Interest rates, house prices and the purchasing power for housing

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Abstract

Real income and the real interest rate have been widely considered as two important determinants of house prices. We find that the purchasing power for housing, which is based on the net present value of future income flows, is a more powerful concept. It is intuitive and realistic in nature for first time buyers who need substantial mortgage-financing. Based on aggregated yearly time series data for Belgium from 1973 to 2009, we find that nominal house prices are cointegrated with the purchasing power for housing. We also find evidence for full capitalization effects of fiscal advantages. Econometrical results for the income-elasticity are in line with the theoretical supposition of our model, namely 1. The ratio price-to-purchasing power for housing is more stable than the price-to-income ratio, while the interest rate elasticity as derived from the imposed functional form of purchasing power for housing is higher than generally found in literature.

Keywords: house prices, interest rate elasticity, cointegration, purchasing power for housing, income, net present value, repayments, borrowing constraint, long run relationship, capitalization, price-to-income, mortgage-financed.

Introduction

“Existing research has not provided adequate explanations for the price dynamics of the housing market” (Leung, 2004). OECD (2005) comes to a similar conclusion in its review of recent empirical studies on house price determinants. House prices do not appear to be linked to income by a stable long-run relationship and the semi elasticity of interest rates ranges between 0 and -9.4.

Moreover there are important methodological issues. Most studies use error correction models (ECM) although Gallin (2006) has demonstrated that house prices and income in the US are not cointegrated. More in general he concludes that aggregated data are likely to be spurious due to small sample

1 Thanks go to the Flemish Policy Research Centre for Spatial Planning and Housing, to the participants of the EMF-ENHR Seminar on Housing and Mortgage Markets, Brussels, 30-31 March 2011 for their useful comments and to Roel Helgers.
testing. This is a serious problem as ECM only models the short term dynamics right if the long-run equilibria are estimated correctly.

In other cases testing for cointegration is done but for a specific functional form and a specific dataset. This implies that rejecting the cointegration hypothesis is only valid for the functional form applied and the specific dataset. The user cost approach for instance indicates that there is some theoretical evidence for cointegration between house prices and income. See e.g. Meen (2002) who found ADF cointegration statistics close to their critical values for both US and UK data. But ECM’s based on user cost approaches also have their weaknesses. They usually ignore financial market mechanisms.

Moreover, housing affordability may be closely related to financial market mechanisms and government regulation. “In many countries, the state has developed new approaches to risk management that can widen access to owner occupation” (Scanlon, 2004). So far, housing affordability is mainly analyzed in one-direction: the house price is given, while endogeneity is to be expected: households are borrowing constraint and this constraint may impact the house price. McQuinn and O’Reilly (2008) try to solve some of these problems by modeling the demand-side determinants of house prices in Ireland as a function of the average amount borrowed by households given current disposable income and interest rates. In this way McQuinn and O’Reilly hope to capture that most house purchases are mortgage-financed and that the amount lent by mortgage providers is ultimately a function of income and interest rates. The same functional form is used by Bourassa (1996) to get a hold on affordability. We take a similar starting point. First we give a detailed theoretical framework for the concept of the purchasing power for housing and point to some differences with other house price models. In a last step we apply this approach to explain the Belgian house prices.

**Theoretical framework**

**The concept purchasing power for housing**

The main idea is that the concept of current income should be adjusted because households don’t pay for their house at once but with future cash flows, namely mortgage repayments. The level of these repayments is related to current income. Mortgage providers translate these future repayments into a loan via the net present value method, where the mortgage interest rate comes into play. Thus instead of using income and interest rate as two distinct variables, we introduce the concept of purchasing power for housing, which we define as the net present value of a proportion of future income streams (mortgage repayments) in a given time period (mortgage term). The demand curve for housing can then be defined as the willingness to pay a certain amount of monthly income for a certain period. As households compete for “house-holding”, a vicious upward spiral of house prices can materialize without much rationale about future house price appreciation. It suffices that a buying a house in general is seen as a good investment. However, households are bounded by budget and borrowing constraint, imposing a limit on house price appreciation.

This model assumption differs from the user cost approach (e.g. Poterba 1984) that reflects rational asset pricing fundamentals. One of the key elements in the user cost formula is the expectations on future price or rent appreciation. The lack of good estimates for these variables is a major drawback.

We first decompose the house price into five financial components, which is in line with the model a mortgage provider would use to calculate a loan with fixed annuities and fixed interest rate for a household.

