Explaining the Spatial Variation in Housing Prices: An Economic Geography Approach

Karolien De Bruyne, Jan Van Hove*
European University College Brussels (EHSAL)
Centre for Economic Studies, KULeuven

March 29, 2006

Abstract

Housing prices vary geographically, even between municipalities. Local differences can be attributed to differences in incomes, demographic effects and real estate characteristics. This paper argues that one should additionally take into account the geographical location of municipalities. In particular, housing prices are affected by distance and travel-time to important economic centers offering jobs and extensive services. Following the economic geography literature, we develop a model showing the impact of geographical barriers on housing prices. We estimate this model on municipality-level housing prices for all 589 Belgian municipalities in 2001. We also differentiate between the two main regions of Belgium (Flanders and Wallonia) as both regions are characterized by political, economic and geographical differences. We distinguish between the attractive forces exercised by both the capital city Brussels and other regional clusters. Our empirical results confirm the expectations. Geographical barriers have significantly negative effects on housing prices. Nevertheless we find important differences between the regions and the means of transport considered.

1 Introduction

Housing prices vary considerably between countries and regions[1]. Differences between the macroeconomic situation and performance may account for this variation. Even between municipalities within the same country, however, price differences can be observed on the housing market. These local differences can easily be attributed to differences in income levels, demographic effects, government policy and quality of housing and living. This paper argues that there is an additional factor that should not be neglected as determinant of this price variation. The relative geographical position of municipalities has an impact on property values as well. In particular, housing prices are affected by the distance and travel time to important economic centers that offer many job opportunities and an extensive services network.

The economic geography literature stresses the importance of mobility, transport costs and travel time for the growth (and origin) of municipalities (see in particular chapter 8-13 in Fujita et al. (1999)). In

*Correspondence address: karolien.debruyne@econ.kuleuven.be and jan.vanhove@econ.kuleuven.be

[1] It is even often observed that real estate prices vary more than commodity prices (see e.g., Tabuchi (2001) for Japan). Especially in recent years the disparities have become larger in many countries (see e.g., Ley and Tutchener (2001)).

this paper we develop a simple model that shows the impact of geographical barriers on housing prices. We will estimate this model on average municipality-level housing prices for all 589 Belgian municipalities in 2001[2].

It is obvious that apart from geographical barriers there are other determinants of housing prices too. We will divide these other factors in two categories, namely *socio-economic variables* (like e.g., income) and *real estate characteristics* (like e.g., average age of houses or housing market conditions). Moreover, we split up our analysis at the national – Belgian – level into analyses for the northern (Flanders) and southern (Wallonia) part of Belgium. As both regions differ in terms of political, geographical and economic situation, such a regional analysis seems appropriate[3] .

The structure of this paper is as follows. In the next section we discuss the evidence in the literature about the impact of geographical barriers and mobility facilitators on housing prices. In section 3 we develop a theoretical model that explains the impact of geographical barriers on housing prices. Section 4 explains the empirical methodology, while our estimation results are discussed in section 5. Section 6 concludes.

[2] In an overview of the housing literature, Gibb and Hoesli (2003) call a coherent economic analysis of the spatial dimension of real estate markets a major research topic.

[3] Belgium consists of 3 regions (Flanders, Wallonia and Brussels). Housing prices tend to be highest in the Brussels' area because of the attractiveness of the capital city. Further, both Flanders and Wallonia are each composed of 5 provincies (for Flanders: East-Flanders, West-Flanders, Antwerp, Limburg and Flemish Brabant, for Wallonia: Liège, Namur, Hainaut, Luxembourg and Walloon Brabant).

2 Determinants of Housing Prices: Evidence about the Impact of Geography and Mobility

Some factors are traditionally considered to have an impact on housing prices. We categorize them as either socio-economic variables or real estate characteristics and provide a brief overview of the existing literature.

In terms of *socio-economic variables*, most importantly, the general economic performance of a country, region, city or household affects the equilibrium price on housing markets. Higher incomes enable potential buyers to spend more on housing. Empirical studies extensively confirm this expectation. However, people are also interested in finding a job – if possible even within their own municipality. Therefore, next to income, employment opportunities are an attractive force for municipalities which triggers increases in local housing prices (see e.g., Berg (2002)). We expect a higher unemployment percentage in a municipality therefore to drive housing prices downwards. The higher the importance of agriculture in a municipality, the lower therefore we also expect prices to be: there are fewer job opportunities available in the municipality.

Apart from income and job market perspectives, several other demographic effects may have an impact (e.g., Malpezzi (2002), Leishman and Bramley (2005)). First, recent population growth has an upward influence on housing prices. Migration between countries, regions and municipalities (like (sub)urbanization) affect housing prices. Generally speaking one expects to find a negative impact from emigration and a positive impact from immigration. Nevertheless, Magnusson and Turner (2003) point out that the impact of migration might be more complex and the outcome can be different from intuitive expectations. Further, the presence of autochthones and race diversity may influence prices both positively and negatively (e.g., MacPherson and Sirmans (2001)).

Among *real estate characteristics* we consider indicators of quality of life and market conditions. Quality of life, as reflected in environmental policy and characteristics, has a positive impact on housing prices. On the one hand, Saphores et al. (2005) show that polluting industries significantly reduce the prices of houses. On the other hand, the availability of green areas may be an attractive force.

Further, the balance or imbalance between supply and demand on the housing market matters as well. This depends on the number of houses sold relative to the available housing stock, as well as on the number of new construction projects (private or by real estate developers). The average age of houses may have an influence on prices too, although evidence is mixed regarding the a priori expected effect.

