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Impact of a Metro System on Business Revenue: A Logistic Regression Approach

Abstract: This paper examines the impact of a new transport system on business revenue by investigating the case of the under-construction metro system in Thessaloniki. Particularly, the research focuses to the investigation of views and expectations of the business enterprise owners around ten under-construction metro stations. For that reason, a questionnaire-based survey took place from October 20, 2014 to November 8, 2014, addressed to business enterprise owners and professionals in the specific areas. Finally, 120 questionnaires were collected, 12 questionnaires from each station. Moreover, the data collected by the questionnaire survey were reinforced with additional elements such as the distance of each business from the nearest under-construction metro station. The collection of the above mentioned data is followed by their statistical analysis. Inferential statistics is used in order to identify factors with statistical significant impact on respondents' perceptions concerning the estimated turnover increase. Furthermore, the paper concludes with the development of an ordinal regression model, aiming to quantify the impact of specific parameters on the expected, by business enterprise owners and professionals, turnover increase. The model includes as statistically significant independent variables the business-to-station distance, years of operation of the business, the difficulty of finding a parking space in the area (in the current situation) and the type of business. Statistical models of this type could be extremely useful in the case of implementing alternative funding methods, such as Value Capture Finance, assuming that business enterprise owners are aware of the factors influencing the profitability of their businesses.

Keywords: business revenue, metro system, ordinal regression model, questionnaire-based survey, transport geography

Introduction

Between transport systems and real estate there is a strong interaction reflected in land uses. 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 seems that land values increasing while accessibility getting improved, assuming that 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 neighboring properties. According to Fogarty et al. (2008), land and

property values are already beginning to rise from the official announcement of the transport project. They also continue to rise during construction phase and reach a maximum of just before operating. In case of an improvement or expansion, it may be an increase during the life cycle of the project.
Regarding commercial land uses, 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 (Cervero and Duncan, 2002, Ko and Cao, 2013, Hass-Klau et al., 2004). However, there are studies which argue that in some cases transport projects may have the opposite effects, that is decrease in property and land use prices (Yan et al., 2012, Yukun, 2010).
The present paper aims to investigate the impact of a new metro system on business revenue, which is expected to increase due to the improved accessibility. Also, according to a previous study conducted in the city of Thessaloniki, it is expected that the under-construction metro system will have significant impact on the land uses around the metro stations (Roukouni et al., 2012). 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 put into operation.

Study area and data collection

Study area is the center and the eastern part of the city of Thessaloniki and more specifically the areas located in the perimeter of the stations of Thessaloniki's, under-construction, metro main line. The main line which will be 9,6 km long and will run through the city center includes 13 stations. The University station was excluded from the research, as it is going to mainly serve the campus of Aristotle University of Thessaloniki, as well the stations of Voulgari and Nea Elvetia which are in the Eastern part of Thessaloniki, while they are in areas with predominant use of residence. Therefore, 10 stations were selected, half of them located in the city center and the rest in the Eastern part of Thessaloniki. Should be mentioned that the buffer zone of each metro station was defined within a 250 m radius.
For the purposes of the survey a questionnaire designed, consisting of two sections. The first section included businesses' characteristics and the second business enterprise owners' views. Questionnaire survey carried out during October and November, 2014 through the personal interview method (Nikiforiadis, 2015a). In each of the under-construction metro stations, 12 questionnaires were completed and therefore the final number of 120 survey questionnaires resulted. Should be also noticed that efforts have been made to fill out the questionnaires in businesses which are located at different distances from the under-construction metro stations. Figures 1 and 2 present the areas around the under-construction metro stations in the city center and in Eastern Thessaloniki. Yellow areas are within a 250 m radius from under-construction metro stations and green points are the business locations were questionnaires completed.

