The impact of urban traffic and environmental conditions on the housing market: an analysis of Italian and Slovenian urban areas

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Abstract

Urban traffic has been shown to affect the housing market. The objective of this paper is to explore the impact of urban traffic on the property market in a "former" and a "new" EU-member country. In this context, this article investigates the relationship between the property price effect due to changes in environmental conditions and the countries' purchasing power. The paper starts with the estimation of the marginal willingness to pay for air quality in the North-Italian town of Padua by applying the hedonic pricing method. Since Italy is bordering on the new EU-member country Slovenia, a further hedonic model is set up for urban areas in Slovenia. Consequently, the impact of the urban traffic on the housing market is discussed from different perspectives considering the location-specific differences and similarities regarding the housing market, urban transport systems, economic development and environmental criteria related to urban traffic. In the first section, the hedonic pricing models are developed by disaggregating homogenous areas within Italian and Slovenian towns regarding accessibility, socio-economic criteria, other environmental factors etc. The next section involves the estimation of hedonic regressions. Finally, the results are presented with the focus on the influence of the urban traffic (and other environmental conditions) on the property prices with similar geographic and environmental pre-conditions, but differences in public policy and economic development. Moreover, possible future implications of the urban traffic systems are indicated.
Keywords: urban transport, purchasing power disparities, hedonic model, housing market, environment, supply roads, traffic density.

1 Introduction

A well functioning economic system requires an excellent urban transport system referred to as the link between offer and demand. As variations in housing prices show, urban transport has an interacting impact on social welfare and economy: the fact of accessibility (e.g. the proximity to and existence of job possibilities) raises housing prices, whereas noise and air pollution negatively interact with real estate prices. On the basis of country-specific distinctions exemplified by the Slovenian town of Maribor and the North-Italian town of Padua, this paper evaluates the property price effect caused by urban transport in 2002/2003 in different urban areas confronting a "new" EU-country with a lower overall price level before EU-membership to a country with earlier EU membership. In Maribor, urban traffic represents the major source of VOC-, PM_{10}- and NO_x-pollutants in comparison to heating and industry (Lukan [1], Smaka-Kincl et al [2]), even though the former most important industrial centre of Slovenia was located in Maribor. Urban traffic is also considered the major source of noise and air pollution in Padua (ARPAV [3], [4]), even though the town is characterized by different architectural aspects. In relation to the larger surface of Padua compared to Maribor, commercial transport in Padua is limited to roads remote from the centre, whereas supply roads in Maribor are not distant from the centre, although the Maribor supply roads are characterized by a lower traffic density compared to the Paduan supply roads. Since the river Drava separates Maribor into two urban areas, the connecting bridges display a relatively high traffic density, elevating the traffic density near the centre, too, since the centre is located on one river side. Due to the different sizes of the cities, also the geographical distances between supply roads vary within a town, whereby the supply roads in Maribor are closer to each other. Nevertheless, central streets are comparable in terms of traffic density in both towns. Motor vehicles as well as the train are the main means of public and private transportation, since apart from the train, neither tram nor underground was available in 2002/2003 in the towns.

2 Method and data

The effect of urban traffic on the housing market is estimated by means of hedonic price regressions. The estimated marginal implicit prices for urban traffic are presumed to approximate the marginal willingness to pay for a reduction in different types of pollution related to urban traffic (Turner [5]), since the study focuses on homogenous residential areas, in which buyers of houses are presumed to reveal similar preferences. Given the purchasing power disparities not only between countries, but also within countries and the geographical variation in the housing price level within individual cities, the marginal willingness to pay for criteria related to urban traffic are expressed in terms of elasticities. Actual selling prices of non-commercial properties and housing characteristics in 2002 have been obtained from one of the largest real estate agency "Dodoma" in Maribor since the gap between the actual selling