Finally, different kinds of government regulations and planning policies influence the market outcome (see e.g., Gollard and Boelhouwer (2002), Bardhan et al. (2003)). In particular different municipal tax rates may make municipalities more or less attractive to potential house buyers.

Government policies bring us automatically to our third and final category of determinants of housing prices. One of the most influential government policies, possibly in cooperation with private investors, are investments in the transport network, including roads, highways and public transport systems. All affect the commuting time and travel distance. The latter are at the core of the decision-making process of individuals and households who select the location of their future house, taking into account the travel time to their job. Geographical elements like distance and travel time cannot be neglected as driving forces for price diversity.

In particular, improved transport systems have a very positive effect on housing prices. This has been extensively argued, even in the early literature (von Thünen (1826), Alonso (1965), Muth (1969), Evans (1973), Haig (1986)). Empirical studies find a clear negative impact on housing prices caused by transport in many ways. A first way is the cost of transportation: higher transport costs reduce the value of houses (see Miller (1982) for an overview). Secondly, there is extensive evidence that the availability of public transport increases housing prices (Bajic (1983) for the Toronto subway, So et al. (1997) for the Hong Kong subway; RICS (2002) for an overview for the US and Canada). Transport networks positively affect land prices in Darlington (UK) as well (Cheshire and Sheppard (1995)). Thirdly, improvements in the transport system trigger higher housing prices as well (e.g., Coulson and Engle (1987), Damm et al. (1980), Dewees (1976) for Toronto, Laakso (1992) for Helsinki, Chau and Ng (1998) for Hong Kong, Henneberry (1998) etc.). Finally, even expected transport improvements may influence housing prices. Whereas Henneberry (1998) observed a negative impact in the short run due to anticipated nuisance, Yiu and Wong (2005) find positive price expectation effects. Engel et al. (2005) show that it might even be beneficial that real estate developers are allowed to bid for highway franchising, as they are willing to grant toll reductions given the increasing value of real estate properties in the neighborhood.

Recent studies clearly find evidence that proximity to economic centers increases housing prices. Fik et al. (2003) find evidence that the value of location is indeed related to its accessibility and distance to economic centers. They even argue that the value of location is not separable from other determinants of housing value. Similar results are obtained by Brounen and Huij (2004) for the Dutch housing market. Nevertheless we believe that relative location to economic centers, even taken separately, determines the value of houses.

3 Theoretical Framework: An Economic Geography Approach to Housing Prices

In this section we develop a simple model of housing prices in line with the role of distance and travel costs in the economic geography literature. We derive an expression for housing prices maximising the utility of consumers subject to their budget constraint, based on work by DeSalvo (1985).

Suppose we have two municipalities, the core C and the periphery P. We assume that workers living in the core will also work in the core. Workers living in the periperhy however have the choice between working in the periphery or commuting to a job in the core. A share δ of periphery residents earns its income in the periphery, a share of $(1-\delta)$ earns its income in the core. Income equals the wage, w, times the number of hours worked, W, minus the costs of commuting T. The communting cost is an increasing function of distance and entails both direct travelling costs and the opportunity cost of commuting. We assume the number of hours one works to be the same in the core and the periphery. This implies that workers who commute to the core have to give up some of their leisure to commuting time.

Income of a resident of the periphery working in the periphery is therefore $w_p W_p$, while a resident of the periphery working in the core has an income of $w_c W_c - T$[4]. Average income in the periphery is therefore $\delta w_p W_p + (1-\delta)(w_c W_c - T)$. The number of hours worked, W, equals the total number of hours at a person's disposal, M, minus the hours devoted to leisure, L, and minus the hours devoted to commuting, C, We can therefore rewrite the average income in the periphery as:

$$\delta w_p \left(M - L_p^p\right) + (1-\delta)\left(w_c\left(M - L_p^c - C\right) - T\right) \tag{1}$$

where L_p^p is the leisure if one lives and works in the periphery and L_p^c is the leisure if one lives in the periphery and works in the core. The difference between these two leisure times is of course just the commuting time $\left(L_p^p = L_p^c + C\right)$[5]. Plugging this in expression (1) gives us the expression for average income in the periphery:

$$\left(M - L_p^c - C\right)\left[\delta w_p + (1-\delta)w_c\right] - (1-\delta)T \tag{2}$$

We use this income expression in the budget constraint of the conumers' utility maximisation problem. Consumers have to make a double choice. We assume a Cobb-Douglas utility function where leisure has a weight of α and working (earning an income) has a weight of $(1-\alpha)$ as consumers on the one hand choose between leisure (L) and working (earning an income). On the other hand, consumers decide about spending their earned income either on housing (H)[6] or on consumption goods (X). The division of income between consumption goods and housing is reflected by another Cobb-Douglas utility function with a weight β for consumer goods and a weight $(1-\beta)$ for housing. Using the expression for income

[4] Workers from the periphery are attracted by higher wages in the core than in the periphery. These higher wages are the typical centripetal force in economic geography models. Assume that, in a Dixit-Stiglitz framework with differentiated products and free entry, the number of brands produced in the core is fixed and higher than the number obtained endogenously if labor demand is equalized to local labor supply. This high number of brands is the result of some core functions, like shopping centers, larger marketing efforts, etc. In order to produce those additional brands, the core needs more workers. As workers from the periphery face commuting costs, the only way to convince them to commute, is by paying higher wages. Which individuals will commute in the end might be the result of a selection process, i.e. the core attracts the best workers among those willing to commute in the periphery.

[5] Note that $L_p^p = L_c^c$, the total amount of leisure is the same if one works in the region of residence, whatever that region is. This is true because the total working time in both regions is assumed to be the same.

