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DOI
10.1016/j.trpro.2020.03.097

Publication date
2020

Document Version
Final published version

Published in
Transportation Research Procedia

Citation (APA)
Nikiforiadis, A., Roukouni, A., Basbas, S., & Chrysostomou, K. (2020). Do businesses expect benefits from the existence of metro stations in their area? A case study in Thessaloniki, Greece. *Transportation Research Procedia*, *47*, 259-266. https://doi.org/10.1016/j.trpro.2020.03.097

Available online at www.sciencedirect.com

ScienceDirect

Transportation Research Procedia 47 (2020) 259–266

Transportation Research Procedia

www.elsevier.com/locate/procedia

22nd EURO Working Group on Transportation Meeting, EWGT 2019, 18-20 September 2019, Barcelona, Spain

Do businesses expect benefits from the existence of metro stations in their area? A case study in Thessaloniki, Greece

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Abstract

There is a great number of studies which have proved that a new or improved transport system has an important impact on land uses and real estate prices. While there are many studies which examine the effect of a new urban public transport system on the values of neighbouring properties, the number of researches which focus on the identification of the benefits that businesses can expect is rather limited. The objective of the present paper is to identify parameters which have a significant impact on the business revenue, as well as to quantify that impact, focusing on the city of Thessaloniki, Greece, where a metro system is under construction A questionnaire-based survey took place, addressed to business enterprise owners and professionals in the surrounding area of ten of the planned locations of Thessaloniki metro stations. The data collected by this survey were reinforced with additional attributes of the businesses, such as their distance from the nearest metro station, and a statistical analysis has been conducted, utilizing also regression modelling techniques The results indicate that more benefits can be expected for businesses which are located closer to the metro stations, especially in areas with limited parking availability. The benefits are estimated to be higher for the land use category that includes restaurants/café/bars. Models of that type can be very useful in cases of implementing alternative funding/financing methods, such as Value Capture. For the implementation of such methods it is very important to accurately estimate the benefits that all the parties involved in an investment will gain.

Keywords: business revenue; metro system; ordinal regression model; questionnaire-based survey

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10.1016/j.trpro.2020.03.097

1. Introduction

Between transport systems and land use there is a strong interaction reflected in real estate prices. This interaction is described by the concept of accessibility (Iacono et al., 2009). According to Litman (2011), accessibility is the possibility to access activities and goods that are in demand. Accessibility can be considered as a concept that incorporates all the benefits that may result from an investment in the transport sector. This view is based on the idea that changes in accessibility can lead to redistribution of activities between areas (Reggiani et al., 2011). Generally, it can be said that land values increase when accessibility improves (assuming that all other factors remain constant) (Smith et al., 2015).

There are several studies which have dealt with the impact of urban public transport systems on the values of neighbouring properties. The vast majority of these studies prove that there is a positive effect of transportation infrastructure proximity on real estate prices. According to Fogarty et al. (2008), land and property values usually begin to rise already just after the official announcement regarding the construction or/and extension of a transport project. They continue to rise during construction phase and reach a maximum just before operating. In case of an improvement or expansion, there may be as well a further increase during the life cycle of the project. However, there is also a number of studies showing that this is not always the case. For instance, Du and Mulley (2007), using Geographically Weighted Regression (GWR) models, found that the relationship between transport accessibility and land value varies significantly over space; transport accessibility can have positive effect in some areas whereas a negative effect in others. Similarly, Efthymiou and Antoniou (2013) used econometric and spatial econometric models and identified a relationship between proximity to transportation infrastructure and house or apartment prices, which may be either positive or negative depending on the type of the transport system.

Regarding commercial land uses, a study conducted by Cervero and Landis (1993) found that rail transit generates some benefits for the owners of commercial properties close to stations, but these benefits are not always so high. Drennan and Brecher (2012) argue that in most cases the positive effect is limited to a short distance around transport projects. Other studies demonstrate that the capitalization benefits within commercial areas are extremely high and they agree that most benefits are concentrated in properties closer to stations (e.g. Cervero and Duncan, 2002; Hass-Klau et al., 2004; Ko and Cao, 2013). Debrezion et al. (2007) used meta-analytical procedures and found that, regarding commercial properties, the benefits from improved access are concentrated within a 1/4 mile (≈400 m) buffer zone from rail stations. These results are supported by the outcome of another survey conducted by Xu et al. (2016). Moreover, Nelson et al. (2015) found that the benefits are experienced within an even smaller buffer zone from light transit stations, namely 1/10 mile (≈160 m).

