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TRANSPORT INFRASTRUCTURE INVESTMENT AND REGENERATION: A NECESSARY BUT INSUFFICIENT POLICY MEASURE

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ABSTRACT

Despite a long-standing tradition within transport studies research, capturing and assessing the long-term impacts of major transport investment projects is still problematic. This is partly due to the relative paucity of empirical data, as well as the considerable research effort involved in undertaking appropriate data collection for detailed longitudinal evaluations. Past studies suggest that economic impacts can vary significantly depending on the type of interventions, the locations and geographical areas served, pre-existing market conditions and other policy and planning factors. However, another issue for evaluation is the extent to which the different studies that are available are comparable in terms of their methodologies, which makes the synthesis of research findings across different case studies extremely difficult.

Whilst we are not able to overcome all of these methodological issues, our main objective in this paper is to construct a typology of the 'success' factors for securing economic uplift from such projects. Our research is conducted in three main stages i) a review of the past studies that are available in published form, ii) deeper secondary analysis of unpublished reports from the Jubilee Line Extension Impact Study (JLEIS), iii) development of an evidence-based typology for use by decision-makers, iv) testing the typology with our own empirical research and economic impact analysis of the Madrid Metro Line 12. The main aim of our research and this paper is to make more transparent key gaps in the evidence base concerning the economic and development impacts of major transport infrastructure impact investments, in order to better inform policymakers and other investors of this under different pre-existing conditions. We also aim to contribute a contemporary case study to the existing databank in order to encourage further international comparison studies.

Keywords: urban transport infrastructure, accessibility, long term economic and urban impacts, impact typology

INTRODUCTION

Transport infrastructure investment is often characterized as having a vital role to play in the regeneration process, largely due to a commonly perceived relationship between improved accessibility and increased economic activity. However, this relationship is far from conclusive and the literature suggests that the nature and extent of these economic impacts can depend greatly on the type and scale of the infrastructure provided, its location and specific operating characteristics, as well as on other factors outside the transport system, such as the pre-existing property market, land uses and local land policies. As such, even if "smart-growth" towards sustainable urban development is seen as the collection of factors that makes a transport project either a success or a failure, in practice it is difficult to specifically identify which factors are the most relevant ones.

One problem in attempting to critically identify a set of factors for the success or failure of such projects is the relatively limited availability of empirically robust impact assessments. There are very few examples of truly thorough longitudinal analyses of the non-transport impacts of a major new public transport infrastructure projects. The few that are available use different methodologies (spatial and temporal) to assess these impacts, largely due to the lack of available data, which makes any direct comparison of their findings problematic (Jones, et al., 2004). For instance, the poor availability of longitudinal datasets on property market values due to the time lags needed to evaluate long term effects. As such, researchers have needed to develop new methodological approaches and model designs to overcome the data problem (e.g. cokriging for commercial properties due to their limited number of transactions, instead of direct hedonic models). This has resulted in a highly variable set of conclusions about the nature and extent of the relationship between the new transport infrastructure investment and property and land use value uplifts.

Whilst we are unable to address these more fundamental criticisms of the available datasets and methodologies in this paper, we suggest that it is possible to synthesis the available evidence for the purposes of improved policy-decision-making for major public transport infrastructure investment. Our research is conducted in three main stages i) a review of the past studies that are available in published form, ii) deeper secondary analysis of unpublished reports from the Jubilee Line Extension Impact Study (JLEIS), iii) development of an evidence-based typology for use by decision-makers, iv) testing the typology with our own empirical research and economic impact analysis of the Madrid Metro Line 12. As suggested by Cervero et al. (1995) the primary intention contribution of our paper is to provide adequate feedback to transport planners and other investor concerning the longer impacts of such investment projects on the sustainable development and renewal of urban areas.

The paper is divided as follows: the next section explains the methodology used. Later we draw lessons about the longer term impacts of transport infrastructure investments from the published literature, with more detailed attention given to the Jubilee Line Extension (JLE) in sections 3 and 4. Section 5 presents the typology of impacts that we have identified from our review of past studies. Section 6 offers a contextual background for our own Metrosur case study and the key aspects of the methodology that was used to identify economic impacts of

the investment in this study. Section 7 presents our findings from applying the typology to the Metrosur case study. Finally, in the concluding section we discuss the implications of our findings for policy decision-making in relation to future transport infrastructure investment projects.

