. The extent of the changes is regulated in the scenario assumptions. The assumptions on future building completions are generated within the module *demand potential for new housing* under the general assumption that these dwellings have been newly built and are already available to the market.

Estimates of the potential demand for new housing and of the potential vacancy rate in each scenario are based on a simple housing market simulation that compares the predicted housing demand with the development in the housing supply, enabling a description of the current state of the housing market. In the module *housing market development*, the relation between housing demand and supply is broken down for the selected submarkets to reveal market-specific imbalances between supply and demand. Again, specific scenario assumptions are required. For example, assumptions must be made regarding requisite submarket fluctuation reserves for households that are relocating. It may also be the case that not all vacant dwellings are fit for market; this proportion should also be taken into account in the scenario assumptions. Due to the dynamic and temporally staggered linking of predicted demand potential for new housing and the completion of buildings, it is possible to identify a forecasted demand for new housing that some years later will have disappeared. Due to the different time periods of forecasting, it is possible to determine the extent to which amount the predicted demand potential for new residential construction is temporary and to which extent it is permanent. For example, in the event of negative growth in the number of households, it is only necessary to build dwellings that are actually needed. The situation is different in regard to the predicted construction of housing in different residential submarkets. Even if there is a sufficient supply of housing to meet general demand, there may still be demand for new construction in a specific residential submarket. This is still true if increased construction leads to a higher vacancy rate in another residential submarket. When granting building permits, the municipality can then decide for itself whether or not it actually wants to support the changed trend in housing demand through new construction. The scenarios in the module *potential housing vacancies* are based on the results of the housing market simulation and the municipal decisions regarding the planned new housing construction. Dilapidated housing stock should be excluded until renovation measures enable buildings to return to the housing stock or to one of the submarkets. In municipalities with continuous population growth, demand and supply structures are often well balanced, allowing the vacancy rate to fall. In this way, the scenarios provide results in terms of the required demand after the construction of new housing. The situation is often quite different in formerly or currently shrinking municipalities. Here the supply of vacant housing can increase at the same time as new residential construction is forecasted, since consumers may wish to acquire housing of another types than the existing stock.

FEATURES RELATED TO LAND FOR HOUSING DEVELOPMENT

In the component *land for housing development*, estimates of land requirements for new housing can be determined for each scenario. This component consists of four modules: “demand potential for land”, “potential supply of land”, “residential land market” and “demand for residential land”. Although this component is not yet part of the online program, there are expansion possibilities for its inclusion. Based on the demand potential for new residential construction (number of dwellings) predicted in the component *trends in housing construction*, the generation of scenario assumptions for the municipal density parameters determines the demand potential for residential land (Gutting and Iwanow, 2014). Independent of this, it is possible to estimate the theoretical supply of residential construction land based on GIS analyses. This is achieved by considering the land and infill development potentials identified in land-use plans, and in particular the potentials for building gaps and post-compaction, which are recorded and whose area is measured. Likewise, it is necessary to compare the forecasted demand potential for residential land with existing supply. Additional attention must also be paid to brownfields that can be used for new housing construction and which may be generated during the forecasting period.

Regarding demand for residential land for construction, the program can determine whether the existing supply of land is sufficient to cover demand or whether further actions should be taken by the municipality. Here there are three potential situations: Firstly, the supply of residential land may exceed demand, so that the stock of existing residential areas will be quantitatively sufficient for the future. The municipality itself should check the qualitative suitability of the partially automated estimate of the potential stock of residential land. It should be noted that not all designated land for residential construction land is actually available to the market. Secondly, the projected demand for residential land may be significantly higher than the estimated supply. Here, the municipality must decide whether to newly allocate land for residential construction or whether to cooperate with other municipalities. Thirdly, there is the ideal case that supply and demand are roughly matching, so that there is no need for municipal action as long as the requisite land qualities are compatible.