Let $\alpha$ denote the repayment ratio, the fixed proportion of nominal net income ($Y$) a household allocates initially on average to yearly mortgage repayments. Given income ($Y$), mortgage interest rate ($i$) and
duration of the loan \((n)\), we can calculate the average loan that an average household would borrow to buy a house by calculating the net present value of future repayments:

\[
L = \sum_{t=1}^{n} \frac{\alpha Y_t}{(1+i)^t}
\]

This loan is related to the house price \(P\), as it can be expressed as \(L + D\), where \(D\) is the deposit or down payment. We model this down payment to be proportional to \(Y\), and use the parameter \(\beta\) as the down payment ratio. This yields \(L = (1-\beta)*P\). We also incorporate the net effect of the tax relief \((ntr)\). This net effect is treated as extra funds for repayments. The price of a house at time \(t\) can then be expressed as follows:

\[
P_t \equiv \left(\frac{\alpha Y_t + ntr}{1-\beta_t}\right) \left(\frac{1-(1+i_t)^{-n}}{i_t}\right)
\]

Which is an exact relationship. So the impact of the diversity of all house price determinants should always be reflected in these five financial factors. Unfortunately, time series data of these variables are hard to obtain.

Estimating the purchasing power for housing is in fact the same process as calculating housing affordability by means of borrowing constraints (Bourassa, 1996). Affordability analyses the impact of house prices on household expenditures, where the purchasing power for housing takes reasonable estimates for \(a, \beta\) and \(n\) to determine long-run house price equilibria. These are two sides of the same coin but with a different causal direction. Gan and Hill (2009) draw a distinction between the concepts of purchase affordability - whether a household is able to borrow enough funds to purchase a house - and repayment affordability - the burden imposed on a household of repaying the mortgage. Purchase affordability is linked with \(\beta\) and \(n\), while repayment affordability is linked with \(a\). Higher \(a, \beta\) and \(n\) decrease affordability, and might be invoked by house price increases due to shortage, demographic pressure, and so on.

However, for the variables income and interest rate, it is plausible to assume that the causal direction is mainly one way: changes in income and interest rate result in changing house prices, while the reverse effect is rather unlikely. So if we observe that \(a, \beta\) and \(n\) are more or less constant over time, there would even be no need for an econometric model since the relationship in the equation is exact, and no parameters need to be estimated. The time series purchasing power for housing is calculated with the relationship above, for plausible and fixed \(a, \beta\) and \(n\) and with actual data for \(Y\) and \(i\). In the second step we analyze whether the purchasing power for housing is cointegrated with actual house prices. The purchasing power for housing, which is denoted by \(X\), can thus be written as:

\[
X_t \equiv \left(\frac{\alpha Y_t + ntr}{1-\beta_t}\right) \left(\frac{1-(1+i_t)^{-n}}{i_t}\right)
\]

Purchasing power for housing is thus a nonlinear function of income and the interest rate. The net tax relief is kept constant (see infra). The effect of each variable is not easy to interpret: not only has income a direct influence on the house price, but \(a, \beta\) and \(n\) can also be influenced by income and the interest rate and so indirectly have an extra effect on house prices. These variables are correlated, namely \(\alpha(P,Y,\beta,i,n,...)\) . \(\beta(P,Y,\alpha,i,n,...)\) and \(n(P,Y,\alpha,i,\beta,...)\), where income and the interest rate are assumed to be exogenous.
The effect of income and the interest rate on the purchasing power for housing thus covers only part of the effect of these variables on the house price. Based on this formula, we will analyse the following functional form:

\[ P_t = \beta X_t + \ldots \quad (4) \]

We could also use a decomposition of \( Y_t \) by taking the log (formula 5), which would lead to a functional form that is more similar to the user cost approach and other models that can be found in literature (formula’s 6-7).

\[
\log(P_t) \equiv \log(\alpha Y_t + nt'\tau) - \log(1 - \beta_i) - \log(i_t) + \log(1 - i_t^n) \quad (5)
\]

\[
\log(P_t) = \beta_1 \log(Y_t) + \beta_2 \log(i_t) + \ldots \quad (6)
\]

\[
\log(P_t) = \beta_1 \log(Y_t) + \beta_2 i_t + \ldots \quad (7)
\]

If we compare formula 5 with formula’s 6 & 7 we note that the interest rate is not a linear function of \( P \), since the last term is a combination of interest rate and duration. Moreover, our model would suggest to model a log-log specification using the nominal interest rate. In this paper we are not attempting to bridge the link between different modeling approaches. So we focus on formula (4), where we expect the parameter estimate to be around 1 in case \( n, \beta \) and \( \alpha \) do not differ too much throughout time. Therefore, we first give an overview of how these financial variables are related with house prices and illustrate the importance of each variable by a sensitivity analysis where the impact of a change of each variable on house prices is calculated, keeping the others constant.

