Casametrics

The art of modelling and forecasting the market value of houses

English summary of inaugural lecture

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by

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Mevrouw de Rector Magnificus,
Mijnheer de Decaan,
Dear family, friends and colleagues,

1. Introduction

In the past fifteen years or so a lot has changed in the way real estate in the Netherlands is being appraised. Models are playing an ever-increasing role in both determining and validating values. Back in the 1990s values for the Real Estate Appraisal Law (Wet WOZ), with its main purpose of levying taxes, were still largely determined without the help of models. Starting in 2008, the periodical re-appraisal was replaced by an annual one, a change only made possible thanks to the utilization of models. Important arguments in support of this change are objectivity, reproducibility, efficiency and cost reduction. Besides the fact that models have by now proven their worth. Yet such valuation models are not only employed for taxation purposes, but also to calculate the indirect returns of housing associations based on the open market value in non-rented state (Investment Property Databank European Social Property Services). These mass appraisals are applying models on a large scale. Model values are furthermore used to obtain financing when purchasing a private residence. Starting January 1st, 2010, it is required that, in order to obtain the National Mortgage Guarantee, the open market value as determined by an independent appraiser, free from any rent or use, is compared to a model-generated valuation report.

In day-to-day practice, therefore, models are frequently used for the appraisal of homes in both the rental and owner-occupied sector. Apparently, the market has plenty of confidence in the operation and outcomes of these models. Given the great importance of model-based valuation, it is quite remarkable that up to the present day there have never been set any clear quality standards for these models.

A positive exception to this is the “Appraisal instruction for annual valuation”, published by the Dutch Council for Real Estate Assessment (Waarderingskamer, 2008). It is an important step toward establishing specific criteria for models to adhere to. Roughly, these criteria are as follows: the model must contain at the very least the characteristics of location, type of object, construction year and size of home and plot, and furthermore include minimally five years of sales history; mutual differences in the characteristics between the homes must lead to explainable differences in value. While this is admittedly a great leap forward, there is no guarantee that it actually works. There are no requirements concerning the specifics of the model and not every characteristic used in practice is always very useful.

With this in mind, I want to give some attention to what considerations, from a real estate and econometric perspective, play a role in formulating a real estate valuation model. The focus will be on the housing market. That is why I have decided to title my inaugural lecture “Casametrics”, a combination of the Latin word for home (*casa*) and the practice of econometrics. Here I want to address the special character of the real estate market and the implications this has for valuation models. Next, I will pose a number of concrete requirements that real estate valuation models should comply with. Finally, I will answer the question of how reliable valuation models are in real life.

The second part of the inaugural lecture will centre on the question whether the Dutch housing market is overvalued and, if so, to what degree? Are the home prices too steep in comparison to other economic data, such as interest rates and income? In other words, how bloated is the Dutch housing market? And can we expect this bubble to burst, causing a collapse of the market similar to what has happened in the United States of America? After all, the Netherlands also experienced a long uninterrupted period of rising home prices, from 1985 until 2008. Between 1996 and 2001 prices even increased between 10 and 18% on an annual basis. This growth period came to an end in August of 2008. The annual difference between 2008 and 2009 is approximately minus 3%. Whether further price drops can be expected in the near future depends especially on the question whether the current home prices are too high in relation to the relevant economic factors. To answer this question, I will present an error correction model. This model can measure a potential over-valuation, as well as make predictions concerning future home prices.

2. Real estate model valuation

Market value
The real estate market is an uncommon asset market, in which transactions occur according to a relatively rare and irregular pattern, and are the result of privately negotiated deals in which unique assets are traded in their entirety (Geltner et al., 2007, p. 272). These aspects clearly distinguish a real estate market from, let's say, a stock market. After all, shares are continuously traded between many buyers and sellers on the public exchange, and transaction prices or rate changes can consistently be monitored across the globe. The more transactions of homogeneous products are instantly available to the public, the closer these transaction prices will be to their actual market value. We realize, of course, that market value remains a theoretical concept. In the case of share prices everyone may think they know best, but the compromise between all these varied opinions is simply that the transaction price is equal to the market value.

On the contrary, real estate objects are unique and the prices people pay for them are partly dependent on the information that is available to buyer and seller and their respective negotiation skills. The market value itself is not very transparent, but can be inferred from comparable transaction prices. The idea is that it should be possible to determine the market value based on transaction prices. This is obviously the case when there are sufficient transaction prices available for a great number of identical objects with matching transaction dates. In reality, the transaction prices of these objects will differ somewhat from one another. They form a probability distribution that can be considered as representative for the objects. Practical statistical definitions of the market value are therefore easy to come by. The market value for these identical objects could be defined as the average transaction price (the transaction prices weighed by their probabilities) or the most likely value (the transaction price with the highest probability). The spread of the transaction prices around the market value is called the transaction noise.