[6] H entails the cost of having a place to live - this might entail both buying and renting. In our empirical part we will focus on buying a house.

(2), we get the following maximisation problem for residents of the periphery:

$$\max U = \left(L_p^c\right)^{\alpha} X^{\beta(1-\alpha)} H^{(1-\beta)(1-\alpha)} + \lambda\left[\left(M - L_p^c - C\right)(\delta w_p + (1-\delta) w_c) - (1-\delta)T - p_H H - pX\right]$$

where p_H is the price of housing and p the price of consumption goods[7].

The four first order conditions of this maximisation problem are:

$$\frac{\partial U}{\partial L_p^c} = \alpha\left(L_p^c\right)^{\alpha-1} X^{\beta(1-\alpha)} H^{(1-\beta)(1-\alpha)} - \lambda\left[\delta w_p + (1-\delta) w_c\right] = 0 \tag{3}$$

$$\frac{\partial U}{\partial X} = (1-\alpha)\,\beta X^{\beta(1-\alpha)-1}\left(L_p^c\right)^{\alpha} H^{(1-\beta)(1-\alpha)} - \lambda p = 0 \tag{4}$$

$$\frac{\partial U}{\partial H} = (1-\beta)(1-\alpha)\, H^{(1-\beta)(1-\alpha)-1}\left(L_p^c\right)^{\alpha} X^{\beta(1-\alpha)} - \lambda p_H = 0 \tag{5}$$

$$\frac{\partial U}{\partial \lambda} = \left(M - L_p^c - C\right)(\partial w_p + (1-\delta) w_c) - (1-\delta)T - p_H H - pX = 0 \tag{6}$$

Dividing (3) by (5) leads us to the following expression for leisure:

$$L_p^c = \frac{\alpha}{(1-\alpha)(1-\beta)} \cdot \frac{p_H H}{\delta w_p + (1-\delta) w_c} \tag{7}$$

Equation (7) illustrates the trade-off between leisure and housing prices. The share of spending on housing ($p_H H$) in the (average) wage earnings ($\delta w_p + (1-\delta)w_c$) is positively related to leisure. If one chooses to have more leisure (L_p^c), this implies that one commutes less ($L_p^p = L_p^c + C$), and therefore lives closer to the centre where one would expect housing prices to be higher. One therefore trades off more leisure (opt for living in the centre) against a lower spending on housing (opt for living in the periphery).

Dividing (5) by (4) gives us the trade off between consumption and housing:

$$\frac{(1-\beta)}{\beta}\frac{X}{H} = \frac{p_H}{p} \tag{8}$$

The higher the housing prices relative to the goods prices, the more one spends on goods compared to housing.

Plugging (8) into (6) leads us to a first expression for housing prices:

[7] Note that in a Dixit-Stiglitz framework, higher wages in the core than in the periphery imply also higher prices for consumption goods in the core (see e.g., Helpman (1998)). One can possibly interpret higher prices as high-quality of brands (vertically differentiated goods). As one assumes love for variety in these models, the price of consumer goods should be interpreted as a price index of all brands produced, ignoring differences in income elasticities and transportation costs for goods at this moment.

$$p_H = \frac{\left(M - L_p^c - C\right)\left(\delta w_p + (1-\delta) w_c\right)(1-\beta) - (1-\beta)(1-\delta) T}{H} \tag{9}$$

Finally, substituting leisure away using (7) we get our final expression for housing prices:

$$p_H = \frac{(1-\alpha)(1-\beta)\left[(M - C)\left(\delta w_p + (1-\delta) w_c\right) - (1-\delta) T\right]}{H} \tag{10}$$

Equation (10) illustrates that housing prices are determined by income, housing demand and commuting costs. Additionally we assume the housing market on average to be in equilibrium such that demand equals supply. First we see that a higher supply of housing[8] implies a lower housing price. Secondly, a higher income (due to either a higher number of hours worked or due to a higher wage) implies a higher housing price. The easiest way to see this is by substituting $(M - C)$ by $(W + L_p^c)$. This allows us to further analyse the impact of distance on housing prices. An increase in the commuting distance will negatively affect housing prices in two ways. First of all because of the increase in costs T. If commuting distance increases, commuting costs increase too and people are prepared to pay less for a house that is further away from the core. Secondly, an increase in commuting time implies fewer leisure time. Since people value leisure too they want to be compensated for the loss in leisure by saving on their housing expenditures. This is the trade-off between leisure and housing prices in equation (7).

4 Empirical Methodology

4.1 Empirical model

Several models and testable theories have been developed in the literature. Many of them try to understand better the underlying essential market processes in the real estate sector. We look for a parsimonious empirical model that captures most of the price variation observed between municipalities and that pays attention to the role of geographical barriers. For the time being, we ignore more complex modeling techniques, that may undoubtedly provide tools for a more detailed and in-depth analysis of some of our findings. Following our theoretical model we know that income, housing supply and distance are three important explanatory variables for housing prices. As already mentioned, however, other socio-economic variables and real estate characteristics are important too. We therefore extend the model with these extra explanatory variables. The equation we will estimate for each municipality i is the following[9]:

$$\text{lnHP}_i = \alpha_0 + \alpha_1 \text{ lnI}_i + \alpha_2 \text{ UE}_i + \alpha_3 \text{ FHO}_i + \alpha_4 \text{ AGR}_i + \alpha_5 \text{ lnPD}_i + \alpha_6 \text{ TAX}_i + \alpha_7 \text{ AGE}_i + \alpha_8 \text{ D}_i + \alpha_9 \text{ S}_i$$
$$+ \alpha_{10} \text{ lnSAT}_i + \alpha_{11} \text{ DIST}_i + \varepsilon_i$$

with

[8] E.g. a larger number of construction projects thanks to lower investment costs

[9] ln stands for logartihms.