**Interest rate and semi interest rate elasticity of purchasing power for housing**

In our model we take the nominal fixed interest rate as reference interest rate\(^2\). We don’t include inflation as a variable, because all the data are in nominal terms. As both Kearl (1978, 1979) and Schwab (1982) suggest, inflation, by raising nominal interest rates, may have an effect on housing demand through the ‘front-loading’ of mortgage interest payments in real terms, which is called the “tilt” effect. Real repayments are tilted towards the earlier periods. Meen (1989) therefore included a measure of expected inflation separately. Moreover, the real mortgage interest rate can only be approximated since the nominal interest rate is given, but future inflation should be estimated\(^3\).

Empirical results of Berkovec and Fullerton (1989) also give evidence that the lower income classes are inhibited to buy a house due to the repayments constraints as a result of high inflation, while Brunnermeier and Jullieard (2006) find opposite results. We use the nominal mortgage rate because it is inherent on our model assumption, where borrowing constraints are the central theme, and not investor’s rational expectations.

Since the interest rate is part of the purchasing power for housing concept, we first derive the semi interest elasticity for the purchasing power for housing. Since \( X \), the purchasing power, is a function of \( i \), and assuming that the other variables (\( \alpha, \beta, n, Y \)) are independent of \( i \), the derivative of \( X \) with respect to \( i \) can be calculated as follows:

\[
\frac{\partial X}{\partial i} = \left( \frac{1 - (1+i)\alpha}{i^2} + n\frac{\beta}{i} \right) \left( \frac{\alpha Y}{1 - \beta} \right) \quad (8)
\]

Hence, the semi interest rate elasticity is equal to:

\(^2\) In case of variable interest rates, the purchasing power of housing concept is more difficult to apply because it is not clear how households incorporate the risk of variable interest rate into their decision process. It may be interesting for further research.

\(^3\) The expected inflation is less volatile than current inflation so the choice whether or not to incorporate inflation into the model is less important than one would expect at first sight.
\[ \frac{\partial X}{\partial i} = \frac{\left[ 1-(1+i)^{-n} \right]}{i} + n^* \left[ (1+i)^{-n-1} \right] \]

The semi interest rate elasticity is a function of the interest rate itself, and the mortgage term. As illustrated by figure 1, the purchasing power is highly dependent on the current level of the interest rate and the mortgage term as the semi interest rate elasticity is not a constant. In the user cost approach and most econometric models, the interest rate is not modeled as being dependent on \( n \), as McQuinn (2008) already noticed. While this difference would not lead to serious differences in case \( i \) would be high, it might yield to different results when \( i \) is low as figure 1 illustrates. Clearly the choice of model, borrowing constraint versus rational expectations, is crucial and the specific choice will depend on specific regional market mechanisms\(^4\).

Recent interest rates are historically low, and as figure 1 illustrates, heavily influence the purchasing power for housing. A one percentage point decrease of the interest rate increases purchasing power for housing with 10% with \( i = 4\% \) and \( n = 25 \).

Figure 1. Semi interest rate elasticity for the purchasing power for housing

\[ \text{duration} \]
- low
- average
- high
- infinite

**Down payment and mortgage duration: the trade-off between both**

Gan and Hill (2009) suggest that deregulation of the mortgage market has acted to increase average mortgage lengths while reducing average down payment ratio’s. So, a household with a given initial level of wealth and expected future income stream can buy a more expensive house than before, i.e. purchase affordability has improved. Clearly, there is an interaction between both factors: a smaller \( \beta \) can be offset by a larger \( n \). It is however not clear how purchase affordability should be interpreted. In case there is a higher down payment requirement, a household should save part of its income first, but

\(^4\) Even in case the user cost approach is more appropriate, it may be interesting to investigate if modeling to infinity is appropriate in case of low interest rates.
this disadvantage may be more than offset by a shorter mortgage length. So, it may be more relevant to look at \( \beta \) and \( n \) as a whole to determine the investment horizon, the full length a household has to finance a home. So the time horizon of investment is actually larger than the mortgage length (see figure 2).

Figure 2. The time horizon of investment

![Figure 2. The time horizon of investment](image)

**Repayment ratio and mortgage duration: no trade-off between both?**

We assume \( \alpha \) to be relatively constant over time, although changes in other housing expenses – heating, taxes, imposed quality conditions of housing – may have an impact. If \( \alpha \) would be too high, repayment affordability would be low (Gan and Hill, 2009). Note that \( \alpha \) is calculated as the ratio of the first repayment to current income. Since we work with fixed annuities, the repayment affordability is mainly an issue at the start of repayments, which is not necessarily the case for variable interest rate mortgages.