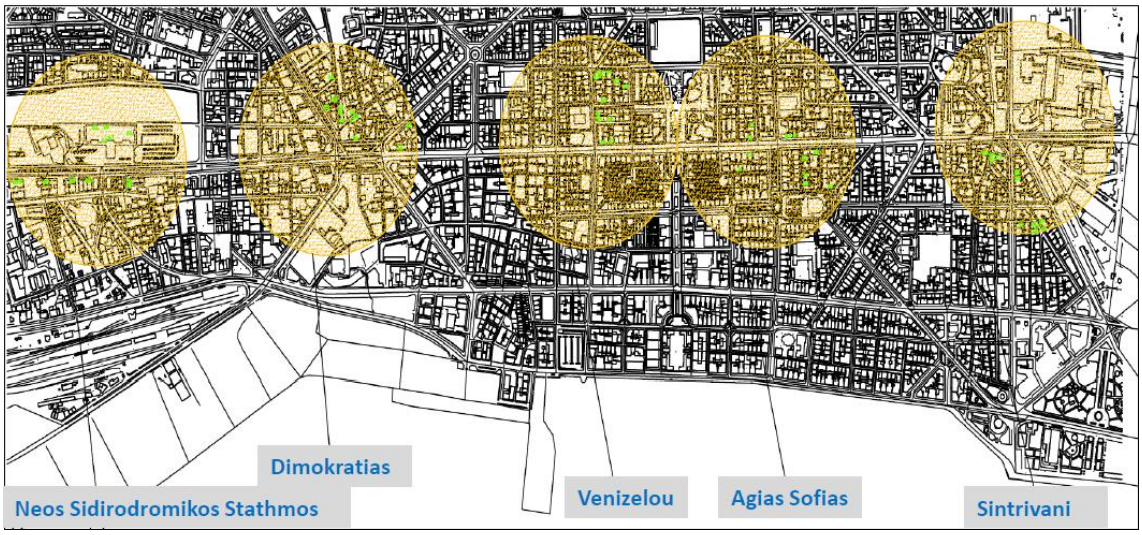

Figure 1: Areas around under-construction metro stations in the city center (Cartographic background: Organization of Planning and Environmental Protection of Thessaloniki OR.TH., own setup)

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

Descriptive and inferential statistics

Descriptive statistics aim to provide an overview of the sample, as well respondents' expectations, due to the operation of the metro system.

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 by retail shops, while only the 3% are offices and 2% parking facilities. There are also 9% restaurants/café/bars and 13% private services. Moreover, the sample is well distributed regarding the years of operation of the businesses. Most of the business enterprise owners (37%) chose the specific area for their

business due to its commercial character and 17% because the area is easily accessible by public transport. Most businesses (49%) employ 2 – 4 people, 43% of them are personal businesses and 8% employ more than 4 people. Business enterprise owners were also asked about the time they usually spend to find parking spot in this area. 44% of the respondents usually need less than 5 minutes and 32% more than 10 minutes. Respondents 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 questionnaire's second section revealed that business enterprise owners and professionals have extremely high expectations by the metro system operation. Very high percentages of the total sample expect a significant increase on their businesses revenue, as well environmental and quality of life improvement in the specific areas. They also assess that an increase in rental prices will take place. Regarding business revenue, on which the paper focuses, 82% of the respondents believe that it will be held and the majority of the respondents identify it between 10% and 50%.

Inferential statistics aim to identify factors which affect respondents' perception concerning the estimated turnover increase. Therefore, a correlation matrix, which contains only the most important variables, calculated and presented in Table 1. It is noted that only business-to-station distance ($r=-0,256$, $p<0,01$) and business type ($r=0,162$, $p<0,1$) found to have significant impact on business enterprise owners' view about revenue increase in their business.

Figure 3 demonstrates that there is a negative correlation between business-to-station distance and expected revenue increase, namely business enterprise owners and professionals of businesses located very close to an under-construction metro station expect higher revenue increase. Figure 4 shows that restaurants/café/bars expect the highest increase, while retail shops owners are not so optimistic. Regarding offices and parking facilities it is not possible to draw conclusions as the sample is too small.

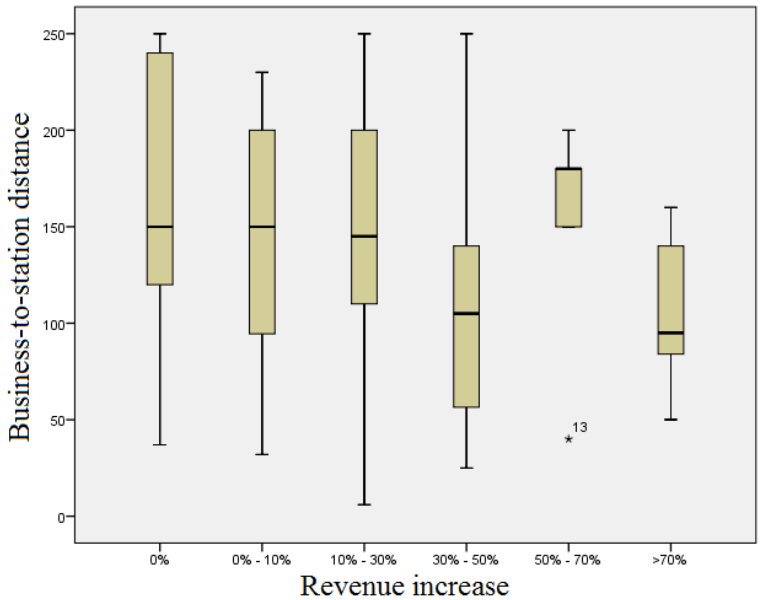

Figure 3: Relation between business-to-station distance and expected revenue increase