According to a previous study conducted in the city of Thessaloniki, Greece, it is expected that the metro system will have significant impact on the land uses around the planned metro stations (Roukouni et al., 2012). While many studies have been conducted concerning the impact of transportation infrastructure on land uses and real estate prices, to the best of our knowledge, there is limited literature estimating the impact of a new or improved infrastructure on businesses revenue. The present paper aims at providing valuable insights on the impact of a new metro system on business revenue, due to the improved accessibility. The current research is based on the business enterprise owners' views and perceptions. It is assumed that they are aware, in a high level, of the changes that their businesses are going to face when the new transport system will be put into operation.

2. Description of the Undertaken Research

2.1. Study area

The study area is the centre and the eastern part of the city of Thessaloniki and more specifically the areas located in the proximity of the stations of the main line of the metro. The main line, that is expected to be operational by 2020, will be 9.6 km long and will run through the city center including 13 stations (Attiko Metro S.A., 2019). Three of these stations were excluded from the research:

- University station, which is close to the city centre, as it is going to mainly serve the campus of the Aristotle University of Thessaloniki, as well as the University of Macedonia,

- Voulgari station, which is located in the Eastern part of Thessaloniki, due to the fact that the predominant land use type in that area is residential, and
- Nea Elvetia station, which is the last station of the main metro line for the same reason.

Therefore, the remaining 10 stations were examined, half of them located in the city centre and the rest in the Eastern part of Thessaloniki. A buffer zone for each metro station was defined within a 250 m radius. The determination of the radius was based on previous similar studies in the field of interaction between land uses and urban rail transit (e.g. Pan et al., 2007; Pan and Zhang, 2008); in addition to that, the characteristics of the metro system (e.g. distance between stations) and city's local characteristics were considered. Fig. 1 and 2 present the 10 selected metro stations, located in the center and the Eastern part of the city of Thessaloniki respectively, as well as the 250 m radius areas around them, marked in yellow, and the locations of the businesses that participated in the questionnaire survey marked with green points.

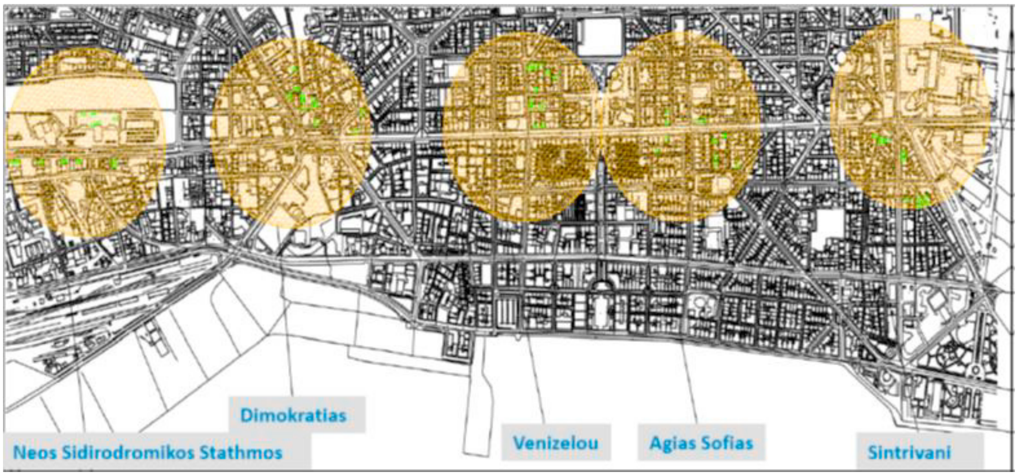

Fig. 1. Areas around the metro stations in the city centre (Cartographic background: Organization of Planning and Environmental Protection of Thessaloniki OR.TH., own setup).

