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DOES A NEW METRO LINE PROMOTE BUSINESS ACTIVITIES CLOSE TO ITS STATIONS? CASE STUDY OF METROSUR IN MADRID¹

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ABSTRACT

The construction of a new public transportation infrastructure in a metropolitan area has a great impact, in many different ways, on the neighborhoods surrounding the stations. The objective of this paper is to evaluate the influence that the construction of a new metro line has on the promotion of businesses (shops, offices and so on) near the stations. To that end, we have analyzed, as a case study, the construction of the new metro line in the south east of Madrid. Using a Geographical Information System, we estimated for each of the new stations the variation in the density of business activities during a period of ten years, from the conception of the line to four years after the line entered into operation. We found that the new stations prompted a large increase in business activity in new neighborhoods where there used to be little business activity before the construction of the metro line, especially in those neighborhoods where the street network has a traditional pattern. However, we did not find a significant impact in the neighborhoods where the business and retail activities were already consolidated. Moreover, we did not find any conclusive evidence regarding the influence of the distance to the station (within a range of up to 500 meters) on the amount of business activity.

INTRODUCTION

Public transportation infrastructure in urban areas has a significant impact. Banister and Berechman (1) classify those varied effects, among other things on: transportation-related effects, land-use effects, and effects on jobs and business activities. Moreover, researchers such as Mas and Maudos (2) have shown that transportation infrastructure does not only have significant effects on the area directly influenced by it, but also on areas close or connected to it.

Those effects can be classified as short-term and long-term (3). Short-term effects are those related to reductions in travel time for the population living or working around the infrastructure. Long-term effects are mostly those stemming from agglomeration economies caused by the existence of positive externalities that improve the efficiency of firms due to economies of scale (4) (5).

Commuter rail and metro stations often have positive rather than negative effects. More metro stations increase the accessibility to public transportation for the people living nearby and reduce their travel time to other destinations in urban areas. Similarly, business activities (both offices and shops) near the stations also enjoy some advantages. On the one hand, jobs and shops are now more accessible for those coming from any destination. On the other hand, business activities close to the stations—especially shops—can take advantage of the increase in the number of people who pass by near the shops in their way to or from the stations. Moreover, metro stations may have also negative effects caused by such externalities as greater noise and damage to the urban landscape. The effects described above depend on the type of transport infrastructure (6) (2), its location, and its specific characteristics.

Literature, both theoretical and empirical, on industrial location show that the location of firms is not a random process, but rather the result of an analysis aimed at maximizing location benefits for individual firms, where the location decision is based on the future profits that a firm expects to earn in that location (7). In this respect, such authors as Mori and Nishikimi point out that there is a process of reciprocal reinforcement between industrial agglomeration and transport (8). In spite of that, the location of businesses does not depend only on transportation infrastructure by itself, but also on a combination of factors which include, among others: industrial agglomeration, a reliable transportation network, labor market characteristics, land market, and enhancement of environmental quality (9).

In fact, economic development and economic growth are the result of the long-term increase in economic activities which can be attributed in part to the direct impact of improvements in the transportation infrastructure, such as travel time reductions that promote industrial agglomeration. However, economic development requires a social and political framework that prompts such economic growth. Banister and Berechman (9) propose that the analysis of such a framework will include the study of:

- Political factors related to policy actions and institutional support.
- Availability of funds for investment and its efficient implementation.

- Economic conditions such as labor force and other positive externalities.

Measuring the economic impact caused by transportation infrastructure has always been complicated, since information and data are not always available at a local or regional level (10). In spite of this difficulty, there are some studies that have attempted to quantify those effects (3).

The goal of this paper is to assess the effect that an increase in accessibility caused by the construction of a new metro line may have on changes in the density of business activities close to new stations. We conducted the analysis for the case study of Metro line 12 (known as Metrosur) located at the south of Madrid. We found that the new stations prompted a large increase of business activities in neighborhoods where the original business activity had not been great.

The paper is organized in the following way. The first section, after the introduction, shows the characteristics of Madrid Metropolitan Area and describes the main characteristics of the municipalities where the new metro line known as Metrosur was built. The second section defines the objectives of the research and describes the methodology used. The third section describes the results. The last section analyses the results and offers the main conclusions.

THE ROLE OF METROSUR IN THE MADRID METROPOLITAN AREA

Characteristics of Madrid Metropolitan Area

Almost six million people live in the Madrid Metropolitan Area (MMA) (11), which is made up of a huge economic and social pole (Madrid City with a population slightly over three million) at the centre and a set of small and medium cities around this central population pool. Those cities are connected to Madrid City through both private and public means of transportation.