For a group of almost identical objects it generally holds up that the market value is almost the same. The statement that the transaction prices of identical objects have a specific probability distribution can be extended to transaction prices of heterogeneous objects. To do so, we assume a relationship between transaction prices and the characteristics of the object. The transaction price consequently emerges as a function of, for example, surface area, type of dwelling, construction year, and location. As a result, an econometric model is created. The market value is the average or most likely transaction price based on the model. The reliability of the market value can be deduced from the distribution of model values vis-à-vis transaction prices.

The difference between market value and transaction price: transaction noise

If the market value is estimated based upon transaction prices, you could effectively state that the transaction noise is equal to the difference between the market value and the actual transaction price. In reality, how great is the transaction noise, the spread of transaction prices around the market value?

One way to find out is to analyze repeat sales, by pairing sales data of the same object with a repeat sales model, see Case and Shiller (1987, 1989). The repeat sales model is used to calculate the price development of real estate, but also provides insight in the size of the transaction noise. The starting point is that the objects under review have not changed in between consecutive sales dates. In fairness, such an assumption can hardly be justified due to the aging of objects and potential renovations or expansions. It is however possible to make partial adjustments for such changes. For all paired sales data the proportional price changes are calculated per object. Subsequently, a general price development is construed from this. The paired sales data can be made mutually comparable by adjusting for the market price development between the first and the second sale. The proportional difference between the indexed sales figures then becomes a yardstick for the transaction noise.

The repeat sales model has been applied to all home transactions registered by the Land Registry Office (Kadaster) in the period between 1993 and May of 2009, see Francke (2009). The standard deviation of the transaction noise amounts to 6.8% for row houses, 7.6% for semi-detached houses, 7.8% for apartments and 8.7% for detached houses. As expected, the noise is lowest for the relatively uniform block homes and highest for the more unique, freestanding homes. These results resemble the results of a study by Goetzmann (1993) for American housing markets. The standard deviation for the transaction noise for single-family homes in Atlanta, Chicago, Dallas and San Francisco hovers around the 6.5%.

The average standard deviation of the transaction noise for homes therefore amounts to 7%. Why is the size of the transaction noise relevant?

Because it serves as a lower bound for the quality of a valuation; the standard deviation of a valuation will almost always be greater than the standard deviation of the transaction noise. The reason for this is that in most valuations there are only transaction prices available of somewhat comparable objects and accordingly a correction must be made for the differences between the object to be appraised and comparable objects. To do so, assumptions are relied upon that are only an approximation of reality.

Requirements for valuation models

Economic theory gives no guidelines toward the specification of a valuation model (Orford, 1999, p. 25-28). This makes specifying the valuation model an empirical matter. Which requirements can be imposed upon a valuation model from an empirical, econometric perspective? A model depends on both the available data as well as the manner in which such data are processed. Available information consists of transaction prices, sale or rental prices, transaction date, selling date or start of the rental contract, location and object characteristics such as surface area (size) and construction year. The art of modelling is to find the most ideal model to process this data collection: a model in which the model values deviate minimally from the transaction prices, a model with the smallest possible standard deviation of the residuals, based on the least amount of information.

The most logical thing to do is to measure the residuals as the percentage difference between the model value and the transaction price. A difference between a transaction price and a market value of €10.000 at a market value of €100.000 is significantly worse than a similar difference at a (total) market value of €500.000. The quality of a model is therefore being measured by the standard deviation of the percentage differences between the transaction prices and market values.

A second requirement that can be imposed onto these models is that for most of its characteristics a model must be defined in multiplying factors instead of additive terms. This is especially true for the impact of time and location on the value of the object. It makes much more sense to say “the value of a home in neighbourhood A is 5% higher than in neighbourhood B” than “the value in neighbourhood A is €10.000 higher than in neighbourhood B”. This statement may hold true for the average home, but not for the cheaper or more expensive ones. Statements concerning price developments are therefore typically formulated in percentages, or in relative terms.

A third requirement should be that, almost by definition, prices are not proportional to the size of the object. The specification must allow for the law of diminishing returns: the increase in living space from 45m^2 to 50m^2 provides a substantially greater increase in value than a similar-size expansion from 100m^2 to 105m^2.