price and the quoted price in Slovenian real estate announcements was on average 21,2% in 1999-2001 (Murko [6]). According to interviews with employees working for real estate agencies (Libero [7]) and other informational sources (e.g. EdilSud [9]) in Padua the deviation of the actual selling prices from the quoted prices is not as remarkable. Hence, property prices of private houses and apartments in Padua and information on structural housing characteristics are found in announcements published by various real estate agencies from the period February-June 2003. The collected disaggregated market prices are considered cross-section, since the slight upward trend in the housing price level does not bias the property prices collected in that period. Data on traffic density and noise are gained from the Municipality of Maribor and the annual report 2002 of the "Regional Agency for Environmental Prevention and Protection of the Veneto" (ARPAV [3]). Information on traffic density is measured in terms of numbers of vehicles in Maribor in 1999 and in Padua in 2002, respectively. The Maribor noise level is evaluated in decibel units in the daytime in 1999. Data on air pollution in Padua are measured near the streets - consequently the measured emissions are highly correlated to immissions. In order to find out whether there should be considered any huge discrepancies between subjective perceptions and objective measures, employees working at real estate agencies (Libero [7]) as well as the employees working at the municipality in Maribor (Krmelj and Potrc [8]) have been talked to. Since the decibel are measured on a logarithmic scale, noise immissions, air pollution and traffic density in the relevant places are assumed to be correlated to the inhabitants´ perceptions, no further surveys have been conducted. Moreover, in both towns inhabitants are kept informed about the noise and air pollution, respectively. Given that the average selling price/sqm of € 2463 in the historical centre of Padua is around 55% higher than in the semi-central due to centre-specific criteria, buyers of central properties might differ from consumers buying semi-central property in terms of preference, income and other socio-economic characteristics. Hence, the central areas of Padua and Maribor, respectively, are be evaluated by a separate regression model. Compared to Padua, the geographic variation of the average selling price/sqm in Maribor is as not as considerable (20%). This appraisal made by brokers corresponds approximately to the sample statistics, since the average price/sqm in the centre of Maribor amounts to € 595/sqm, whereas the price/sqm in the outlying areas is about € 490. Due to brokers (Bauer [10]) 85% of the buyers of properties in Maribor are relocating families or individuals from Maribor and surroundings representing similar preferences. The remaining percentage is represented by the amount of people from remote places in Slovenia, foreigners or families purchasing a second home etc. Also in Padua buyers of houses located in particular districts do represent comparable socio-economic characteristics (Buzzaccarini [11]). The dependent variable in the hedonic regressions is defined by the property price/sqm in order to a priori exclude people searching for a place to live for a short-time period. In addition to the created dummy variables expressing structural housing characteristics (e.g. new, not restored, garden, garage, orientation), for both towns, dummy variables take on the value 1 if the property is adjacent to open space, monuments or particular

sites, places with a higher criminal rate (Buzzaccarini [11]) and zero otherwise. Furthermore, dummy variables are defined for the proximity of properties to local roads, supply roads, the train roads, roads near and exactly in the street with a bus route in Maribor. The vicinity to active and non-active industrial amenities is defined by dummy variables for the Maribor-sample, whereas the Paduan industrial district is geographically excluded from the sample.

3 Empirical results

3.1 Estimation of the willingness to pay for air quality in the centre and traffic density the semi-central and outlying areas of Padua

Using OLS, the estimated hedonic regression models for the centre and the semi-central and outlying areas of Padua, are given in table 1 along with absolute t-statistics in parenthesis. In the centre of Padua the highly correlated PM_{10}-, C_6H_6- and NO_x-pollutants (measured in kg/km) as well as traffic density are more significant than VOC- or CO-pollutants. Hence, PM_{10}-pollutants, mainly emitted by buses, autos, commercial transport, explain the impact of traffic on the property price/sqm in the regression for the centre. For the regression explaining the property effect/sqm in semi-central and outlying urban areas, traffic density was found to be the most significant traffic-related explanatory variable. The choice of the functional form was based on the expected relationship between the independent variables and the price/sqm as well as on model selection criteria by testing frequently used functional forms (Palmquist [12]).

Table 1: Regressions for Padua centre and outlying/semi-central areas.