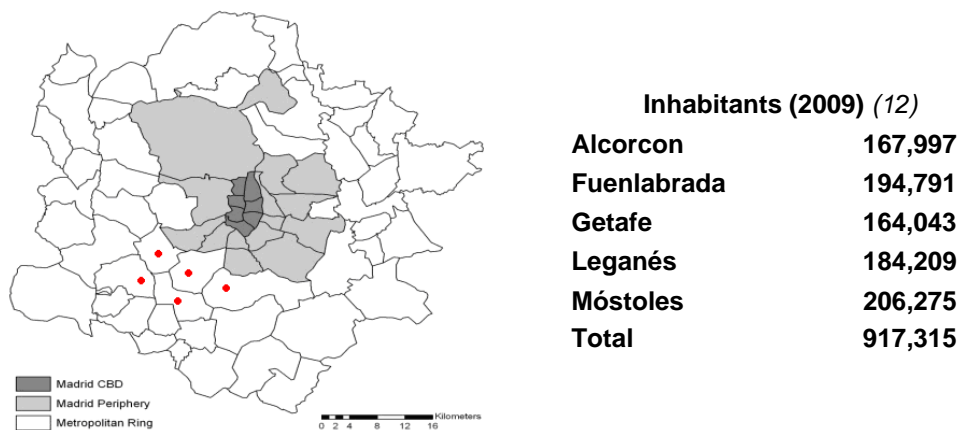
In the last three decades, the municipality of Madrid itself has substantially constrained new real estate development inside Madrid City, which has prompted high real estate prices in the city. Due to this fact, some municipalities outside of, but surrounding Madrid City, have promoted large real estate developments in order to increase the supply of affordable housing. As a consequence of this, some municipalities, which four decades ago were small villages with little connection to Madrid City, became in only few years satellite cities with large populations, places where people lived who commuted everyday to Madrid City. The most impressive growth occurred in five municipalities located to the southeast of Madrid (Alcorcón, Móstoles, Leganés, Getafe and Fuenlabrada), especially remarkable if one takes into account that the population of all these municipalities is almost 1 million, whereas the population of Madrid City is slightly over 3 million.

Figure 1 shows the location of these municipalities within the MMA (see the areas with a red dot inside). The shaded areas represent Madrid City. The darkest shaded areas show the central districts of Madrid City, while the areas that are only slightly shaded show the outer

1 districts of Madrid City. Until recently, the metro system of Madrid City did not extend beyond
 2 the Madrid City limits so as to reach other municipalities (shaded areas).
 3

4 The urban areas of the five municipalities mentioned before are neither connected to each
 5 nor connected to the City of Madrid. In other words, between each city there remain large areas
 6 where there is still undeveloped land. The transportation systems in these cities used to be
 7 focused on connecting these municipalities to the City of Madrid through both commuter trains
 8 and regional buses. The public transportation networks linking these five municipalities used to
 9 be extremely poor.

10
 11 One of the most important problems of those municipalities is that they are basically
 12 “dormitory” cities where most of their inhabitants commute everyday to Madrid City.
 13 Consequently, jobs and business activities are, in these municipalities themselves, noticeably
 14 scarce.
 15