The aforementioned requirements can be satisfied by applying a mathematical transformation on both the transaction price as well as the size of the object, namely by using the logarithmic transformation. An additional advantage is that through this logarithmic transformation the multiplicative model becomes an additive model, which can be estimated with standard linear regression techniques. A statistical argument for taking the logarithmic of the transaction prices is that the model residuals will more closely resemble a normal distribution, one of the assumptions in applying a linear regression. More generally, it can be said that the arguments made here are not only common sense, but are also confirmed by statistical analyses, see also Francke (2008).

The hierarchical trend model

Parametric models – with the linear model described previously as an example - assume *a priori* a structure between characteristics and value and contain the assumption that the errors have a particular statistical distribution. The great advantage of these assumptions is that the estimation results are easily interpreted and explained to a non-statistics-minded audience, such as real estate appraisers. The statistical framework also makes it possible to test the assumptions made in a coherent manner and to formally compare competing models with each other.

An oft-mentioned objection against the parametric models is that they are too rigid. Supposedly, too much structure is imposed on these models, making them not flexible enough to work with. This stands in sharp contrast to more data-driven models, such as non-parametric ones and neutral networks. However, these latter models hold the important drawback that the results are much more difficult to interpret or to formally put to the test. Moreover, these data-driven methods demand a great many observations in order to calibrate the model. And the empirical results rarely seem to have improved because of it. In practice, they are therefore hardly used as a method for mass valuation.

But within the class of parametric models there exist alternative models with a more flexible functional form, ‘semi-parametric’ one could say. A good illustration hereof is the hierarchical trend model for homes as described in Francke and De Vos (2000). In this model the impact of time on transaction prices is modelled in an advanced and flexible manner. The model contains a time-invariant and time-dependent component that is measured in months. The time-invariant component contains the specification of the home characteristics. The time-dependent component consists of three building blocks: a common trend, a district-specific trends and house type-specific trends. The model can be paraphrased as followed:

Log transaction price = influence of individual characteristics (time-invariant)
+ level common trend
+ level district trend
+ level house type trend
+ error term.

The district and house type specific trends are modelled as deviations of the common trend by random walks. The common trend has a more sophisticated specification, namely a local linear trend model. Both the random walk aand the local linear trend model do not impose a fixed relation between price and time up front. In the random walk model it is assumed that the *expected* price level in the coming month is equal to that of the current month and in the local linear trend model it is assumed that the *expected* price change in the coming month is equal to the change in the current month. The models keep the middle between a linear price change – prices rise or fall always with the same percentage – or no structure at all, modelled by dummy variables per month. But this last approach has the disadvantage that a large number of explanatory variables must be included in the model. The random walk and local linear trend specifications are flexible, but at the same time quite parsimonious with the number of variables needed.

Modelling the impact of time with the aid of dummy variables is frequently used in hedonic price models and repeat sales models in order to derive a price index. The implicit supposition in these models is that the price level of the current month does not depend on the price level of preceding and subsequent months. In other words, the price level in a specific month is only determined based on the sales prices in that month. If, however, the number of sales (data) in a particular month is low and/or the sales prices include a few outliers, then estimating the price level in said month is rather unreliable. After all, the sales price may deviate from the market value due to the transaction noise. As a consequence, the resulting price indices become unreliable. In the hierarchical trend model, due to the specifying of the random walks and the local linear trend model in establishing the price level, transaction prices from preceding and subsequent periods are taken into account. This reduces the impact of the transaction noise, the deviation between market value and transaction prices. To what degree upcoming and previous periods play a role in the determination of the current price level is estimated from the data, so that an optimal trade-off between signal and noise is made.