Fig. 2. Areas around the metro stations in Eastern Thessaloniki (Cartographic background: Organization of Planning and Environmental Protection of Thessaloniki OR.TH., own setup).

2.2. Data collection

For the purposes of the survey a questionnaire was designed, consisting of two sections (Roukouni, 2016). The first section included questions about businesses' characteristics (e.g. starting date of operation, number of employees, ownership status), as well as information relevant to employees' and customers' mobility characteristics (e.g. transport mode employees usually use to approach the business, transport mode most customers use to approach the business, average search time for parking). The second section included questions about business enterprise owners' views and expectations regarding the main metro line operation.

Following the design of the questionnaire, a pilot survey was carried out to identify any deficiencies or imperfections. During the pilot survey 14 questionnaires were completed, resulting in slight improvements of the design. The final survey was carried out during October and November 2014 through the personal interview method. The personal interview method was selected in order to provide the necessary clarifications to the respondents and to avoid misinterpretations when completing the questionnaire. In each of the metro station areas, 12 questionnaires were completed which resulted to a final number of 120 survey questionnaires. This number is considered to be satisfactory based on the total number of businesses in the areas which were examined. It is noted that efforts have been made to fill out the questionnaires in businesses which are located at various distances from the metro stations.

3. Descriptive Statistics

Initially, the responses collected were analysed using descriptive statistics. Descriptive statistics aim to provide an overview of the sample, as well as respondents' expectations, related to the operation of the new metro system. The most important results of the descriptive statistical analysis are presented below.

Regarding business-to-station distance, 13% of the businesses are located closer than 50 m from a station, 64% lying at a distance between 51 – 200 m and 23% between 201 and 250 m. The vast majority of the sample (73%) consists of retail shops, while only 3% are offices and 2% are parking facilities. There are also 9% restaurants/café/bars and 13% private services. The sample is well distributed regarding the years of operation of the businesses, having a sufficient proportion of businesses which established before 1980 (11%), between 1981 and 1990 (12%), between 1991 and 2000 (16%), between 2001 and 2010 (32%) and after 2010 (29%). In many cases, business enterprise owners chose the specific area for their business due to its commercial character (37%) and because it is in a short distance from their residence (19%). Also, a significant 17% chose the specific area due to the fact that it is easily accessible by public transport, while only 3% of the business enterprise owners chose the area based on how easily they can find a parking spot. Most businesses (49%), employ 2 – 4 people, while 43% of them are personal businesses and 8% employ more than 4 people. In many cases (42%), employees approach their workplace by private car, while walking (23%), motorcycles (17%) and public transport (17%) also achieve high proportions. Business enterprise owners were also asked about the time they usually spend to find parking spot in this area. The highest proportion of the respondents stated that they usually need less than 5 minutes (44%). Also, 24% stated that they usually need between 6 and 10 minutes, while 32% stated that they need more than 10 minutes. Business enterprise owners were also asked to state the transport mode by which customers mainly approach their business, based either on their personal knowledge of their customers' mobility patterns or on estimations. The majority of the business enterprise owners answered that their business is mainly approached on foot (33%), by public transport (28%) or with private car (26%).

The descriptive statistics analysis of the questionnaire's second section (perceptions section) revealed that business enterprise owners and professionals have extremely high expectations by the metro system operation. More specifically, 80% of the respondents expect an increase in their business revenue and 61% of those who expect an increase, stated that they estimate it between 10% and 30%. Many business enterprise owners (31%) stated that the revenue increase could be even higher than 30%. What is more, 87% of the respondents believe that the operation of the metro system will contribute to the improvement of those areas' commercial character. The same proportion (87%) expects that the metro system will also upgrade the environment and the quality of life in the specific areas. Finally, the vast majority of the sample (82%) assess that an increase in rental prices will take place and 48% of them believe that this increase will be between 10% and 30%, while 27% estimate it between 30% and 50%.