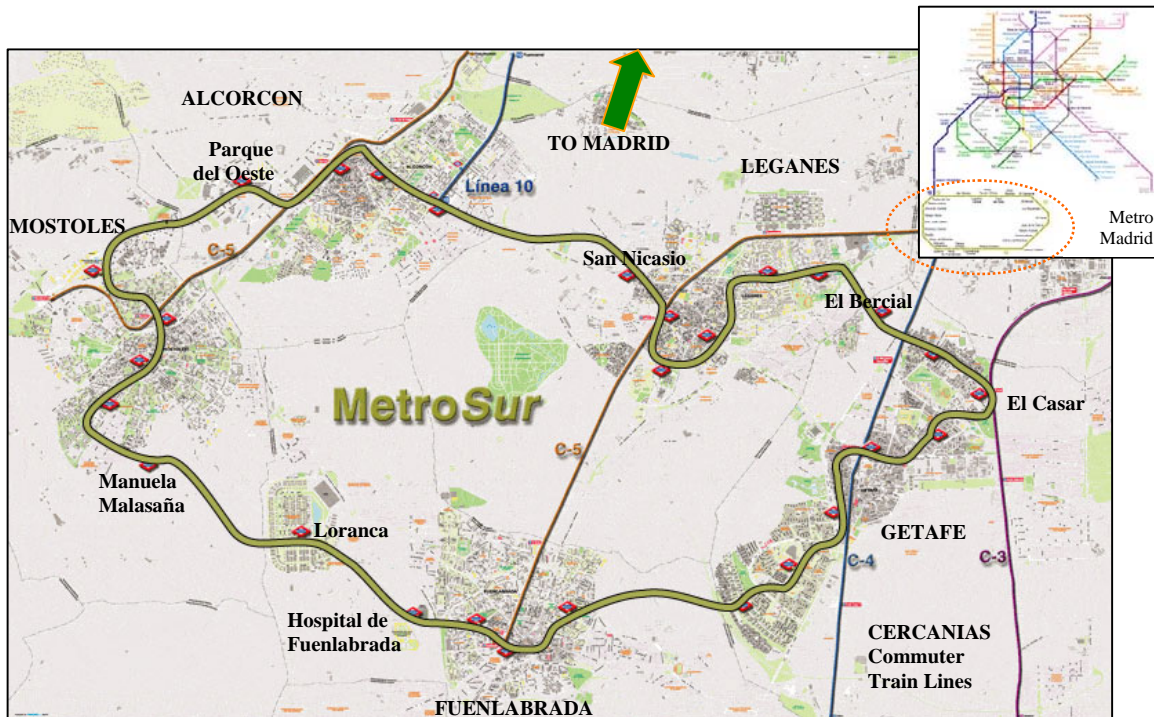


16 **FIGURE 1. Map of Madrid City and the Surrounding Municipalities**
 17
 18

19 **The construction of METROSUR**

20 Owing to that fact, the Regional Government of Madrid decided to adopt some measures to
 21 promote a more balanced growth of those municipalities intending to foster economic activities
 22 through promoting greater accessibility to transportation and a better linkage among these five
 23 municipalities around Madrid City. To that end, it was decided to build a new circular metro line
 24 (named Line 12 or Metrosur) linking the five municipalities. This new line is connected to the
 25 metro network of the central city through Line 10, which reaches one of the Metrosur stations.
 26 The line was built entirely underground in order to minimize the negative environmental impact.
 27 This was the first time that the metro network was extended beyond Madrid City itself (see
 28 Figure 2).
 29

1 Metrosur serves the five municipalities of the southeast of Madrid (Alcorcón, Móstoles,
 2 Fuenlabrada, Getafe and Leganés). It contains 28 stations, and it is connected to six commuter
 3 rail stations and to one transfer station on Line 10 that takes people to Madrid downtown or to
 4 further locations. The construction of Metrosur began in 1999 and its operation started in April
 5 2003. It is a circle line of about 54.6 km, and its construction cost was about 52.7 million €/km,
 6 including the trains (13).
 7



8
 9
 10
 11 **FIGURE 2. Map of Metrosur and its connection to Madrid City**
 12
 13

14 One of the most ambitious of the objectives connected to the building of Metrosur was
 15 that of boosting business activities in the five municipalities. The aim was to turn these
 16 municipalities from mere “dormitory” cities into cities with a better balance between population
 17 and jobs.
 18

19 **OBJECTIVES AND METHODOLOGY**

20
 21 The main goal of this research is to answer one main question: did the construction of Metrosur
 22 increase the amount of business activity close to the new stations in the five cities? More
 23 specifically the objectives of this research are the following:
 24

- 25 • To evaluate whether Metrosur has promoted business activities close to the stations or
 26 not, and to quantify its influence.

- To analyze whether the impact of Metrosur has been similar across municipalities or not, and, in case they are not, to seek the reasons.
- To evaluate the influence that distance to the stations has on the promotion of business activities.
- To evaluate the influence that the characteristics of the area (built-up neighborhoods vs. new neighborhoods) has on the promotion of business activities.

To carry out this analysis, a Geographic Information System (GIS) was used. GIS provides important tools for transportation research and planning because it facilitates the calculation of which urban areas are best served by a certain station (14). For instance, GIS enables us to calculate the service area at a given distance from a metro station exit. There are two different approaches to the evaluation of this service area. The simplest approach consists of drawing concentric circles around the station using ordinary Euclidean distance (Figure 3a). However, this approach overestimates the size of the area or the population served by a transport facility, therefore overestimating its usage (15). The second and more sophisticated approach consists of calculating the distance to the station allowing for the real walking distance calculated over the street grid. This is the way in which the distance to the business activities (shops, offices industrial and so on) from the Metro have been calculated in this research. Figure 3b shows, for a Metrosur station with two exits, how the catchment areas of those who walk to the station go from 150 meters up to 500 meters, have been estimated. It is notable how neither of these areas has anything to do with the concentric circles drawn according to Euclidean distance.