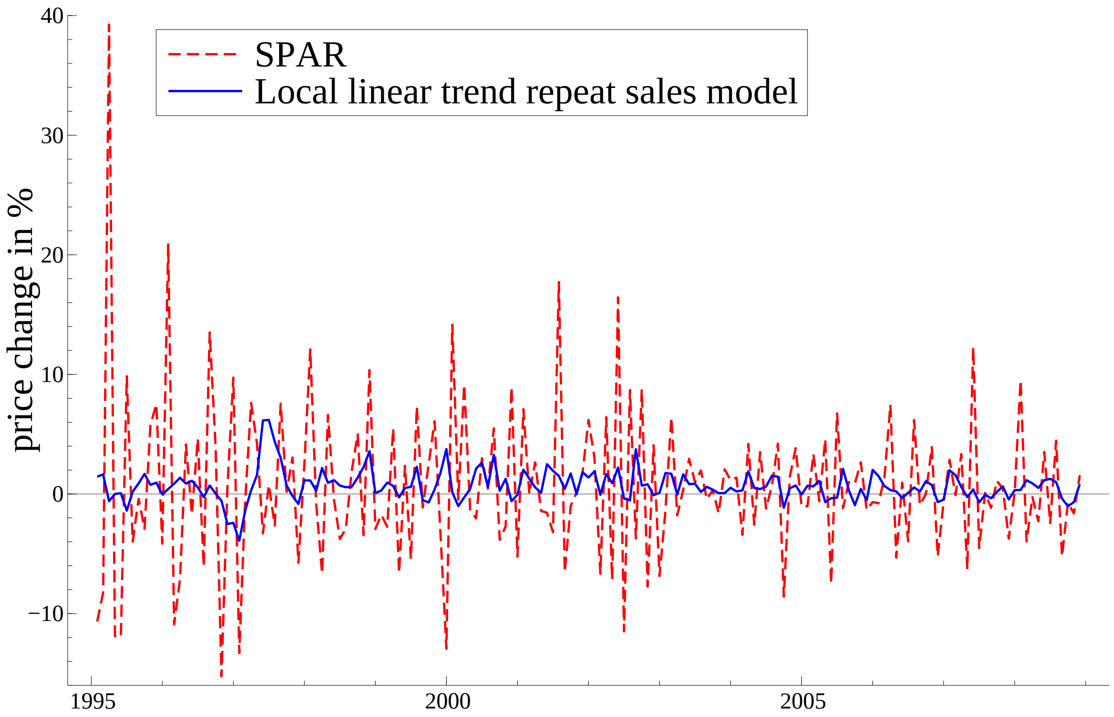

Figure 1 Price changes for apartments in Friesland

An example may shine some light on the difference. The Sales Price Appraisal Ratio (SPAR) price index of homes is published monthly by Statistics Netherlands (Centraal Bureau voor de Statistiek). The SPAR index is based on sale prices from the Land Registry Office. To determine the index the ratio of sales prices and WOZ values are calculated on a monthly basis. Sales prices from the previous month play no role in the calculation of the index in the current month. We compare this index to an index based on a local linear trend repeat sales model. The repeat sales figures are also taken from the Land Registry Office, on average making up about 40% of the total number of transactions. Figure 1 shows the monthly price changes for apartments in the province of Friesland in the period 1995 until 2008. The average number of transactions per month amounts to 54. The dotted line shows the SPAR price changes, the solid line the price changes from the local linear trend repeat sales model. It is clear that the SPAR index behaves much more volatile. Improbably large price increases, at times up to 40% on a monthly basis, are quickly followed by dramatic declines in prices. All transaction noise is absorbed in estimating the price level. This leads to unrealistic price fluctuations. The rise in one period is compensated by a decline in the next period. The price changes that follow from the local linear trend repeat sales model are much smoother, even though they are based on only repeat sales. The local linear trend model has ensured that the transaction noise has been filtered out of the index.

Another aspect of the hierarchical trend model is that the trend is divided in separate components, a common, a district and a house type specific trend, the latter components deviating from the common trend. By using this hierarchy it is possible to determine reliable price developments in detail. Francke and Vos (2004) demonstrate for the regions Amsterdam and Breda that with the hierarchical trend model price changes can be measured much more precise than with a standard hedonic price model. The differences between both methods are greatest for price changes on a monthly basis in smaller market segments: the standard deviations are almost cut in half.

Best practices

How reliable is model valuation in practice? To what degree do model values and transaction figures correspond with each other? As already indicated the standard deviation of the transaction noise is a lower bound for the reliability of the model values. For homes this amounts on average to about 7%. From estimations by the hierarchical trend model for homes in Heerlen, based on 2658 sales in the period 2001-2004, it turns out that the standard deviation of the relative deviations between model values and sales figures amounts to 11.8% (Francke, 2008). This standard deviation is almost 5% points higher than the one of the transaction noise. This increase is caused by incomplete data – not all value-determining characteristics are known or included in the model –, by inconsistencies in the characteristics and by simplified assumptions in the model.

The example of Heerlen gives a good indication of what may be expected of a valuation model based on the quality of the available data. The limited availability of quality data is one of the most important restrictions of model-based valuation.

What difference does it make which valuation model is chosen? Clapp and O'Connor (2008) describe an experiment in which various valuation models are compared to one another. All in all they looked at seven professional parties and four parties consisting of academics, each bringing their own model. All parties received the same data set, namely 51.590 sales data and characteristics of houses in Fairfax County in Virginia (a suburb of Washington, D.C.) in the period 1967-1991. They were asked to assess a value for 5000 homes, while the sales data of these houses were, for the purpose of the experiment, kept secret. The models were then compared based on the average of the absolute relative deviations between sales prices and model values, an alternative for the standard deviation. The scores of the private parties varied between the 11.8% and the 27%, and for the academics between the 11.8% and 12.6%. The difference in score between the worst and the best model is more than factor 2. In other words, it pays to use a solid valuation model.