Borrowing for a longer period is not only suitable for relaxing the pressure on high down payments, spreading the mortgage burden can also lead to a lower repayment ratio. This trade-off seems also to be pleasant for young households. However, we argue that there is a risk for fallacies of composition (Caballero, 1992). Something that is optimal for person A individually and optimal for person B individually is not necessarily optimal for persons A + B together. If many individuals change their idea about an optimal mortgage length, this could cause a longer mortgage length without a lower repayment ratio. So, if the average household gradually decides to borrow for a longer period, this change of Zeitgeist or social epidemic (Shiller, 2007) will be capitalized in higher house prices. Initially repayments ratio’s could be lower with longer mortgage durations, but due to “house”-hold competition, low repayment ratio’s only happened to be for a short time period. It illustrates that the causal relationship between higher house prices and longer mortgage length might be bidirectional and that financial mechanisms that ease the access to capital, are capitalized in house prices. Higher house prices can lead to longer mortgage durations, but longer mortgage durations can also lead to higher house prices. This simultaneity is difficult to prove econometrically, but there are reasons to believe that in Belgium mortgage length resulted in higher house prices since 2005, because a new fiscal policy was introduced for home-buyers, resulting in longer fiscal optimal mortgage lengths. This effect is stronger in case of low interest rates which lead to higher net present values for values in the far future. The marginal utility for an additional year of mortgage duration is higher and can serve as an accelerator for this effect to take place. In addition, historical appreciation rates were high, inciting household propensity to consume housing, because of the higher expectations of future house price growth as described by Shiller (2007).
In the sense that mortgage duration can have an impact on house prices, we can even speak of a semi-mortgage duration elasticity, which can easily be derived from formula (3). Figure 3 illustrates this semi-mortgage duration elasticity for different \( n \) and \( i \). In case the interest is zero, house prices increase by the inverse of the duration.

\[
\frac{\partial X}{\partial n} = \frac{\ln(1+i)^n(1+i)^n}{\left(1-(1+i)^{-n}\right)}
\]

(10)

Figure 3. semi-mortgage duration elasticity for the purchasing power for housing

Table 1 summarizes the effect of a change in one variable on the house price, all other variables kept equal. It is interesting to note that the down payment ratio seems to have little impact on house prices. We capture the impact of interest and income in the concept of purchasing power for housing. We don’t capture the effect of longer mortgage durations as perceived in most countries since 2000. However, we give evidence that low interest rates are to a certain degree a necessary condition for long mortgage durations, although we don’t state that the low interest rates caused the longer durations. Fiscal policy can also be an incentive, as are other factors like demographic pressure or a supply shortage.

Table 1. The effect of a change in one variable on the house price, all other variables kept equal

<table>
<thead>
<tr>
<th>Variable</th>
<th>Initial state</th>
<th>Change</th>
<th>Impact on house price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest rate</td>
<td>5%</td>
<td>- 1% (pp)</td>
<td>+ 9%</td>
</tr>
<tr>
<td>Down payment ratio</td>
<td>80%</td>
<td>- 1% (pp)</td>
<td>+ 1,2 %</td>
</tr>
<tr>
<td>Repayment ratio</td>
<td>25%</td>
<td>+ 1% (pp)</td>
<td>+ 4%</td>
</tr>
<tr>
<td>Income</td>
<td></td>
<td>+ 1%</td>
<td>+ 1%</td>
</tr>
<tr>
<td>Duration</td>
<td>20 y.</td>
<td>+ 1 y.</td>
<td>+ 3%</td>
</tr>
</tbody>
</table>

**Tax relief**

In the concept of purchasing power for housing we treat tax relief as a kind of income measure. So we assume full capitalization: mortgage interest tax relief makes housing no more affordable to new
buyers. In literature one can find mixed evidence\(^5\) for this hypothesis (e.g. Berger et al., 2000; Brounen and Neuteboom, 2008; Saarima, 2010; Bourassa and Grigsby, 2000).

**Demographic factors and housing supply**

As stated by the literature, demographic factors and housing supply are important factors. However, although often found to be significant in the short-run, long-run effects are less clear. In our model we therefore focus first on interest rates and income. The effect of demographic pressure can be temporarily in nature, since it may be offset by extra housing supply in the long run. Price elasticities of supply and demand can vary over time and are heavily intertwined. One could argue that the equilibrium between demand and supply for demographics is based on quantities, which implies that the long-run equilibrium is a horizontal line. On the contrary income and the interest rate have a permanent price effect which is not offset in the future by other factors. Changes in prices can temporarily result in different demand and supply quantities, but in the long run, one could expect the equilibrium line to be vertical. The underlying assumption is that equilibria in the long run will be set – whether or not via government intervention – according to the fact that there is no shortage, nor excess stock, and housing affordability is guaranteed for most households. The former results in the horizontal equilibrium line on the left in figure 4, the latter in the vertical equilibrium line on the right. However, this doesn’t mean that land availability is not an issue. On the contrary, scarcity of land is a condition for this theoretical framework to hold, otherwise house prices would be more in line with building costs, and not with affordability. “House”-holding competition is also only a valuable starting point if there is no demographic shrinkage, just like long mortgage terms are only tempting when interest rates are low. Clearly, this theoretical framework focuses on price drivers like income and interest rate, but some conditional factors of supply and demand should be present in it to make sense.