4. Results

4.1. Model estimation

Considering the descriptive statistics results, an ordinal regression model was developed to investigate the influential coefficients for businesses expected revenue increase. According to the objectives of the statistical model, the dependent variable is the "Revenue_increase", that is the business revenue increase, which business enterprise owners expect. The type of model used, due to the ordinal nature of the dependent variable, is an ordinal regression model, a differentiated version of a binary logistic regression model, which considers the ordinal coding of the dependent variable. The model determines the odds of an event, and all the events that are ordered before it, to occur instead of not occurring. Therefore, ordinal regression models are concerned with cumulative probabilities and not with probabilities of discrete categories (see Gutiérrez et al., 2016 for more details). The odds are expressed as:

$$\theta_j = {prob\ (score\ \leq j)}\Big/{(1 - prob\ (score \leq j))} \tag{1}$$

Furthermore, the ordinal logistic model for a single independent variable is:

$$\ln \theta_j = \alpha_j - \beta X \tag{2}$$

where θ represents the odds and j extends from 1 to the number of categories minus 1 (Norusis, 2005).

Concerning the independent variables, after several "try and error" tests, the variables shown in Table 1 are finally included in the model. It should be mentioned that "Distance", "Years" and "Time_for_parking" were used as continuous variables and not as classes. From those independent variables, only "Type" has reference category, since the other variables are continuous. Retail shops were used as reference category because they concentrate the largest proportion of the sample.

Table 1. Model variables and reference categories.

Variable code	Variable description	Reference category
Distance	Business-to-station distance	-
Years	Years where the business operates	-
Time_for_parking	Minutes usually searching for parking spot	-
Type	Business type	Retail

Table 2 outlines the predictor variables, included in the model, along with the parameter (beta) estimates, the standard error (S.E.), the Wald statistic and the significance level.

Table 2. Parameter estimates for the model.

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence	
							Lower Bound	Upper Bound
Threshold	[Revenue_increase=0]	-3.193	.761	17.620	1	.000	-4.684	-1.702
	[Revenue_increase=1]	-2.692	.730	13.588	1	.000	-4.123	-1.261
	[Revenue_increase=2]	.125	.638	.039	1	.844	-1.124	1.375
	[Revenue_increase=3]	2.014	.763	6.966	1	.008	.518	3.510
	[Revenue_increase=4]	3.108	.944	10.853	1	.001	1.259	4.958
Location	Distance	-.010	.004	7.367	1	.007	-.017	-.003
	Years	-.051	.019	6.827	1	.009	-.089	-.013
	Time_for_parking	.031	.014	4.743	1	.029	.003	.059
	[Type=offices]	1.619	1.178	1.890	1	.169	-.689	3.928
	[Type=private services]	1.275	.753	2.870	1	.090	-.200	2.750
	[Type=restaurant/café/bar]	2.941	.991	8.810	1	.003	.999	4.884
	[Type=retail]	0	-	-	0	-	-	-

Table 3 presents the overall fitting indices for the model. The Model Fitting Information indicate a statistical significant improvement, as to whether the explanatory coefficients improve statistical significantly the model, compared to a baseline (intercept only) model that does not contain any independent variables. The performed test compares the -2LL (Log Likelihood tests) of the baseline and the final model. The result of the p-value (sig.<0.001) reveals a statistically significant reduction of the -2LL and thus an improvement over the baseline model. Additionally, the Goodness-of-Fit tests applied suggest that the model is consistent to the data (p-values>0.05), since the null hypothesis is that the fit is good. Finally, Pseudo R-Square consist another indicator of the model's goodness of fit. In logistic regression R-Square cannot be computed and as a result there are three approximations. Based on the Nagelkerke R-Square value, the final model can explain approximately 35.7% of the variance.

Table 3. Overall fitting indices for the model.

Model Fitting Information				
Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	193.210			
Final	165.357	27.853	6	.000
Goodness-of-Fit				
		Chi-Square	df	Sig.
Pearson		238.602	329	1.000
Deviance		165.357	329	1.000
Pseudo R-Square				
Cox and Snell	.336			
Nagelkerke	.357			
McFadden	.144			

4.2. Model interpretation

The ordinal regression models' interpretation is based on the calculation of the odds ratios. It should be noted that the odds ratios are calculated among the statistically significant intervals (confidence level 95%) of response variables' and their reference categories, as well as for an interval (private services) which slightly overcome the aforementioned confidence level. The calculated odds ratios are presented in Table 4.