3. Is the Dutch housing market overvalued?

Will the Dutch housing market decline any further, or has the trough already been reached. Put differently: are homes in the Netherlands overvalued? In the last couple of years several reports have appeared on this issue, with widely diverging conclusions. The Organization for Economic Cooperation and Development reported an overvaluation in 2004 of 20% (Girouard et al., 2005, p. 136). The International Monetary Fund (IMF, 2008, p. 113) announced that the Dutch housing market in 2007 was overpriced by 30%. Kranendonk and Verbruggen (2008) of the Netherlands Bureau of Economic Policy Analysis (CPB) stated in their reaction to the IMF report that the overvaluation of approximately 10% in 2003 has dwindled down to about 0% in 2007. The IMF (2009a, p. 24) pointed out that prices at the beginning of 2009 were approximately 7% too high. The preliminary countries report of the IMF (2009b) demonstrated that global housing prices are in agreement with fundamental economic factors, a conclusion that was confirmed by De Vries (2009) of the research institute OTB. All these studies are rooted in error correction models that lead, depending on the variables used and model specification, to different results.

The housing market is a typical example of a so-called stock market. Each year no more than 1½% is added to the stock. In the short term, therefore, supply does not adjust to demand, yet in the long run it does. For the Netherlands there are some indications that, partly because of government interference in the real estate and housing market, the supply in the medium-long term is also fairly inelastic. This implies that the supply is more or less fixed, regardless of the height and development of the price, see for this the CBS reports of Verbruggen et al. (1995) and Vermeulen and Rouwendal (2007). The real housing prices are therefore largely determined by demand factors: how affordable are homes given the status of wage earnings, the interest rates and the mortgage tax relief?

In the error correction model (ECM) a distinction is made between two equations, describing respectively the long and the short-term price developments. The long-term price development depends on the *levels* of the variables, such as the height of the income and the interest rate. This long-term equation defines for each period an equilibrium price, depending on the height of the explanatory variables. If the actual price (P_t) is above the equilibrium price (P_t^*), there is talk of overvaluation. $(P - P^*)_t$ is called the error correction term. In the short-term equation price *changes* are explained from previous price *changes*, *changes* in the fundamental economic variables and the deviation between the actual price and the equilibrium price in the previous period. In its basic form, the ECM looks as follows:

$$P_t^* = \beta_1 x_{1,t} + \ldots + \beta_k x_{k,t},$$
$$P_t - P_{t-1} = \alpha(P_{t-1} - P_{t-2}) + \delta(P - P^*)_{t-1} + \gamma(x_t - x_{t-1}) + \varepsilon_t,$$

in which $x_{i,t}$ stands for the fundamental economic factors, and ε_t the error term. The coefficient α of the term $(P_{t-1}-P_{t-2})$ indicates how the current price changes relate to previous price changes. The existence of this effect can be explained as speculation effect and/or market inefficiency (Hort, 1998). The coefficient δ indicates how quickly prices revert to the long-term equilibrium. If δ is equal to -1, then prices adjust immediately to changes in the fundamental variables. The coefficient γ measures the contemporaneous price adjustments as a result of changes in the current fundamental economic factors.

Francke et al. (2010) estimate an ECM based on data from 1970 on. This is opposed to some studies in which the large price increases of the 1970s, followed by the crisis in the housing market around 1980, are not included. Another difference is that instead of average or median annual sales prices a constant quality price index is used. For the period to 1995 the repeat sales price index of Mahieu and Van Bussel (1996) is drawn upon. From 1995 onwards the SPAR index, as published by the CBS, is utilized. Ultimately, as explanatory variables for the long-term relation of the real home prices, only demand factors are used. Supply data, such as the number of new construction units, whether or not in the private sector, the housing stock and the construction costs fail to explain the price changes in this period. The model contains the following demand-related factors: the user costs as a percentage of the home price, the aggregated disposable wage income per household and the aggregated financial capital per household. The user costs consist of the mortgage rate, corrected for the mortgage tax relief and increased with maintenance and insurance costs and depreciation minus the expected inflation (Poterba, 1992). Changes in the aggregated disposable wage income per household can be the result of changes in the average wage, the size of the working population and the unemployment rate. The financial wealth per household contains savings and other liquid capital reduced by debts. Mortgage debts and home and stock ownership have been kept out of consideration. The short-term explanatory variables are the annual changes of the user costs and the aggregated wealth per household and the growth of the gross domestic product.