HP: housing prices

I: income

UE: unemployment rate

FHO: percentage of foreign house owners

AGR: importance of agriculture

PD: population density

TAX: municipal tax rate

AGE: average age of housing

D: demand (population growth)

S: supply of houses

SAT: satisfaction indicator (satisfied with shops, satisfied with green)

DIST: distance measures (distance and travel time by car, travel time by train, dummy for the presence of a station)

The dependent variable in our estimations is the average housing price in each municipality in 2001 expressed in Euros. The source for this variable is the Belgian national institute for statistics (NIS). The independent variables can be classified into three categories: socio-economic indicators, real estate characteristics and geographic indicators. For a detailed description of the explanatory variables, we refer to Table 1 in the Appendix. We use data for 2001 since some of our explanatory variables result from the socio-economic poll that only takes place every ten years.

We estimate our equation by OLS. A correction for heteroskedasticity is applied to the cross-sectional regression as the error term of the model shows considerable variation over municipalities. We took logarithms of some variables[10] in order to obtain elasticities. However, for most variables this was not possible. Their coefficients are therefore to be interpreted as semi-elasticities.

We add fixed effects for each of the provinces, as unobservable factors may influence the estimated coefficient of the other variables. It appears that the geographical variables are particularly sensitive to the inclusion of these fixed effects. We however focus on the estimation results without fixed effects but mention when the inclusion of fixed effects lead to different results[11]. Unfortunately, due to lack of data for more years, we are unable to use panel data to test our hypotheses for the moment.

4.2 Expected impact of geographical barriers

Mobility plays an important role in peoples' lives nowadays. The distance or travel time to the location of professional activity is crucial in deciding where to buy a house. Since a shorter distance or travel time implies more free time, one will be prepared to pay a higher price for such houses. We define

[10] We took logarithms of housing prices, income, population density and the satisfaction indicators.

[11] The estimation results with fixed effects are available from the authors upon request.

"geographically attractive" in two ways; we look at a capital cluster and at provincial clusters. Belgium is a small country with a centrally located capital offering the highest employment within the country, thanks to the presence of many international institutions and multinationals[12]. Moreover, Belgium also has other large municipalities that are capitals of provinces[13]. In these municipalities there are also extensive job opportunities. We therefore investigate the importance of distance and travel time with respect to both the country's capital and the provincial capitals. We use a variety of geographical variables to answer this research question.

From our model and previous evidence in the literature, we expect municipalities with a smaller distance or a shorter travel time to these capitals to have a higher average housing price. We moreover make a difference between commuting by car or by train. As far as commuting by car is concerned, we make a difference between the commuting distance and the commuting time. One can live rather far from one's place of work but have a perfect highway connection. For commuting by train it is obvious that only the travel time matters. We expect a negative impact of commuting distance and time on housing prices. We also expect a larger impact of travel distance by car for provincial capitals than for Brussels. Indeed, more commuters take the train to get to Brussels while more people prefer the car for commuting within the province. For the same reason, we expect a larger impact of travel time by train for Brussels than for provincial capitals. Finally, we add some dummy variables to the empirical specification in order to capture possible impacts from railway stations or a highway access.

We will estimate this equation for the whole of Belgium. There are however important differences in housing prices between the three Belgian regions. In the Brussels region housing prices are the highest[14]. Unfortunately there are only 19 communities in the capital region such that we can not perform a separate estimation for this region. We can however perform a separate analysis for the Flanders and Walloon region. Housing prices in Flanders are on average higher than in Wallonia. We want to analyse whether some variables are more important in explaining housing prices in one region compared to the other one. In particular, we wonder whether the impact of geographical elements is identical in both neighbouring regions.

[12] Almost one out of 6 Belgian jobs are located in the Brussels region.

[13] The provincial capitals are: Gent for Oost-Vlaanderen, Brugge for West-Vlaanderen, Antwerpen for Antwerpen, Hasselt for Limburg, Leuven for Vlaams-Brabant, Waver for Waals-Brabant, Luik for Luik, Namen for Namen, Bergen for Henegouwen, Aarlen for Luxemburg and Brussels for Brussels.

[14] The average housing price in the Brussels region is 100557 Euros, the average price in Flanders is 95655 Euros while in Wallonia it is 78479 Euros.

5 Discussion of results

5.1 Results for the entire country (national level)

We subsequently discuss the impact of the three categories of variables on housing prices in Belgium. We start by focussing on the variables in the first two categories of explanatory variables. The results are shown in Table 3. Afterwards, we add geographical variables and analyse their importance (Table 4).

First, we discuss the socio-economic factors. The income level has a significantly positive impact throughout the results. A higher income per capita increases the available funds dedicated to the housing budget. An increase of 1 % in income in a municipality will increase local housing prices by approximately 0.3 %. Moreover, high unemployment municipalities are less attractive.

Some other socio-economic factors appear to matter as well. We find a positive effect of a higher percentage of foreign inhabitants in a municipality. In particular demographic effects are very important however. There appears to be an urbanization effect: a higher population density increases the average housing price. In addition, municipalities with a higher population growth in recent years tend to have higher housing prices as well. The latter observation can be considered as evidence of price increases as a result from increased demand. The importance of agriculture and the municipal tax rate however apparently do not play a role in determining housing prices[15].