A different analysis notes that the characteristics of the street network design determine the attractiveness of the stations because riders access the stations by walking. For example, traditional street patterns (narrow roads with frequent crossings) enhance pedestrian access. However, newly developed areas designed for private transport (longer and wider roads, irregular patterns) limit pedestrian access to the stations (14, 15).

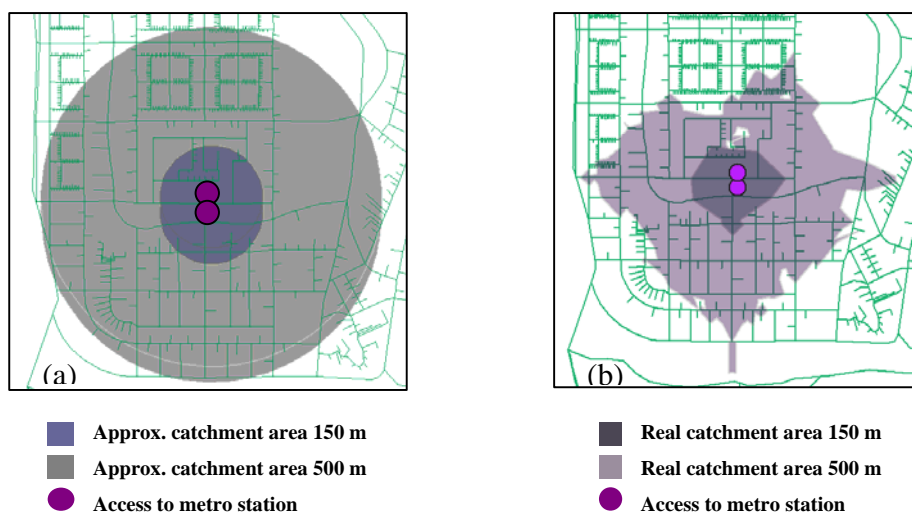


FIGURE 3. Catchment areas of Loranca station, Fuenlabrada, using the Euclidean distance (a) and street network (b) for 150 m and 500 m

1 Some researchers point out that due to agglomeration economies and the advantages of
 2 easy access, most business activities are concentrated very close to transportation stations (6).
 3 However, authors differ on the distance from the station of the businesses affected, which
 4 effects, in type and magnitude, depend on several aspects such as the kind of business, the type
 5 of infrastructure, and demographic and economic characteristics (16). In this research we have
 6 decided to analyze two areas: from the station exits to a place 150 meters away, and from the
 7 station exits to 500 meters away, which means approximately a five minute walk, and where the
 8 use of the Metro still remains high (16) (14).
 9

10 Our research evaluates how the location of business activities (offices, shops, industrial
 11 and so on) evolves throughout the years both before, and after, the inauguration of Metrosur. The
 12 data about business activities was obtained from the Bureau of Statistics of the Region of
 13 Madrid. We decided to analyze the evolution of business activity across the five municipalities
 14 over a period of ten years (1998 to 2007), from the time the construction of the metro-line was
 15 planned to four years after the inauguration of the line.
 16

17 In order to evaluate the business activity, we have defined a variable called Density of
 18 Business Activity (DBA) which can be easily calculated for each zone according to the equation
 19 1.

$$DBA_t = \frac{B_t^i}{S^i} \quad (1)$$

20 where:

21
 22 DBA_t Density of business activity in year t
 23 B_t^i : Number of business activities inside area i in year t
 24 S^i : Surface of the area i in square kilometers
 25

26 Consequently, the DBA every year is calculated as the number of business activities for
 27 that year divided by the surface of the relevant area in square kilometers. As each of the five
 28 municipalities has its own specific characteristics, we decided to carry out the analysis separately
 29 for each municipality, though some comparisons across municipalities are also conducted. The
 30 control variable for each municipality is the annual growth of the DBA in the whole
 31 municipality. We compare this value with the annual growth of the DBA in the two areas
 32 mentioned before: at 150 meters distance from the station and again, at 500 meters distance from
 33 the station.
 34