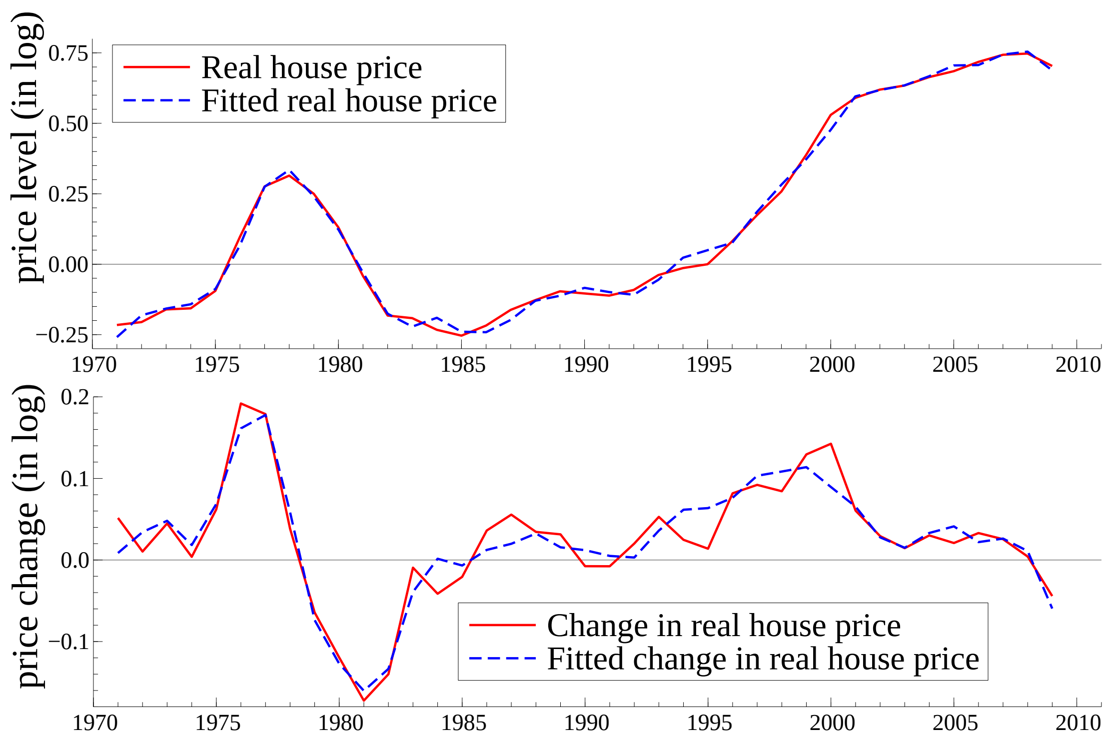

Figure 2 Realized and fitted real price index (change) in log.

Between 1970 and 2009, the real home prices have risen by an annual average of 2.6%. Figure 2 shows that within this period there are huge differences. For example, prices increased 80% between 1970 and 1978, followed by a decline of 43%, with 1985 as a low point. At the end of the millennium prices increased yearly with more than 10%. The last few years the growth was more moderate, around 2%. In 2009 prices declined approximately 4%, all percentages in real terms. The user costs are to a significant degree determined by the mortgage rate and the inflation. The seventies are characterized by a high inflation percentage, more than 7%, and a growing mortgage rate. The average mortgage rate increased from 8% in 1970 to almost 13% in 1981. On the other hand, from 2003 onwards the interest rate and inflation are relatively low. The aggregated disposable wage income has annually increased over the period 1970-2009 in real terms with an average of 2.1%. In the early eighties the wage income declined, whereas in the late nineties there was substantial growth, partly because of the increased participation of women in the labour force. See also the CPB publication by Ewijk and Teulings (2009, p. 96).

A good model gives a valid description of the data on plausible grounds. “Our” ECM satisfies both requirements. All explanatory variables possess the right sign and the expected size. The coefficients can be interpreted as elasticities. The coefficient of the wage income amounts in the long-term relation 1.43, meaning that the prices, by approximation, increase with 14.3% if the wage income increases by 10%. The coefficients for the user costs and the financial wealth amount to respectively -0.35 and 0.69, with a comparable interpretation. In the short-term relation the coefficients for the *changes* in gross domestic product, financial wealth and user costs are respectively equal to 1.22, 0.16 and -0.08. Figure 2 shows that the ECM explains the home prices correctly. The upper part of the figure displays the prices in levels, the lower half displays them in annual differences. The solid line is the realized price (change), the broken line is the modelled price (change). In general the modelled price (change) appears to follow to the real price (change) quite remarkably. The model only has some difficulties describing the extremes, as can be noted around the year 2000.