Next, we turn to the real estate characteristics. Firstly, the average age of the existing housing stock has a mixed impact on the average housing price. The significantly negative impact of house age disappears once we take into account provincial fixed effects. In the latter case the availability of older houses may even have a positive effect on prices. Probably we capture here the impact of residential properties in major municipalities that tend to be popular on the housing market, in particular for restoration and renovation. Secondly, a relatively large supply of houses on the secondary market decreases prices, as one would expect. Finally, we add some measures of local happiness. We only report local happiness with respect to the availability of shops, and of the availability of green areas (like parks, woods, etc.). The former appears to have no impact, whereas the latter is very significant and shows a very positive effect. Hence, people have a high willingness to pay for houses in locations with considerable green areas.

One could therefore conclude that housing prices are indeed affected by both socio-economic variables and real estate characteristics market. We however now want to add our geographical variables to determine their impact on housing prices. In Table 4 we subsequently add the travel distance by car, travel time by car and travel time by train. Finally, we add the presence of a station as an explanatory variable[16].

[15] Note that if we do not include the satisfaction with respect to 'green' variable, the agricultural variable does become significant.

[16] Note that the number of observations drops to 277 when we add either the presence of a station or the travel time by

As is obvious from Table 4, the socio-economic variables and the real estate characteristics have the same signs as before. As far as the geographical variables are concerned, one can say that generally speaking longer distance and/or longer travel time to capitals drives housing prices down. The distance to Brussels appears to be almost equally important as the distance with respect to the provincial capital. The travel time by car is important both to Brussels and to the provincial capital, but slightly more influential for Brussels, if one does not add provincial fixed effects to the specification. Taking into account these provincial fixed effects, travel time by car to Brussels is no longer significant. This can be explained by the small size of Belgian provinces: travelling through one entire province by car doesn't take much time, hence a common provincial effect can be expected for travel time by car[17].

The presence of a station itself does not play a role at all for the housing prices. The travel time by train however turns out to be important. Nevertheless, it is only the travel time by train to Brussels that matters[18] ; the travel time by train to a provincial capital does not play a role. As already mentioned before, this could have been expected. In commuting to the provincial capital, people use the car more often than the train.

The coefficients of the geographical variables are fairly small however. They vary between 0.001 and 0.002. This implies that an increase in travel time of 1 minute or an increase in travel distance by 1 kilometre will lower housing prices by between 0.001 and 0.002 %.

5.2 Results at the Regional Level: Determinants of Housing Prices in Flanders and Wallonia

Since there are large differences in housing prices between the northern (Flanders) and the southern (Wallonia) part of Belgium (cfr. Table 2), we are also interested in knowing whether the determinants of housing prices differ between the regions. In order to answer this question we split up the sample and re-estimate our equation for the 2 regions separately. Tables 5 and 6 show the estimation results for Flanders and Wallonia respectively[19] .

Again, we will first of all focus on the socio-economic variables and the real estate characteristics.

Income appears to play a smaller role in Wallonia than in Flanders. This might be an indication of different preferences for housing reflected in a different propensity to spend income on housing in both regions. A higher unemployment rate in a municipality has a negative impact on the housing price in both regions. However, the impact in Wallonia is almost four times as high as the impact in Flanders. This can be explained by the fact that not only the average employment rate but also the variance in

train as an explanatory variable. The reason for this is that not every municipality has a station. Finally, note that the results for the presence of a highway access are insignificant and hence not reported here.

[17] One could therefore state that the 'provincial' effect dominates the 'geographical municipality' effect

[18] The positive effect of closeness to Brussels may partly be explained by the expectation of a better transport network around Brussels (GEN-project and Brabant-Brussels-network). Further research is needed to figure out this possibility.

[19] There are 307 Flemish and 263 Walloon municipalities. Including the stations or travel time by train as an explanatory variable decreases the number of observations to 141 for Flanders and 123 for Wallonia.

the unemployment rate in Wallonia is much higher (cfr. Table 2). The importance of agriculture in a municipality is almost always insignificant for both regions.

As far as the importance of foreign owners is concerned, we observe very different effects between the two regions. In Wallonia they either have no or a negative impact on housing prices. In Flanders, however, more foreign owners drive prices up. This can be explained by the 'Netherlands' effect. Housing prices in the Netherlands are much higher than in Belgium such that Dutch people buy houses just over the border in Flanders. Moreover, since a few years, Dutch people can deduct the interests on the financing of real estate they purchase abroad from their taxes. Municipalities in the upper north part of Belgium are indeed well known for their high percentage of Dutch inhabitants. Of course, a higher demand for houses in those municipalities drives housing prices up. Also a higher migration to the economically more prosperous Flanders may explain this outcome.

Taxes appear to have a higher impact in the Flanders region. This makes sense because the variance of this tax variable is higher in Flanders than in Wallonia. It is therefore obvious that this variable will explain differences in housing prices better in Flanders than in Wallonia. There appears to be no urban effect (population density) in Flanders, however, there is an urban effect in Wallonia. This could be explained as follows. Since the population density in Flanders is already almost twice as high as in Wallonia, a further increase will have less impact on housing prices. In Flanders there are also more 'large' municipalities than in Wallonia, implying that one will be more often close to an urban centre than in Wallonia. Increases in population density will therefore explain differences in housing prices in Wallonia much better.

The coefficient of housing age is in most specifications not significant. Even if it is significant, the results for Flanders and Wallonia are different. The presence of more recently built houses drives prices up in Flanders while it will lower the average housing price in Wallonia. One possible explanation for this difference is the presence of a lot of older farms in Wallonia. These are very wanted and people are prepared to pay a lot of money for an old farm they can renovate. Adding more recently built houses in Wallonia might therefore lower the housing prices there.