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\(^5\) A lack of statistical significance might not be taken as evidence that full capitalization should be rejected since it may be due to a misspecified model, especially the specification of the time-lag (the rate of adjustment) seems to be sensitive to determine the rate of capitalization.
Empirical Results

Empirical specification

In this paper we check whether there is a long-run relationship between the house price and the purchasing power for housing. Rather than including the (nominal) interest rate and (nominal) income separately in a linear regression model, we include the purchasing power for housing. We check whether house prices and purchasing power for housing are cointegrated. If so, we additionally estimate an ECM. Cointegration is tested for using the Engle-Granger approach and implies the existence of a long-run relationship between the two time series.

The model we estimate in the regression analysis is a fairly simple linear regression model, namely the following equation:

\[ Y_t = \beta X_t + u_t \]  

(11)

Variables \( Y_t \) and \( X_t \) are in levels. \( Y_t \) denotes the price of housing, \( X_t \) is a matrix or vector of explanatory variables, \( \beta \) is a vector of parameters that we estimate and \( u_t \) is a vector of residuals. We perform regressions with different alternatives for both \( Y_t \) and \( X_t \), and check whether there are \( \beta \)'s, for which the residuals (denoted by \( \varepsilon_t \)) are stationary (integrated of order zero). To check for stationarity we perform ADF-tests. We use adjusted critical values since the residuals are estimates and are likely to be less volatile than the true error terms generating the data.

We estimate three different models. The first or base model uses purchasing power as a sole explanatory variable. Theoretically, if the house price is only a function of purchasing power for housing, we should find that the base model performs relatively well. The second model also includes the growth rate of the population between 25 and 35 years. These demographic evolutions might have an important effect on the price of housing due to an increase or decrease in the demand. Finally, the third model contains both purchasing power and a constant. Including a constant might improve the fit of our model and provides a good robustness check for our model assumptions.

After having estimated the model using the data in levels, we estimate the corresponding error correction models (ECM) which show the short run dynamics of house prices. Note that estimating an ECM is only valid when there is a cointegration vector, i.e. two or more variables are cointegrated and are subject to a long-run relationship. From the ECM we can derive the speed of adjustment towards the long-run equilibrium. More formally:

\[ \Delta Y_t = \beta \Delta X_t + \gamma ECT_{t-1} + \varepsilon_t \]  

(12)

Where:

\[ ECT_{t-1} = + \mu_{t-1} \]  

(13)

In this equation \( \gamma \) represents the speed of adjustment, and \( \Delta \) is the first-difference operator, where \( ECT_{t-1} \) can be interpreted as the deviation from the long-run equilibrium. \( \gamma \) should be smaller than 0, implying that there is convergence towards the long-run equilibrium. No constant is included in this framework, since we implicitly assume that there is no deterministic increase/decrease in the price of housing.

Case study: the Belgian housing market

In order to test the model we use the Belgian case. Regional characteristics heavily influence the housing markets mechanisms and therefore we shortly describe the Belgian housing market. Home-ownership is the tenure choice of the large majority of households (75%). There are more first-time buyers relative to second time buyers due to high transaction costs which amount to 20% of the house
price. Approximately 85% of the purchases is mortgage-financed (Heylen, 2007). A fixed, long term interest rate is almost standard, with exception of the years 2005 and 2010, when variable interest rates were more common. The government imposed caps on the yearly adjustment of variable interest rates to protect customers, which possibly invoked mortgage providers to set higher margins on the variable interest rate, making them less attractive for customers. Homeownership is fiscally favorable, which implies that households have an incentive to buy a house relative to renting one in the private market. The share of social housing is negligible. Belgium is densely populated and land is relatively scarce. Building plots are mostly owned by private individuals, who consider it as a good investment. We thus assume that the supply of housing is rather inelastic due to land constraints, and hence, the link between house prices and construction costs is minimal.