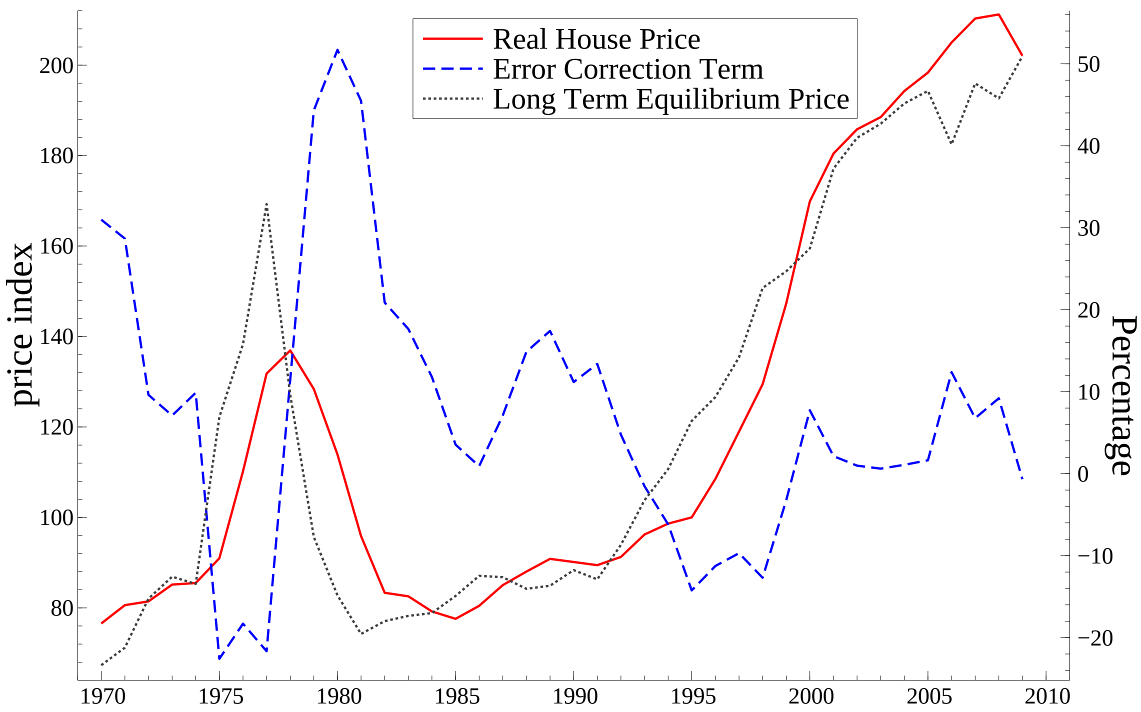

Figure 3 Real price index, long term equilibrium relation (left axis) and error correction term (right axis). The real price index for 1995 is equal to 100.

The ECM provides a direct insight in the degree of overvaluation of the housing market. In Figure 3 the solid line shows the development of the real sales prices, expressed by a price index, in which the index in 1995 is equal to 100. The dotted line is the long-term equilibrium relation, also expressed by an index. Of both series the scale can be found on the left axis. The solid line is the difference between the real price and the equilibrium price, expressed in percentages, as displayed on the right axis. The figure shows that halfway the seventies there was a substantial undervaluation. At the end of the seventies and in the early eighties there was a great overvaluation; at the time the real prices are significantly higher than the equilibrium prices. The last few years the differences between real prices and equilibrium prices are small. From the perspective of the ECM there is no reason to assume that there is an overvaluation of the housing market at the moment. This conclusion is in line with the recent reports of research institutions like the CPB, IMF and OTB.