35 Moreover, we decided to make a distinction between stations located in new
 36 neighborhoods and stations located in neighborhoods that have already been consolidated. New
 37 neighborhoods are those areas of the municipalities which have been developed in the last few
 38 years. They are often detached from the older quarters of the city, and they have empty parcels
 39 that were promoted for future urban developments. The distinction between new and old built-up
 40 neighborhoods was made based on the analysis of different ortho-photos of the Municipalities
 41 (17) and other literature (13). The best way of estimating the annual DBA growth is obtained by
 42 equation (2):

$$LN(DBA_t) = \alpha^i \cdot t + \beta^i + \varepsilon_t^i \quad (2)$$

where:

DBA_t : Density of business activity in year t
 t : Year
 α^i : Annual growth estimated by the model
 β^i : Calibration parameter of the regression
 ε_t^i : Error of the regression in area i in year t

RESULTS

In this section, we obtain the results and assess them. First, we analyze in detail two of the five municipalities (Fuenlabrada and Getafe). Then we show a summary of the results from all the municipalities and analyse the larger trends.

Fuenlabrada

Figure 4 shows at first sight the results in Fuenlabrada. This figure displays a map that locates the business activities in the city in 1998 and 2007. The left side of the Figure shows the location of business activities in different areas of the city in 1998 depicted as blue circles, and the right side shows the same picture for 2007 (this time the business activities are represented as green circles). The larger the number of business activities located at the same address the larger is the circle.

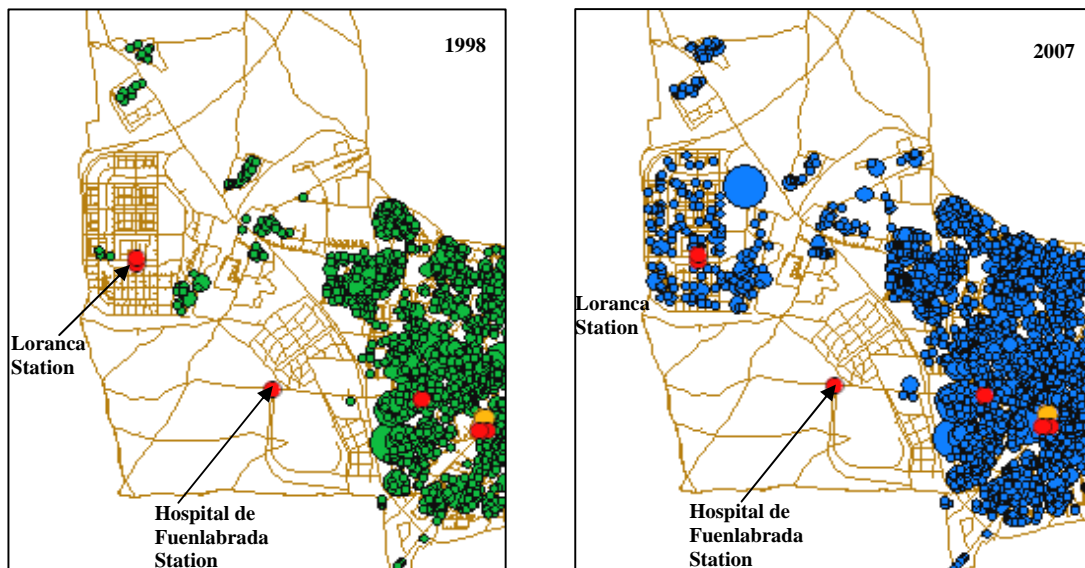


FIGURE 4. Evolution of Business Activities in Fuenlabrada

The exits of the new metro stations are depicted as red circles, while the commuter rail stations are depicted as orange circles. Two circles close to each other represent two different exits at the same metro station.

Fuenlabrada has five new metro stations. Three of them are located in old built-up neighborhoods, and the other two—“Loranca” and “Hospital de Fuenlabrada”—are located in new neighborhoods. Figure 4 shows at first sight that the greatest DBA growth has taken place around “Loranca” Station.

Figure 5 shows the calibration of the model previously defined. The analysis was conducted for the whole municipality, and for the areas reachable by walking, at both 150 meters and then at 500 meters, from the station exits, located either in old built-up or new neighborhoods.