Since 2005 the mortgage tax relief is replaced in Belgium by a mortgage repayment tax relief for first homes only. This is generally a tax relief with a fixed amount, around 2770 € / year per person, while the previous tax relief was around 2500 € / year per household (e.g. Valenduc, 2008). For the majority of households, the tax relief thus more than doubled. This tax relief should be multiplied by the marginal tax rate of about 50% to get the net effect of the tax relief. Although there is mixed evidence about capitalization, it seems plausible to assume that a tax relief will be more easily capitalized if the tax relief is comprehensive and easy to calculate, which is the case for Belgium. Because of these fiscal incentives the expected cost of owning a house is less than the cost of renting, and thus housing tenure is not neutral. Households have a serious incentive to buy a house as returns for homeowners outperform these for landlords due to fiscal and government policy. Households can be considered as the driving force for house prices, since they constitute the vast majority of buyers.

We use annual aggregated data for Belgium for the period 1973-2008. Since the purchasing power for housing focuses on mortgage-based financing and affordability, annual median sales prices for “normal” houses are taken as a reference. We assume that this is the main category of houses sold. Furthermore we perform some robustness checks by performing similar regressions for both Q75 and the mean. The median house price is in line with those of apartments, but far lower than the prices for villa’s. Ideally we would have income statements of young 2-person households (age 30-35), but since these are not available for this period we compose a number of new time series based on different evolutions of income. For annual changes we take the indices of nominal GDP, nominal GDP/capita, and nominal GDP/(capita > 20 years) with reference year 2005. As a reference for 2005 we take the median of the nominal after-tax income for a 2-persons household of age 30-35. Annual income is after-tax income for the year 2005 multiplied with the index of the corresponding year. The interest rate that is used to compute the purchasing power for housing is the nominal long term mortgage interest rate.

Furthermore we make different scenarios on how people use the tax relief (“woonbonus”). We develop three different scenarios. First, people do not consider the tax relief as an additional means of income. Second, people consider the tax relief as an additional income, but incorporate it only rigidly. Third, people incorporate the tax relief fully from 2005 on. The last scenario implies that this additional income is fully capitalized in the house price. We assume that people are willing to invest a fixed fraction of their disposable income (30%) for housing and furthermore assume that the down payment ratio is constant over time (20%). Since no data is available on these two variables, we fix these by assumption. A last important distinction is on the duration of mortgages. Up to 2005 we assume that the mortgage duration is fixed at 20 years. This is a reasonable assumption. In 2005, however, a tax relief is introduced. Due to “fiscal optimization” we again differentiate three different scenarios. In a

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6 See Meen (2002) for a discussion.
7 The earlier mortgage tax relief was a combination of a fiscal advantage on both interest and capital repayments.
8 The tax relief is indexed each year. For 2005 it was € 2490 per person, while in 2010 it was € 2770. After 10 years, this amount decreases with approximately € 600. For households with more than 3 children at the start of the mortgage there is an additional € 70 euro.
9 Administrative sales data are split into 3 categories: apartments, normal houses and villa’s.
first scenario the mortgage duration is unadjusted and remains fixed at 20 years from 2005 onward. In the second scenario the mortgage duration is adjusted to 22 years. The third scenario considers the possibility that mortgage duration shifts to 25 years. Again, due to lack of data availability, we consider different scenarios as robustness checks.

Results
Table 2 presents a summary of the possible cointegration relationships we find in the data. It indicates a cointegration relationship at the 10% level. As mentioned before adjusted critical values are used. The table presents only the results of the base model.

Table 2. Cointegration relationships base-model

<table>
<thead>
<tr>
<th>Tax relief</th>
<th>Not incorporated</th>
<th>Rigid adjustment</th>
<th>Fully incorporated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration (from 2005 on)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>22</td>
<td>25</td>
<td>20</td>
</tr>
<tr>
<td>Price (Yt)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q50</td>
<td>GDP</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>GDP/(capita&gt;20)</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Q75</td>
<td>GDP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GDP/(capita&gt;20)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>GDP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GDP/(capita&gt;20)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The table indicates that there is potential evidence for a cointegration relationship between purchasing power and the house price. The mean house price is clearly cointegrated with purchasing power when we assume that households fully incorporate the tax relief into their budget. This implies that the tax relief is fully capitalized in the price of housing.

Despite that we estimated a rather simple model - the model contains only one explanatory variable - we find a number of cointegration relationships indicating the presence of a long-run equilibrium.