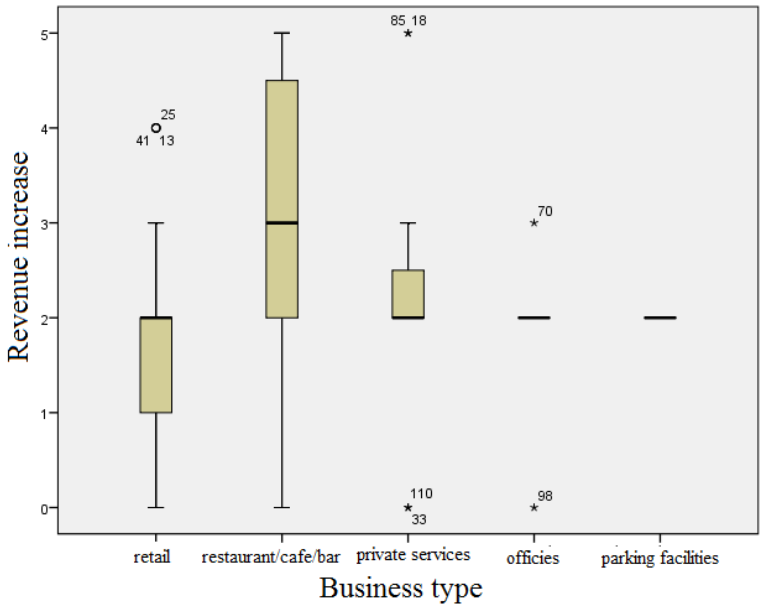

Figure 4: Relation between business type and expected revenue increase

Table 1: Correlation matrix and two tailed probabilities

			1	2	3	4	5	6	7	8	9
1	Downtown_Suburbs	Pearson Correlation	1	,057	-,072	,093	-,016	-,046	-,169	-,073	-,100
		Sig. (2-tailed)		,538	,433	,330	,859	,618	,156	,431	,278
2	Distance	Pearson Correlation	,057	1	,155	-,029	-,041	-,213	,117	-,009	-,256
		Sig. (2-tailed)	,538		,091	,764	,656	,020	,326	,920	,005
3	Type	Pearson Correlation	-,072	,155	1	,085	-,097	,143	-,093	-,157	,162
		Sig. (2-tailed)	,433	,091		,370	,290	,118	,438	,089	,076
4	Years	Pearson Correlation	,093	-,029	,085	1	,117	-,028	,117	-,152	-,123
		Sig. (2-tailed)	,330	,764	,370		,216	,766	,342	,109	,193
5	Reason_establ	Pearson Correlation	-,016	-,041	-,097	,117	1	-,001	-,101	,108	,000
		Sig. (2-tailed)	,859	,656	,290	,216		,996	,398	,242	,997
6	Employees_number	Pearson Correlation	-,046	-,213	,143	-,028	-,001	1	-,095	-,144	,145
		Sig. (2-tailed)	,618	,020	,118	,766	,996		,426	,118	,115
7	Time_for_parking	Pearson Correlation	-,169	,117	-,093	,117	-,101	-,095	1	,065	,132
		Sig. (2-tailed)	,156	,326	,438	,342	,398	,426		,588	,270
8	Mode_customers	Pearson Correlation	-,073	-,009	-,157	-,152	,108	-,144	,065	1	-,106
		Sig. (2-tailed)	,431	,920	,089	,109	,242	,118	,588		,250
9	Revenue_increase	Pearson Correlation	-,100	-,256	,162	-,123	,000	,145	,132	-,106	1
		Sig. (2-tailed)	,278	,005	,076	,193	,997	,115	,270	,250	

The ordinal regression model

Considering the descriptive and inferential 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 is due to the ordinal nature of the dependent variable. An ordinal regression model is a differentiated version of a binary logistic regression model which considers the ordinal coding of the dependent variable as well. The model determines the odds of an event, and all the events that are ordered before it, to occur instead of not occurring. Therefore, the odds are expressed as:

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

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

$$\ln(\theta_j) = \alpha_j - \beta X$$

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 2 were finally included in the model. Only "Type" variable has reference category, since the other independent variables are continuous.

Table 3 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: Model variables and reference categories

Variable code	Variable description	Reference category
Distance	business-to-station distance	-
Years	years which the business operates	-
Time_for_parking	minutes searching for parking spot	-
Type	business type	retail

Table 3: Parameter estimates for the model

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Lower Bound	95% Confidence 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 4 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 statistical reduction of the -2LL and thus a significant improvement. 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. Additionally, the Nagelkerke R-Square suggests that the final model can explain approximately 35,7% of the variance.

Table 4: 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			

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 statistical significant intervals of response variables' and their reference categories. The calculated odds ratios presented in Table 5.

Table 5: 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 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. 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 operations 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 expected by private services and 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.

Conclusions

From the statistical analysis of the data collected by the questionnaire survey which 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. Also, inferential statistical analysis showed that business-to-station distance and business type are the two main factors which effect their expectations.

More interesting are 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 under-construction 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 traffic 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 last 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.

Despite the fact that the survey is not based on real prices, 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 values with those predicted by the model. Statistical models of that type could be a useful tool in case of implementing alternative funding methods, such as Value Capture Finance (VCF). VCF combines the assessment of the benefits that all the parties involved in an investment will gain and the recovery of a portion of that benefit for financing the project (Roukouni, 2016). The possibility of using this funding method in transport projects in Greece, has already been investigated (Basbas et al., 2015, Nikiforiadis et al., 2015b, Roukouni et al., 2018).

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