Centre of Padua		Semi-central, outlying areas of Padua	
Constant and variables	Coefficients	Constant and variables	Coefficients
Constant	8.186314 (105.9)	Constant	14.25255 (9.1)
PM_{10}-pollutants	- .221784 (4.6)	ln (traffic density)	- .410589 (3.0)
Square metres	- .001951 (5.2)	ln (Square metres)	- .482939 (3.7)
Terrace	.0171912 (2.3)	Not restored	.444903 (4.5)
		ln (adjacency to the centre)	1.742144 (2.8)
		Garage	0.183302 (1.9)
R^2 = .48, Adj. R^2 = .45, JB = 1.12 Number of observations = 58 Dependent variable: ln (price / sqm)		R^2 = .74, Adj. R^2 = .68, JB = 0.01 Number of observations = 191 Dependent variable: ln (price / sqm)	

The log-log specification for the outlying and semi-central areas explains about 74% of the variance of ln (price / sqm). The fitting of log-lin specification for the centre is also satisfactory, taking into consideration the fact of cross-section data and that the centre of Padua is especially homogeneous (in terms of

e.g. infrastructure). Wang and Wolverton [13] found out that a regression model with a low R^2 estimated from a very uniform sample could give a better price prediction (smaller errors, less bias) than a model with more explanatory power estimated from a more heterogeneous sample. Due to the low value of Jarque-Bera, JB, no deviation from normality of residuals is indicated in the two regressions. All coefficients are significant at a 95% confidence interval, except for the coefficient "garage" that is significant at a 90% confidence interval. As expected, the negative coefficient of PM_{10}-pollutants implies that an increase in one unit of PM_{10}-pollutants reduces the prices/sqm about 22%, meaning that for a 1% reduction in PM_{10}-emissions buyers of houses in the centre are disposed to pay .1% more per sqm (the elasticity is calculated by multiplying the coefficient by the average PM_{10}-pollution level), leaving other explanatory variables unaffected. It is surprising that the numerical impact of PM_{10}-pollutants is even higher than that of square metres and terrace. In the outlying areas the price/sqm decreases on average by .41% if traffic density increases around 1%. By assuming constant elasticities in the areas, this result is substantial, considering that a 1% increase in sqm has almost the same effect (about .48%) in outlying areas. For buyers of a non-restored building, the property price/sqm is about 45% lower compared to a new or restored property. The possibility of an additional garage in the outlying areas or a terrace raises the property price/sqm around 18% and 1.7%, respectively. By moving towards the city centre, a 1% reduction in the distance to the city centre leads, on average, to a 1.7% increase in the price/sqm. Consequently, the importance of accessibility to the city centre is not only based on the experience of brokers, but also empirically proved.

3.2 Estimation of the willingness to pay for quiet in the centre and traffic density in outlying urban areas of Maribor

In the hedonic regressions for Maribor, the variables "bus rout in the street", traffic density and noise are highly correlated. Hence, only the most significant traffic-related factor is included in the regression. Furthermore, since the noise level measured in the daytime is also highly correlated with the noise level measured in the night and as the purchase decision is generally made in the daytime, measurements in the daytime explain the property price effect in the following regression. For both urban areas of Maribor, the double-log specification is preferable. Nevertheless, a log-lin relationship was expected for the regression established for the central urban areas, since noise is measured on a logarithmic scale due to the fact that human perception of loudness is assumed to conform on a logarithmic scale (Rich and Nielsen [14]). Table 2 presents the hedonic regressions for the centre and the outlying areas of Maribor with the absolute t-statistics in parenthesis:

Similarly as in table 1, the hedonic model established for the outlying areas explains a higher variation in the price/sqm than the regression model set up for the centre. Contrary to Padua, however, in the centre of Maribor the elasticities of demand for a reduction in noise are higher than the elasticities of demand for traffic density in the outlying areas. One explanation could be that the central houses of Maribor are located on streets with a traffic density of about 9738 cars