There is an important demand effect in both regions, but it is stronger in Wallonia than in Flanders. This is no surprise because the population growth in Wallonia is higher than in Flanders. The important supply effect on the other hand is larger in Flanders. If one would want to lower housing prices in Belgium one would therefore better opt for a policy increasing the supply of houses in the northern part of the country.

Happiness with the presence of shops does not appear to have an influence on housing prices. However, municipalities where people are happy with the green around have higher housing prices. This effect appears to be stronger in Wallonia where people on average are less happy with the green around but where the variance in this variable is larger.

As far as the geographical variables are concerned we have one big constant in our results. For Flanders the distance and travel time by car appears to matter only for the provincial capitals. In Wallonia however, the distance and travel time by car matters most for Brussels. The presence of a station in itself is not important. Moreover, it is only for Wallonia that the travelling distance by train to Brussels matters. This makes sense because in Flanders there are also a lot of people working in the larger provincial capitals to which they mostly commute by car[20] .

6 Conclusion

We investigate the impact of geographical elements on housing prices in Belgium, Flanders and Wallonia. To a large extent, our expectations are confirmed by the econometric estimation results. Geographical barriers have a negative effect on local housing prices. Accessibility of an economic cluster causes price increases, even after taking into account a large variety of other determinants. In particular, distance to the capital city has the largest negative effect on housing prices, taking into account provincial fixed effects. The travel time by car, however, appears to matter only for the provincial cluster, whereas travel time by train appears to affect only commuters going to the capital city. However, these results are influenced by whether or not one controls for provincial fixed effects in the estimation. Moreover, the estimated coefficients are fairly small.

The main findings regarding the socio-economic and real estate determinants confirm the expectations as well. Housing prices tend to be higher in municipalities with a higher average income level, with lower unemployment, with more satisfaction about green areas, with higher population growth in recent years or higher population density, and – maybe surprisingly – with a larger share of foreigners living there. A larger proportion of older houses in a municipality has a mixed impact on the price of houses sold. Higher municipal tax rates mostly have a negative effect on housing prices, although the estimated coefficient is not always statistically significant. The impact from more agriculture or a higher satisfaction concerning the persence of shops is also statistically insignificant. A relatively large supply of houses on the secondary market decreases prices, as one would expect.

Generally speaking, the impact of socio-economic and real estate factors at the regional level is similar to the impact at the national level. The impact of the geographical variables differs nevertheless. In Flanders, the more densely populated region, with a better economic performance and higher attractiveness from the provincial clusters, both distance and travel time to those provincial clusters have a significantly negative effect on housing prices. Distance and travel time to Brussels do no longer matter. In the Walloon region, which depends more heavily on Brussels for employment opportunities, it is the

[20] The average unemployment rate in the 5 Flemish provincial capitals is 5.77 % while in the Walloon provincial capitals it is 10.23 %.

distance and travel time to Brussels that matters for housing prices, not the distance and travel time to the provincial clusters.

Finally, neither the presence of a railway station, nor the presence of a highway access appears to have a significant impact on the variation in housing prices.

These findings have important policy implications. Transport networks and public transport are policy tools to relieve upward price pressures in densely populated areas (or attractive poles, like major municipalities). From a social redistributive point of view, differences in real estate prices can be softened by improving the accessibility of attractive poles. However, it is important to determine which economic center should be focused on a priori.

An important, and critical, question is whether our results for Belgium can be generalized for other countries. There are reasons to believe they can. Belgium is a small, densely populated country with an extensive road-, highway- and public transport-system. If geographical elements have an impact on housing prices in Belgium, they definitely also have an impact on other, less densely populated countries. We expect to find even a larger impact in many other countries, which opens the door to further research.

Appendix

Table 1: **Explanatory variable description and data sources**

Abbreviation	Variable name	Description of variable	Source
Socio-economic variables			
I	Income	Net taxable income per capita	NIS, ECODATA
UE	Unemployment rate	Unemployment as a percentage of labour force	Socio-economic inquiry 2001
FHO	Foreign house owners	Foreign house owners as a percentage of total house owners	NIS, ECODATA + own calculations
AGR	Importance of agriculture in municipality	Agriculture as a percentage of total surface area	NIS, ECODATA + own calculations
PD	Urban effect (population density)	Population per km^2	NIS, ECODATA
TAX	Municipal tax rate	Tax rate	FOD Finance
Real estate characteristics			
AGE	Age of houses	Share of houses built after 1981	NIS, ECODATA
D	Demand for houses	Population growth	NIS, ECODATA
S	Supply of houses	Share of houses sold as a percentage of all houses	NIS, ECODATA
SATG/SATS	Satisfaction indicators	Satisfaction over the presence of 'green' (SATG) or 'shops' (SATS) in the municipality	NIS, ECODATA
Geographical indicators			
DISTCB	Distance by car to Brussels	Expressed in kilometres	www.mappy.be
DISTCP	Distance by car to provincial capital	Expressed in kilometres	www.mappy.be
TIMECB	Travel time by car to Brussels	Expressed in minutes	www.mappy.be
TIMECP	Travel time by car to provincial capital	Expressed in minutes	www.mappy.be
TIMETB	Travel time by train to Brussels	Expressed in minutes	www.mappy.be
TIMETP	Travel time by train to provincial capital	Expressed in minutes	www.mappy.be
STATION	Dummy for presence of station in community	Dummy = 1 if a station in the municipality	www.mappy.be