Table 4. Odds ratios results.

Variable	Intervals	Odds ratios
Distance	-	0.990
Years	-	0.951
Time_for_parking	-	1.031
Type	private services	3.578
	retail (reference category)	-
	restaurant/café/bar	18.942
	retail (reference category)	-

According to the odds ratios, an increase of one unit (meter) in business-to-station distance results in an increase in the chance of expecting lower revenue increase by 1.010 (=1/0.990) times. In order to make the impact of distance on revenue increase more perceptible, it is advisable to calculate the odds ratio for a higher distance value. Therefore, in case of an increase of 100 meters, business enterprise owners are 2.705 times more likely to expect lower revenue increase. Moreover, owners of businesses which started their operation in the last years are more optimistic, as a one unit (year) increase implies an increase in the chance of expecting lower revenue increase by 1.052 (=1/0.951) times. Also, according to business enterprise owners, the benefits of metro operation are most likely to be met in areas experiencing parking problems. An increase of one minute searching for parking spot will increase the expected turnover growth by 1.031 times. Regarding business type, the most important benefits are expected by private services and especially by restaurants/café/bars. Private service entrepreneurs are about 3.6 times more likely to expect a larger increase in turnover compared to those who own a retail shop. Also, owners of restaurants/café/bars are approximately 19 times more likely to expect higher turnover increases than retail shops.

5. Conclusions

From the statistical analysis of the data collected by the questionnaire survey which was conducted in businesses located around 10 under-construction metro stations in the city of Thessaloniki, useful conclusions are drawn.

Descriptive statistical analysis revealed that business enterprise owners and professionals are extremely optimistic regarding the operation of the new metro system. More specifically, it was found that they expect significant benefits (economic and environmental) for their businesses and for the wider area of their business. It is expected, from most business enterprise owners, that businesses will have revenue growth of 10% to 30%, while similar is the increase they expect in rental prices.

Very interesting are also the results of the ordinal regression model, which aims to quantify the impact of specific parameters on the expected revenue increase. The results indicate that greater benefits are expected by businesses close to the metro stations (2.705 times more likely to expect lower revenue increase in case of a 100 m increase in business-to-station distance), in areas which deal with parking shortage problems (1.031 times more likely to expect higher revenue increase in case of a 1 minute increase in time searching for parking spot) and especially by restaurants/café/bars (almost 19 times more likely to expect higher revenue increase in compare with retail shops). In addition, the model showed that businesses which started their operation in the more recent years are more optimistic and this is probably linked to the fact that some business enterprise owners have chosen the specific areas for their business due to the future operation of the metro system. That choice of business enterprise owners, in some cases was also revealed during the completion of the questionnaires.

Statistical models of that type could be a useful tool in the case of implementing alternative funding methods, such as Value Capture. Value Capture combines the assessment of the benefits that all parties involved in an investment will gain and the recovery of a portion of that benefit for financing the project (Mathur and Smith, 2013, Roukouni, 2016, Sun et al., 2017, Roukouni et al., 2018). The possibility of using this funding method in transport projects in Greece, has already been investigated by examining citizens' acceptance and business enterprise owners' acceptance (Basbas et al., 2015, Nikiforiadis et al., 2015).

Aside from the benefits that business enterprise owners are expected to gain due to improved accessibility, it is crucial to address the problems encountered by them during the construction phase of a transport project. According to a study which was conducted in Los Angeles, businesses within 400 m from metro rail stations show significantly lower survival chances during the construction due to lost access, loss of parking, nuisances like dust and noise etc. (Ray, 2017). Similar problems were also observed in the case of the Thessaloniki's metro, which were made even worse by the project construction delays that occurred. This creates a justifiably negative attitude of the business enterprise owners towards the metro system and therefore it was very difficult to collect a larger sample.

Despite the fact that the survey is not based on real prices, but in professionals' perceptions, it is assumed that business enterprise owners understand and they are aware of the benefits that their business is going to gain. For future research, it would be interesting to carry out a survey after the completion of the system and to compare the real value differentiations with those predicted by the model.

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