Table 3. Cointegration relationships (model with demographics included)

<table>
<thead>
<tr>
<th>Tax relief</th>
<th>Not incorporated</th>
<th>Rigid adjustment</th>
<th>Fully incorporated</th>
</tr>
</thead>
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<tr>
<td>Duration (from 2005 on)</td>
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<td>20</td>
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</tr>
<tr>
<td>Price (Yt)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q50</td>
<td>GDP</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>GDP/(capita&gt;20)</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Q75</td>
<td>GDP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GDP/(capita&gt;20)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>GDP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GDP/(capita&gt;20)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Including demographics does not significantly alter the results as obtained by the base model. Again, a number of cointegration results are identified.
Table 4. Cointegration relationships (model with constant)

<table>
<thead>
<tr>
<th>Tax relief</th>
<th>Not incorporated</th>
<th>Rigid adjustment</th>
<th>Fully incorporated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration (from 2005 on)</td>
<td>20</td>
<td>22</td>
<td>25</td>
</tr>
<tr>
<td>Price ((Y_t))</td>
<td>Q50</td>
<td>GDP</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Q75</td>
<td>GDP</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>GDP</td>
<td>x</td>
</tr>
</tbody>
</table>

Finally, including a constant in the model shows an increase in the number of cointegration relationships. Furthermore, observe the trade-off between incorporation of the tax relief and mortgage duration. Individuals have an incentive to increase mortgage duration whenever house prices increase. The tax relief is also likely to be incorporated into the house price. However, we are not able to identify between these two effects. This does however not invalidate our previous conclusions.

Table 5 presents some summary statistics concerning the parameter estimates for which a cointegration relationship is found.

Table 5: Average value \(\beta\) regression model (when cointegrated)

<table>
<thead>
<tr>
<th>Model</th>
<th>Base model</th>
<th>Base + Demographics</th>
<th>Base + constant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
<td>Q50</td>
<td>0.92595619</td>
<td>0.92602974</td>
</tr>
<tr>
<td></td>
<td>Q75</td>
<td>1.2547974</td>
<td>1.2846864</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>0.96373931</td>
<td>0.96786714</td>
</tr>
</tbody>
</table>

Although this table does not provide all information it gives some important insights. Observe, for example, that the coefficient estimate is dependent upon the price. Obviously, the coefficient estimate for Q75 is higher than the equivalent estimate for Q50. Furthermore we notice that the estimates for the mean are close to one, which is what we would expect if the mean house price is fully determined by the purchasing power of housing. The estimated coefficients suggest that there is a one-to-one connection between the house price and purchasing power. McQuinn and O’Reilly (2007) examined in their model of cross-country house prices a similar approach, but with the variables in logs. This is mainly due the fact that their starting point differs. They assumed that the short-run price of housing depends on the amount that can be borrowed, while we assume to be it on the long run. Nevertheless, they also found cointegration relationships between house prices and the amount borrowed by households. However, their parameter estimates - on average a coefficient of 0.6 for 16 OECD countries for the period 1980:Q1 to 2005:Q4- are harder to interpret in the log-specification \((P = e^{\alpha X \beta})\). Their might be an identification problem between the \(\alpha\)‘s and their \(\beta\)‘s. In a period of high house price increase one should expect that the \(\beta\) would be at least 1.

Based on previous tables we choose to present the estimation results for the median price and the model with both purchasing power and a constant. The regression results are in table 6.
Table 6: Regression results base model + constant (Q50)

| Q50                  | Coef.     | Robust Std. Err. | t       | P>|t| | Diagnostic tests |
|----------------------|-----------|------------------|---------|------|------------------|
| Rigid adjustment of tax relief, mortgage duration 25 years from 2005 on | GDP       | PP               | 0.85043 | 0.01830 | 46.47  | 0.000 | R² = 0.981 |
|                      |Constant   | 6857.89          | 1342.885| 5.11  | 0.000 | RMSE = 5309 |
|                      | GDP/ capita | PP              | 0.86472 | 0.02073 | 41.71  | 0.000 | R² = 0.979 |
|                      |Constant   | 4985.52          | 1452.473| 3.43  | 0.002 | RMSE = 5607 |
|                      | GDP/ capita > 20 years | PP   | 0.87591 | 0.02103 | 41.63  | 0.000 | R² = 0.979 |
|                      |Constant   | 3472.59          | 1480.622| 2.35  | 0.025 | RMSE = 5671 |
| Fully incorporate tax relief, mortgage duration 22 years from 2005 on | GDP       | PP               | 0.86303 | 0.03054 | 28.26  | 0.000 | R² = 0.976 |
|                      |Constant   | 6333.83          | 1648.589| 3.84  | 0.001 | RMSE = 5994 |
|                      | GDP/ capita | PP              | 0.87625 | 0.03369 | 26.00  | 0.000 | R² = 0.973 |
|                      |Constant   | 4502.75          | 1805.051| 2.49  | 0.018 | RMSE = 6390 |
|                      | GDP/ capita > 20 years | PP   | 0.88780 | 0.03423 | 25.94  | 0.000 | R² = 0.972 |
|                      |Constant   | 2958.56          | 1857.329| 1.59  | 0.120 | RMSE = 6444 |

Table 6 displays the regression results for 6 different specifications, the variables of which are all cointegrated. Observe the small standard errors due to the ‘superconsistency’ of parameter estimates when the variables are cointegrated. The coefficients for purchasing power (denoted by PP) show that there is almost a one-to-one relationship between purchasing power and the median price of housing.