It is notable that the DBA growth has been much higher around “Loranca” Station (between 29.52% and 32.97%), than around the stations located in the old built-up neighborhoods. In fact, the DBA growth around the stations located in the old built-up neighborhoods has been similar to the DBA growth in the entire municipality. The station “Loranca” is located in a new neighborhood separated from Fuenlabrada city centre, which was designed using a traditional street grid pattern. In 1998 there was almost no commercial activity but, after the construction of the metro line, it has rapidly increased. It is notable also how the DBA in the area around the station “Loranca” has tended to converge to the average DBA of the municipality.

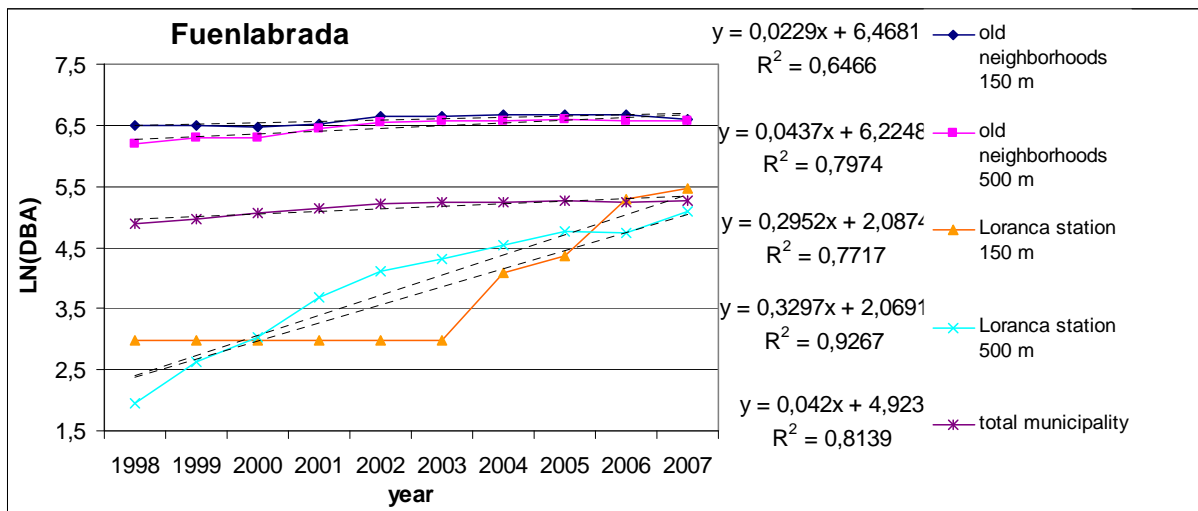


FIGURE 5. DBA estimation in different areas of Fuenlabrada

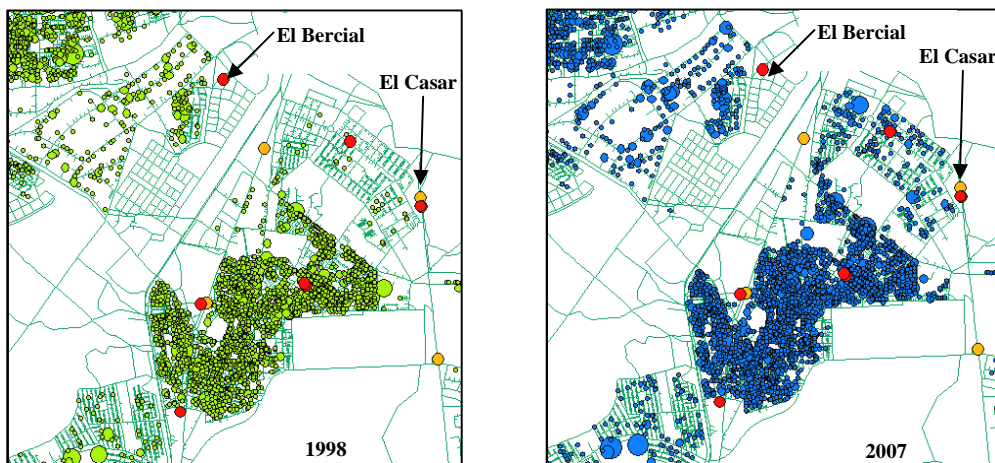
However, the “Hospital de Fuenlabrada Station,” also located in a new neighborhood, has not experienced almost any DBA growth in the last ten years. This zone seems still to be considered an unattractive location for business activity of whatever kind. The station is located

1 close to a new hospital and next to a neighborhood of semi-detached houses. This neighborhood
 2 was designed with wide and long streets, which perhaps has hindered the location of any kind of
 3 business activity near this station.
 4