Table 2: **Average and variance of dependent and explanatory variables**

	Avg Belgium	Var Belgium	Avg Flanders	Var Flanders	Avg Wallonia	Var Wallonia	Avg Brussels	Var Brussels
HP	88936	3,81E+08	95655	2,36E+08	78479	3,13E+08	124567	1,54E+08
I	6838	940721	7079	775294	6504	796222	7557	2794888
UE	6,26	10,61	3,93	1,37	8,66	7,82	10,8	10,93
FHO	4,07	28,52	2,44	14,57	4,83	21,53	19,8	55,63
AGR	55,38	445,3	57,84	352,71	56,19	389,88	4,47	26,6
PD	6,8	305,24	5,13	19,46	3	18,2	86,26	2452,76
TAX	7,05	1,09	6,84	1,25	7,25	0,85	7,68	0,28
AGE	18,99	49,09	22,79	30,4	15,63	29,68	4,01	6,22
D	6,59	46,32	6,18	29,85	7,57	63,61	-0,3	12,84
S	0,02	0	0,02	0	0,02	0	0,03	0
SATS	85,8	597,49	92,11	388,95	75,94	608,79	120,45	675,94
SATG	109,73	315,55	112,65	202,03	105,61	393,17	119,78	650,53
DISTCB	80,07	1707,46	69,64	1114,86	97,77	1673,87	4,42	5,28
DISTCP	34,9	465,93	32,87	294,1	39,49	609,06	4,42	5,28
TIMECB	57,02	589,6	50,98	355,17	67,58	583,8	8,74	17,87
TIMECP	29,09	190,38	28,51	121,61	31,25	249,13	8,74	17,87
TIMETB	67,38	1174,55	57,47	598,62	83,97	1287,49	16,62	142,26
TIMETP	35,11	645,39	34,82	644,58	37,37	664,5	16,62	142,26
STATION	0,47	0,25	0,46	0,25	0,48	0,25	0,68	0,23

Table 3: **Socio-economic variables and real estate characteristics**

	Coeff	Std Error	t-statistic
C	7.1358**	0.7101	10.0491
I	0.3128**	0.0796	3.9279
UE	-0.0271**	0.0031	-8.6972
FHO	0.0089**	0.0012	7.4595
AGR	0.0004	0.0003	1.1279
PD	0.0620**	0.0099	6.2356
TAX	-0.0068	0.0054	-1.2533
AGE	-0.0047**	0.0016	-2.8641
D	0.0100**	0.0015	6.8157
S	-7.2125**	1.1088	-6.5047
SATS	0.0049	0.0223	0.2206
SATG	0.3650**	0.0439	8.3199
R^2	0.73		
Adj R^2	0.72		

Note: OLS estimation with White heteroskedasticity-consistent standard errors; *(*) indicates significance at the 10 % (5 %) level

Table 4: **Socio-economic variables, real estate characteristics and geographical indicators for Belgium**

	Coeff	Std Err	t-stat	Coeff	Std Err	t-stat	Coeff	Std Err	t-stat	Coeff	Std Err	t-stat
C	8.3578**	0.7215	11.58	8.3739**	0.7280	11.5	7.6490*	1.1901	6.42	7.1355**	0.7102	10.05
I	0.1929**	0.0793	2.43	0.1890**	0.0795	2.38	0.2598**	0.1298	2.00	0.3120**	0.0800	3.90
UE	-0.0289**	0.0032	-9.10	-0.0291**	0.0032	-9.12	-0.0259**	0.0054	-4.81	-0.0271**	0.0031	-8.72
FHO	0.0010**	0.0012	8.28	0.0097**	0.0012	8.18	0.0088**	0.0033	2.69	0.0090**	0.0012	7.36
AGR	-0.0002	0.0003	-0.72	-0.0003	0.0003	-0.74	-0.0007	0.0006	-1.20	0.0004	0.0003	1.14
PD	0.0232**	0.0102	2.27	0.0222**	0.0104	2.14	0.0474**	0.0161	2.95	0.0619**	0.0099	6.25
TAX	-0.0090	0.0060	-1.50	-0.0080	0.0062	-1.29	-0.0118*	0.0070	-1.67	-0.0068	0.0054	-1.25
AGE	-0.0031**	0.0016	-1.98	-0.0033**	0.0016	-2.06	-0.0043*	0.0025	-1.71	-0.0047**	0.0016	-2.84
D	0.0085**	0.0014	6.12	0.0086**	0.0014	6.23	0.0134**	0.0021	6.42	0.0100**	0.0015	6.81
S	-6.1203**	1.1194	-5.47	-6.1813**	1.1123	-5.56	-7.4306**	1.6844	-4.41	-7.2221**	11.147	-6.48
SATS	0.0294	0.0218	1.35	0.0295	0.0217	1.36	0.0201	0.0353	0.57	0.0043	0.0227	0.19
SATG	0.3443**	0.0422	8.16	0.3537**	0.0422	8.39	0.3751**	0.0649	5.78	0.3667**	0.0445	8.23
DISTCB	-0.0010**	0.0002	-4.78									
DISTCP	-0.0011**	0.0003	-3.92									
TIMECB				-0.0018**	0.0004	-4.71						
TIMECP				-0.0015**	0.0005	-3.23						
TIMETB							-0.0010**	0.0005	-2.18			
TIMETP							-0.0003	0.0003	-0.97			
STATION										0.0025	0.0108	0.2312
R^2	0.75			0.75			0.79			0.73		
Adj R^2	0.74			0.74			0.78			0.72		

Note: OLS estimation with White heteroskedasticity-consistent standard errors; *(*) indicates significance at the 10 % (5 %) level

Table 5: **Socio-economic variables, real estate characteristics and geographical indicators for Flanders**