– in contrast to the average traffic density of 8338 cars in the outlying areas, whereby the outlying properties are also positioned in close proximity to open space. In the outlying areas, buyers of properties in the adjacency to a local road – in comparison to a supply road or a road with a bus rout – are willing to pay 8.5% per sqm, probably due to accessibility criteria. In addition to the coefficients of interest, all structural housing characteristics are significant at a .95 confidence interval with the exception of the coefficient "north-ward oriented" being significant at a 90% confidence level. The year of construction of a building positively correlates with the property price/sqm in the centre, whereas the same effect is even larger in the outlying areas. The fact of a sun-ward orientation of a building induces an increase in the property price/sqm by approximately 31%, while the price/sqm for north-ward oriented properties decreases about 27%. Against general expectations, the proximity to important sites (e. g. monuments, the river, the stadium) is negatively correlated with the property price/sqm. Surprisingly, in contrast to Padua, the square meters of the properties in Maribor are insignificant. This could be attributed to the fact that the span between the maximum and the minimum apartment size in terms of square metres is smaller in Maribor than in Padua.

Table 2: Regressions for Maribor centre and outlying areas.

Centre of Maribor		Outlying areas of Maribor	
Constant and variables	Coefficients	Constant and variables	Coefficients
Constant	- 111.5896 (2.4)	Constant	- 286.6827 (7.3)
ln (noise)	- 2.007456 (3.5)	ln (traffic density)	- .276414 (4.1)
ln (year)	16.62829 (2.7)	ln (year)	38.87667 (7.6)
East-, south-, westward oriented	.312816 (2.8)	Adjacent to a local road	. 0849394 (4.6)
ln (floor)	.361420 (2.9)	North-ward oriented	- .269016 (1.9)
Adjacent to particular sites	- .418630 (3.2)		
R^2 = .60, Adj. R^2 = .54 JB = .99 Number of observations: 71 Dependent variable: ln (price / sqm)		R^2 = .76, Adj. R^2 = .75 JB = 4.19 Number of observations = 128 Dependent variable: ln (price / sqm)	

4 Results and implications

It is remarkable that the elasticities of demand for a reduction in urban traffic are comparable in different countries irrespective of the purchasing power disparities and difference in the housing price level. By assuming constant elasticities in the investigated urban areas, the willingness to pay for a reduction in traffic density is much lower in regions with a lower traffic density in comparison to high-

traffic density areas in Maribor as well as in Padua. However, as the measured data on traffic density demonstrate - in accordance with the sample statistics that give an idea about at what average level of traffic density properties are positioned - the outlying properties of Maribor are generally situated on streets with a lower traffic density than properties located in the Maribor centre, whereas the same holds for the central properties of Padua. In contrast to Maribor, the Paduan central properties are typically situated at a traffic density of 11330, whereas properties in the outlying and semi-central areas are positioned on streets with a density of about 22751 vehicles. One reason for these opposite results could be the fact that Maribor supply roads are much closer to the centre than supply roads in Padua. Hence, the elasticities of demand for a reduction in factors related to urban traffic are largely determined by traffic density, irrespective of the fact whether the location is outlying or central. In this context, the intuitive assumption that buyers of houses in central areas are indifferent about traffic density and purchasers of outlying properties are willing to pay more for a reduction in traffic density does not hold. Moreover, it is surprising that traffic density is considered the most significant variable in the outlying areas of both towns, whereas noise and air pollution play a more important role in the town centres. In the town centres it is observable that the noise level and the air pollution level, respectively, are equal in many streets - even if traffic density varies - possibly due to traffic jam, variations in velocity etc., whereas open space in outlying areas may reduce this types of pollution. This argument places emphasis on the meaning of keeping the traffic fluid. In this context, road traffic fluency is not only advantageous for economic and environmental reasons, but also for accessibility criteria. However, in Padua a compromise between reducing the traffic density and improving road traffic fluency has been found by allowing e.g. only residents or commercial transport to use certain central roads [15]. Taking into account that the vicinity to train roads is not significant in the regression, the fact that train noise is not considered by the measures of traffic density may not explain the larger significance of noise in comparison to traffic density in the town centre of Maribor. Since in Padua tram construction works are in progress, a future interesting investigation could be whether changes in the transport system (i.e. the provision of alternatives to private car use) have an effect on the volume of auto commuters, road traffic fluency and accessibility criteria determining the willingness to pay for advantages related to urban traffic and social welfare, respectively.

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