5 Getafe

6 The DBA growth in the municipality of Getafe was 2.76%, which is lower than in other
 7 municipalities. Metrosur has eight metro stations in Getafe. Six of them are located in old built-
 8 up neighbourhoods while two of them are located in new neighbourhoods: “El Bercial” and “El
 9 Casar”. Figure 6 shows the evolution of business activity in Getafe in a way similar to what
 10 Figure 4 did for Fuenlabrada.
 11

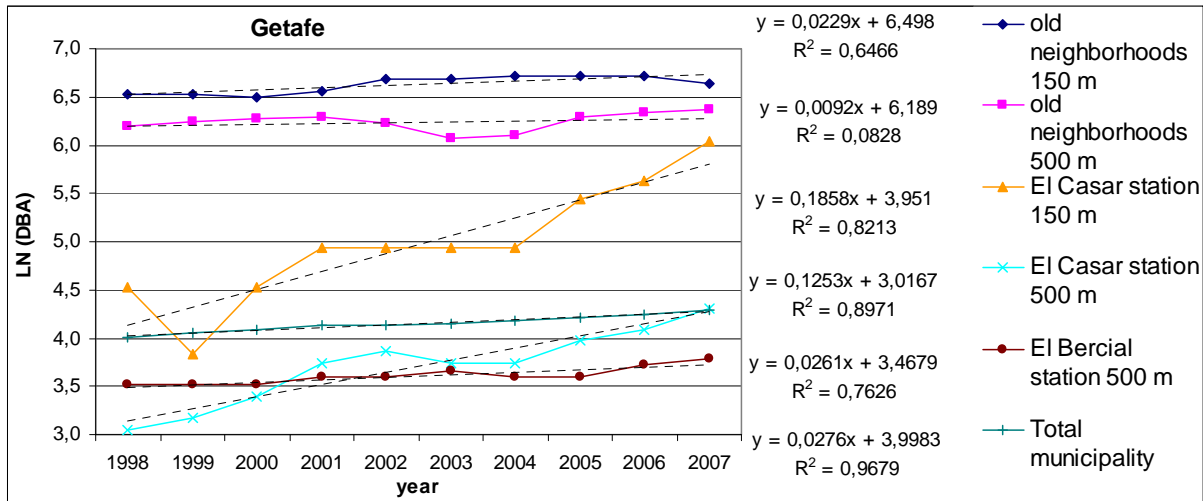
12 The location of the two stations identified in new neighbourhoods is noted in the map
 13 below. As in Fuenlabrada, it is noticeable that the DBA has substantially grown around some of
 14 the new metro stations, particularly around “El Casar” metro station. El Casar has two stations: a
 15 metro station and a commuter rail station. Those stations are connected and were built at the
 16 same time.
 17
 18



19
 20
 21 **FIGURE 6. Evolution of business activity in Getafe**
 22
 23

24 The yearly DBA growth around “El Casar” station is much higher than the DBA growth
 25 for the entire municipality. In fact, the DBA growth was 18.58% in the area located 150 meters
 26 from the station exits and 12.53% in the area located 500 meters from the station exits, whereas
 27 the yearly DBA growth of the municipality was only 2.76%. This trend can be also observed in
 28 Figure 7, where the results of the model for Getafe are calibrated. The fact that “El Casar” station
 29 is a transfer point between Metrosur and the commuter rail network might be an explanation for
 30 this growth.
 31

1 However, “El Bercial” station, also located in a new neighborhood, follows a very
 2 different trend. In the range of 150 meters from the station there has not been any business
 3 activity, so it is not included in Figure 7. In the range of 500 meters, there has been some
 4 business growth, but the DBA growth has followed a trend similar to the one of the entire
 5 municipality of Getafe. This station is surrounded by semi-detached houses, which might be the
 6 reason for the scarce business activity around it.
 7



8
 9 **FIGURE 7. DBA estimation in different areas of Getafe**

10
 11
 12 As in Fuenlabrada, the DBA growth around the stations located in old built-up
 13 neighborhoods is similar, and in some cases even lower, than the DBA growth in the entire
 14 municipality of Getafe. The slow increase within old zones may be due to the fact that those
 15 zones were already very dense and there is little space for more business activities.
 16

17 **Global analysis across municipalities**

18 Table 1 shows a comparative analysis, across different municipalities, of the yearly DBA growth
 19 around the new metro stations, compared to the yearly DBA growth for the entire municipality.
 20 From this analysis a set of common trends arises:
 21

- 22 • The growth in DBA is notable in the five municipalities though there are significant
 23 differences among them.
- 24 • The growth in DBA in the zones around the metro stations located in old and u
 25 neighborhoods is similar to the DBA growth of the entire neighborhoods.
- 26 • The growth in DBA in the zones around the metro stations located in new
 27 neighborhoods is often, but not always, much higher than the DBA growth of the
 28 entire neighborhoods.
- 29 • There is no clear evidence as to which pedestrian distance—150 or 500 meters—from
 30 the station has the greatest influence on increasing business activity.