	Coeff	Std Err	t-stat	Coeff	Std Err	t-stat	Coeff	Std Err	t-stat	Coeff	Std Err	t-stat
C	6.2095**	0.8969	6.9462	6.5227**	0.9138	7.1376	5.3503**	13.513	3.9593	5.5435**	0.8212	6.7454
I	0.5412**	0.1083	4.9991	0.5081**	0.1106	4.5936	0.5843**	0.1518	3.8493	0.6104**	0.0952	6.4115
UE	-0.0123*	0.0065	-1.8960	-0.0137**	0.0066	-2.0778	-0.0191*	0.0105	-1.8322	-0.0118*	0.0064	-1.8343
FHO	0.0075**	0.0014	5.5329	0.0080**	0.0014	5.7108	0.0065*	0.0038	1.7144	0.0068**	0.0014	4.9044
AGR	-0.00001	0.0006	-0.1315	-0.00001	0.0006	-0.1259	-0.0005	0.0007	-0.6311	0.00001	0.0006	-0.16698
PD	-0.0164	0.0209	-0.7814	-0.0184	0.0207	-0.8902	0.0073	0.0321	0.2295	-0.0070	0.0197	-0.3547
TAX	-0.0124*	0.0069	-1.7889	-0.0124*	0.0072	-1.7228	-0.0168**	0.0085	-1.9818	-0.0098	0.0064	-1.5430
AGE	0.0039	0.0024	1.6171	0.0039*	0.0023	1.6720	0.0062	0.0040	1.5637	0.0037	0.0023	1.5736
D	0.0044**	0.0022	1.9768	0.0042*	0.0022	1.9488	0.0049	0.0035	1.3806	0.0050**	0.0022	2.2910
S	-7.6244**	1.5029	-5.0732	-7.4694**	1.4885	-5.0182	-6.0024**	24.363	-2.4637	-8.1119**	1.4243	-5.6952
SATS	0.0118	0.0357	0.3313	0.0139	0.0356	0.3896	0.0089	0.0484	0.1835	-0.0016	0.0346	-0.0472
SATG	0.1278*	0.0712	1.7958	0.1296*	0.0717	1.8066	0.2214*	0.1207	1.8350	0.1363*	0.0699	1.9501
DISTCB	-0.0004	0.0003	-1.577									
DISTCP	-0.0008*	0.0004	-1.879									
TIMECB				-0.0008	0.0006	-13.263						
TIMECP				-0.0016**	0.0007	-23.524						
TIMETB							-0.0003	0.0005	-0.6534			
TIMETP							-0.0003	0.0004	-0.9059			
STATION										0.0066	0.0136	0.4840
R^2	0.65			0.66			0.71			0.65		
Adj R^2	0.64			0.64			0.68			0.63		

Note: OLS estimation with White heteroskedasticity-consistent standard errors; *(*) indicates significance at the 10 % (5 %) level

Table 6: **Socio-economic variables, real estate characteristics and geographical indicators for Wallonia**

	Coeff	Std Err	t-stat	Coeff	Std Err	t-stat	Coeff	Std Err	t-stat	Coeff	Std Err	t-stat
C	9.4603**	0.9701	9.7472	8.7369**	1.0035	8.7064	8.5263**	1.5474	5.5100	6.9995**	0.8893	7.8711
I	0.1727	0.1106	1.5610	0.2588**	0.1132	2.2871	0.3161*	0.1677	1.8844	0.4388**	0.1040	4.2183
UE	-0.0452**	0.0051	-8.7787	-0.0423**	0.0053	-7.9817	-0.0364**	0.0090	-4.0410	-0.0359**	0.0052	-6.9234
FHO	0.0005	0.0026	0.1927	0.0004	0.0027	0.1333	-0.0082**	0.0037	-2.1892	0.0006	0.0029	0.2130
AGR	-0.0008*	0.0005	-1.7031	-0.0004	0.0005	-0.9541	-0.0011	0.0009	-1.3229	0.0005	0.0004	1.0885
PD	0.0259	0.0159	1.6373	0.0280*	0.0168	1.6715	0.0584**	0.0221	2.6391	0.0380**	0.0168	2.2619
TAX	-0.0116	0.0100	-1.1580	-0.0145	0.0103	-1.4160	-0.0045	0.1421	-0.3165	-0.0194*	0.0104	-1.8613
AGE	-0.0017	0.0027	-0.6473	-0.0034	0.0027	-1.2722	0.0015	0.0037	0.4113	-0.0052*	0.0028	-1.8464
D	0.0065**	0.0016	4.0435	0.0076**	0.0017	4.6477	0.0083**	0.0021	4.0113	0.0085**	0.0017	5.1149
S	-4.6576**	16.912	-2.7540	-5.1146**	1.6998	-3.0089	-7.0196**	2.3670	-2.9656	-5.5343**	17.244	-3.2094
SATS	0.0346	0.0259	1.3381	0.0302	0.0264	1.1442	0.0028	0.0482	0.0583	0.0257	0.0275	0.9344
SATG	0.1886**	0.0533	3.5374	0.1795**	0.0545	3.2955	0.1129	0.0796	1.4189	0.1785**	0.0573	3.1152
DISTCB	-0.0014**	0.0003	-4.4377									
DISTCP	-0.0008**	0.0004	-2.4134									
TIMECB				-0.0012**	0.0005	-3.4069						
TIMECP				-0.0004	0.0006	-0.6179						
TIMETB							-0.0013**	0.0006				
TIMETP							0.0004	0.0005				
STATION										0.0026	0.0155	0.1657
R^2	0.77			0.76			0.84			0.75		
Adj R^2	0.76			0.75			0.82			0.74		

Note: OLS estimation with White heteroskedasticity-consistent standard errors; *(*) indicates significance at the 10 % (5 %) level

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