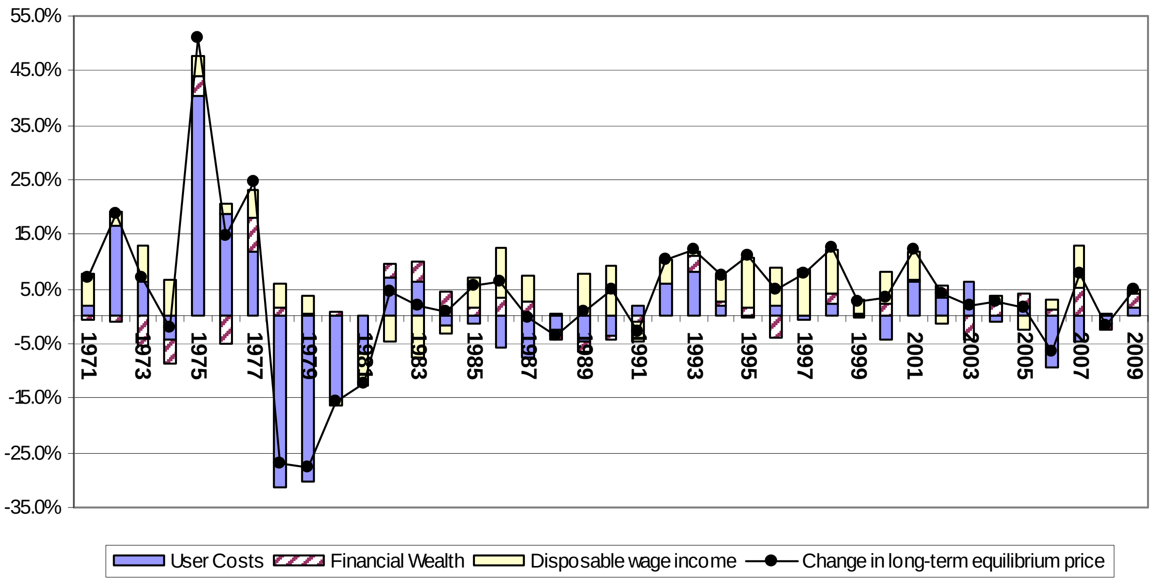

Figure 4 Changes in the long term equilibrium price.

Which factors have contributed to the change of the equilibrium price in the housing market? Figure 4 gives a graphic display of this. In the legend the contribution of the separate factors is shown, the line showing the change in the equilibrium price. In the seventies the changes in the equilibrium price were mainly the result of changes in the user costs. Around 1975 the real interest rate was more or less equal to zero, due to the rising inflation. From 1978 onwards the inflation decreased, resulting in a growth of user costs and a decrease of the equilibrium price. In the second half of the 1990s the rise of the disposable wage income is the most important reason for a rising equilibrium price. The financial wealth plays only a secondary role in explaining the changes in the equilibrium price. The model further proves that the annual price change in the previous period accounts for 30% in the price change of the current period, independent of other economic factors.

Price expectations

Based on this model, what developments in the home prices can we expect in the upcoming years? At any case the real prices in 2009 are not above the equilibrium prices. This implies that there can be no talk of a correction of the home prices as a result of overvaluation. At this moment the predictions of the future home prices from the ECM therefore depend mainly on the predictions of the explanatory variables, such as inflation (+1%), mortgage rate (almost constant), income (-1¾%) and growth of the gross domestic product (+1½%).

For this we base ourselves as much as possible on the predictions of the CPB of December 15, 2009. This is the basic scenario. Subsequently, there is an optimistic scenario in which the economy recovers more speedily from the recession. This means higher growth rates combined with a somewhat higher inflation. Moreover, there is a pessimistic scenario in which the economy recovers only slowly with low growth rates and 0% inflation. For these three scenarios there are predictions of the sales prices of homes for the period 2010-2015. In the basic scenario the nominal price in 2010 increases with 1%, in the positive scenario with 3% and in the pessimistic scenario prices decline with 1½%. In real terms the predictions are -1½%, 0% en 1½% for respectively the negative, basic and positive scenario. In the basic scenario the nominal prices in 2011 are back to the level of 2008. In the negative scenario this price level is reached only in 2014. It is important to note that in these predictions potential changes in the fiscal treatment of home ownership is not taken into account. Changes in the mortgage tax relief will have results for the height of the home prices, see for example the CPB report by Van Ewijk et al. (2006). Our model can also be used to estimate what possible results this may have. And in combination with the work on price developments per district and house type, many more detailed statements can be made on this politically charged issue. In other words, there is still a lot of room for further research, to which I would like to dedicate myself in the near future.

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In the past fifteen years or so a lot has changed in the way real estate in the Netherlands is being appraised. Models are playing an ever-increasing role in both determining and validating values. They are utilized for taxation purposes, to calculate indirect returns for housing associations, and for obtaining National Mortgage Guarantee. Apparently, the market has plenty of confidence in the operation and outcomes of these models. Given the great importance of model-based valuation, it is quite remarkable that up to the present day there have never been set any clear quality standards for these models. The first part of the inaugural lecture gives some attention to what considerations, from a real estate and econometric perspective, play a role in formulating a real estate valuation model.

The second part will centre on the question whether the Dutch housing market is overvalued and, if so, to what degree? An error correction model is presented explaining houses prices by interest rate, inflation, financial wealth and disposable income, based on data from 1970 on. It appears that there is no reason to assume that there is overvaluation of the housing market at the moment. This implies that there can be no talk of a correction of the home prices as a result of overvaluation.

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