REQUIRED INPUT DATA

Two types of data are needed to generate scenarios on population trends and housing market developments at the municipal level. These are, firstly, basic statistical information on population parameters (input for demographic features) as well as on housing stock and building structure (input for the component *trends in housing construction*). Secondly, additional datasets are required on the use of municipal land which identify those areas currently used or suitable for housing (input for component: *land for housing development*). The future behaviour of residents is rarely captured by municipal statistics and must be selected according to user assumptions. In addition, new housing trends can be influenced by the changing behaviour of residents. Such information is becoming more important for both qualitative and quantitative scenario modelling, because the effects of changing basic conditions only become visible and effective in the future. Due to the lack of available official or municipal statistics to support scenario assumptions, creativity is required in the acquisition of data.

In Germany, municipal datasets are primarily drawn from municipal registers or other administrative data for the base year. The local authorities collect basic statistics on urban or municipal development and possess additional local expertise. Unfortunately, information on the number and structure of households is not recorded in the municipal register. Only larger municipalities have dedicated software to generate household data from the municipal registry. Although such data is not available to most local authorities, the number of households can be estimated using IOER methodology, which at the same time has the advantage of being compatible with the scenarios for household development.

A description of the housing and building structure can be provided in most municipalities by considering the municipal housing stock and demolition statistics in Germany. Here it should be noted that some building space is uninhabitable and in need of renovation. This information should be given separately. The number of dwellings used for holiday and recreational purposes should also be entered separately as such dwellings are unavailable to those seeking to rent a residential unit for a longer period. While the number of residential units in a building is usually known, more detailed information should be drawn from the building register, especially structural information such as year of construction or type of use (residential property or rented apartment), etc.

CONCLUSIONS

The accurate forecasting of housing supply and demand is an indispensable instrument for sustainable urban development by providing a robust basis for planning (Ng et al., 2008). An analysis of the use of the IOER web-based service "Forecast of Municipal Housing Demand" showed that primarily municipalities in small and medium-sized cities as well as planning offices adopted the methodology and achieved useful results (Iwanow, et al., 2011: 63). Even though fundamentally different trends in population and the housing market can be identified between cities and rural areas, in the end each municipality has a unique set of characteristics with regard to its population structure, migration dynamics and housing market development. In this respect, every municipality should be encouraged to conduct their own precise analysis and regular monitoring of specific municipal developments by combining local knowledge with other datasets. The municipal scenarios derived from forecasts for *Landkreise* (associations of municipalities) may well run contrary to the trend at this higher administrative level, as confirmed by the examples of some municipalities. The interlinking of the modules should be noted when generating the scenario assumptions in each module as this interdependence will often mutually influence or condition the scenario assumptions. Thus, in addition to the available supply of residential land, the number of vacant dwellings will also provide a rough framework of the potential for attracting new residents. However, without a supply of land for housing, it is impossible to build new homes and residential buildings with rented and owner-occupied flats. In order to keep land consumption for residential purposes as low as possible, the supply of land should be located within the municipalities. Similarly, the generation of migration assumptions should take into account changes in the age structure of the workforce, as the retirement of older workers and their replacement by younger workers has a significant impact on population gains and losses for municipalities (Lindh and Malmberg, 2008). Additional scenarios must be developed in order to deal with the housing needs and integration of refugees.

The methodology can be transferred to other regions or countries. First, analyses of the specific parameters such as birth rate, mortality rates, household behaviour or housing types have to be carried out for the different territorial units. These can then be easily included in the methodology or in a program extension; the language of the front-end user interface (currently only available in German) can be customized to local needs with minimum effort. The adoption potential of this methodology for growing cities in developing economies can be investigated by means of some case studies. Here, major challenges can be the informal nature of economic activities as well as poor access to the required base data (spatial and statistical). However, the “Open Data and Science” initiative offers some hope in this regard. Other alternative data collection methods and community platforms can also be served in some extent, such as Volunteered Geoformation (VGI) and citizen science initiatives (Hecht et al., 2013, Sikder et al., 2018). The robustness of the approach can be further validated by applying a combination of indicator-based generic algorithms and linear regression analysis (e.g. Ng, 2008). Last but not the least, by adapting approaches such as IOER-forecasting, local decision-makers and planners will be able to answer the question of how many housing units or plots of land are needed by their local municipality under alternative policy scenarios in order to achieve the goals of sustainable spatial development of cities and regions. This can also feed into the discussions of local stakeholders.

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