Figure 5: Actual values vs. fitted values (Levels)
The figure 5 displays the actual values versus the fitted values of the model in levels. A cointegration relationship is present using this specification. The model does reasonably well explaining the general evolution.

Now that we have shown the long-run equilibrium relationship between purchasing power and the price of housing we can also estimate short-run dynamics by introducing an appropriate ECM. The error correction model extends a “regular” model in first-differences by including the lagged (1 period) residuals of the model in levels. Note that these residuals are to be interpreted as deviations from the long-run equilibrium. The coefficient for the error correcting term (ECT) displays the speed of convergence towards the long-run equilibrium. Since the first three specifications perform reasonably well (based on the RMSE-statistics), we show the results of the ECM’s for these specifications. Table 7 displays the results of the three ECM’s.

Table 7: Error Correction Models

| AQ50          | Coef.  | Robust Std. Err. | t     | P>|t| | Diagnostic tests |
|---------------|--------|------------------|-------|-------|------------------|
| GDP            | APP    | 0.6394626        | 0.07755 | 8.25 | 0.000 | R² = 0.7028 |
|               | ECT_{t-1} | -0.26969        | 0.13515 | -2.00 | 0.054 | RMSE = 3476.2 |
| GDP/capita     | APP    | 0.6343608        | 0.08270 | 7.67 | 0.000 | R² = 0.6734 |
|               | ECT_{t-1} | -0.25270        | 0.13737 | -1.84 | 0.075 | RMSE = 3644.1 |
| GDP/capita > 20 years | APP    | 0.6330462        | 0.08399 | 7.54 | 0.000 | R² = 0.6675 |
|               | ECT_{t-1} | -0.25351        | 0.1372 | -1.85 | 0.074 | RMSE = 3676.8 |

The ECM’s clearly show the short-run dynamics between AQ50 and APP, where PP denotes purchasing power. Observe that the median price of housing increases with approximately 0.63 euro if purchasing power increases by 1 euro. Furthermore observe that the error correction term is negative and significant (at the 10% level). It thus seems appropriate to state that there convergence towards the long-run equilibrium is present. Whenever there is a deviation from the long-run equilibrium, a correction takes place. Note however, that the RMSE’s as reported are rather high implying an imperfect fit of the model. This might be due to misspecification of short-run dynamics in our model.

Conclusions

The approach of the purchasing power for housing is somewhat unconventional. Variables in nominal terms, levels without log-specification, and a specific modeling of the interest rate in function of the mortgage duration are not standard concepts in house price literature. However, the purchasing power for housing facilitates the interpretation of the impact of different financial variables into which the house price can be decomposed and gives good empirical results for Belgium. It translates a micro-economic finance mechanism to the macro-economic house price explanation. The semi interest rate elasticity is higher than generally found in literature, which not even captures the effect that the interest rate is also a facilitator for longer mortgage durations. However, longer mortgage durations itself cannot be captured by the purchasing power for housing concept. In the case of Belgium, we introduced an innovation, where mortgage duration could increase because of fiscal optimization of the tax relief. This tax relief (2005) is easily incorporated into the model and the model showed evidence that it is fully capitalized into the house prices. This is in line with the fact that the Belgian house price index performed the highest climb between 2005:Q1 and 2008:Q4 among 20 countries on the basis of OECD data. Increased government support in the form of higher tax reliefs affects house prices, just as income and interest rates do, which is quite intuitive.
McQuinn and O’Reilly (2007) also found that house prices are cointegrated with the amount borrowed for 16 countries. However, the link between the parameter estimates and longer mortgage durations, as observed in many countries, as well as new financial products and policy interventions is not easy to interpret in their modeling approach.

The main focus of this paper is an enlargement of the price-to-income ratio. This ratio could raise over time, but a more than equivalent interest rate decrease could lead to lower repayments at the same time. Hence, it is more suitable to compare house prices with the purchasing power for housing, which is actually an affordability measure. If this ratio mounts up, it means that house prices increase more than what households could afford on the basis of income and interest evolution, resulting in a longer investment horizon (higher down payments or longer mortgage duration), or a higher repayment ratio. ECM’s are suitable to correct for this in the short run. However, this paper provides theoretical background to model the ratio between house price and purchasing power for housing directly since there is evidence that both series are cointegrated.

Variable interest rates are not addressed in this paper but interesting for future research. Is the “consumer surplus” represented by the difference in what households would actually pay in the short-term in terms of interests on variable interest rates and what they would pay in terms of interests on fixed interest rates, also capitalized in house prices? In this case, the affordability risk is shifted to later periods.

References