TABLE 1. Yearly DBA growth across different municipalities

Municipality	The entire municipality	Old Neighbourhoods		New Neighbourhoods	
		150 meters	500 meters	150 meters	500 meters
Alcorcón	4.00 %	4.90 %	3.96 %		26.67 %
Fuenlabrada	4.20 %	2.20 %	4.30 %	29.52 %	32.90 %
Getafe	2.70 %	2.20 %	0.90 %	18.58 %	12.53 % ⁽¹⁾ 2.61 % ⁽²⁾
Leganés	2.10 %	3.50 %	1.80 %		4.92 %
Móstoles	3.00 %	2.60%	3.00 %		10.50 %

⁽¹⁾ “El Casar” station

⁽²⁾ “El Bercial” station that does not have any growth 150 m away of the station

DISCUSSION AND CONCLUSIONS

The results show that the construction of a new metro line (MetroSur) has boosted additional business activities in all the municipalities, but it has prompted as well a redistribution of those activities among different kinds of neighborhoods. This redistribution has benefited more the new neighborhoods than the old ones. Several reasons may explain this trend. On the one hand, the old built-up areas already enjoyed dense business activity, particularly shops and retail stores, so there was less room available for additional growth. On the other hand, the old built-up neighborhoods used to provide better accessibility before the construction of the metro line since commuter rail stations and most of the regional bus stops were located close to the consolidated areas of the city. Consequently, the rate of increase in accessibility caused by the construction of the new metro line has been higher for the new neighborhoods than for the built-up ones.

In general, the municipalities of Alcorcón and Fuenlabrada seem to have benefited the most from the increase in accessibility. The first one is closer to Madrid City and, therefore, the advantages for enterprises in locating in a place close to the city but with lower retail prices might explain this trend. In the case of Fuenlabrada, as it is the city among the five municipalities that is farthest away from Madrid City, any increase in its accessibility either by MetroSur or through its connection to the commuter train “Cercanías”, might explain this trend.

Both the design of the street network and the characteristics of the neighborhood seem to have a certain influence on the location of business activities. In general, neighborhoods with greater density of population, a predominance of apartment buildings, and less wide streets tend to have a greater potential for business activities than neighborhoods with low density of population, detached-houses, and very wide streets. Perhaps this is the reason why stations such as “Loranca” in the municipality of Fuenlabrada has experienced such a huge DBA growth since the construction of MetroSur was announced, while other stations located in new neighborhoods have experienced less significant growth.

1
2 The fact that a metro station is connected to other transport infrastructure seems to
3 influence the business activity around the neighborhood. It might be due to the advantages of this
4 transfer station for transport riders.
5

6 Regarding the influence of the distance to the station on the DBA growth, the analysis
7 does not reach conclusive evidence within the range analyzed. The stations located in old built-
8 up neighborhoods seem to affect the DBA similarly in both areas: that from the station to 150
9 meters, than in the area from the station to 500 meters. In fact, some of the stations have greater
10 influence on the 150 meters-distant area while some others have greater influence in the 500
11 meters-distant area. The stations located in new neighborhoods seem to affect the DBA more in
12 the 500 meters area than they do in the 150 meters area. In fact many of the stations in new
13 neighborhoods hardly have any business activities 150 meters from the station. One of the
14 reasons that may explain this is the fact that new neighborhoods are often designed with wide
15 streets so a distance of 150 meters is often not enough to reach any available estate to be
16 developed as a commercial or business activity.
17

18 This study leaves many doors opened to further research. An analysis that considers the
19 type of business activity (industrial, retail, services and so on) and different areas would be very
20 interesting. Similarly, an analysis of the jobs created in the area would shed plenty of light on the
21 influence of the increase in transportation accessibility on the labor market. Finally, an analysis
22 of the relationships among the five municipalities as a result of Metrosur can also be of great
23 interest.

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2

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