METHODOLOGY

The methodology for our paper is based on both secondary and primary research. Initially, we undertook an extensive literature review of past studies of the impacts of major public transport infrastructure projects that have been undertaken in different geographical and national contexts. Next, we turned our attention to a more detailed secondary analysis of the largely unpublished consultancy reports that were produce from the extensive research that was commissioned by London Transport (now Transport for London) for the Jubilee Line Extension Impact Study (JLEIS) in which one of the authors was involved as a researcher. From this more detailed synthesis of the evidence, we developed a typology of the different exogenous factors that were reported to affect the economic impacts of Jubilee Line Extension (see Lucas and Jones, 1998 for more on the detailed methodology for this study).
The primary research is based on a doctoral research project by one of the paper's authors.. Here, we use the outputs from an economic impact analysis of the Madrid Metrosur. It is not the intention of this paper to describe at length the methods employed for this impact study, which is reported elsewhere (See for example Mejia-Dorantes et al., (2011); Mejia-Dorantes et al., (2012); Mejia-Dorantes & Martin-Ramos, (2013)). However, it is important to understand the primary research that is behind the typology testing described in this paper..
House prices: A complete cross sectional dataset comprising accurate information within the five municipalities was compiled. Since there are no official micro data bases, a real estate web was used to obtain this information at the beginning of 2009 from which it is possible to get information related to house prices, location, along with other characteristics and amenities. It was possible to appraise the benefit that an urban mass transport infrastructure produces in house prices using different spatial hedonic models.
Firms' location choice: A detailed firmographic dataset from years 1998 and 2007 was used. It was obtained through the Bureau of Statistics of the Madrid Region and it contains for each firm within the region, the exact location and type of economic activity. In this case, a number of different analyses on the location of firms were carried out. The enterprises were mapped using the Kernel density function in order to visualize how firms have located and clustered over time. Afterwards, using different multinomial logit models, it was analyzed whether new firms have been encouraged to locate in the areas around Metrosur stations.
Moreover, different variables related to socioeconomic characteristics of the region were tested. We took the findings from this analysis to operationalize the typology we describe in later sections of this paper and to develop a set of conclusions regarding its robustness in determining the necessary pre-conditions for economic uplift from public transport infrastructure investments.
Whilst we do not claim our methods as wholly innovative, we believe they do serve to significantly enhance current understanding of when public transport investments can be transformational in terms of encouraging new economic activity and development in the

surrounding areas they serve and when they are less likely to be so. This is the main intention of our paper.

LITERATURE REVIEW OF PREVIOUS ECONOMIC IMPACT STUDIES OF PUBLIC TRANSPORT INFRASTRUCTURE PROJECTS

Investment in a major transport infrastructure has often been seen by policy makers, developers and other investors as a necessary step for an adequate urban growth and/or renewal. Public investment is most often argued on the basis that new local jobs will be created through the increased local trade that will be generated by means of the improved accessibility (Cheung, 1993). In turn, property developers will be attracted by and encouraged to locate in these areas as a result of the enhanced land values brought about through increased accessibility. However, the generalised presumption that this, in turn, will change the nature and/or scale of development and increase development intensity and bring considerable socio-economic advantages to the area, has not been rigorously assessed. For example, in her review of literature on the impact of transport investment projects on the inner cities, Grieco (1994) found that the relationship between transport investment in any area and increased development activity cannot be assumed.

Early research into the economic impacts of public transport infrastructure investment dates back to the early 1970s (Bonnafous, et al., 1975), with many early studies concentrated in the United Kingdom (UK): e.g. Victoria Line e.g Beesley and Foster (1965); Glasgow Rail Improvements e.g. M&V Associates-DoT/DoE (1982), and Mitchell et al. (1983); Tyne and Wear Metro e.g. Bennison, (1982); Manchester Metrolink e.g. Fairweather and Law (1992), Forrest et al. (1996); South Yorkshire Supertram e.g. Antwi (1993, 1995), Henneberry (1996), Dabinett et al.,(1994); Jubilee Line Extension (JLE) e.g. Roger Tym and Partner (2002), Chesterton (2003), Pharaoh (2003).

A number of early studies were also undertaken in the United Stated (US), e.g. the review on different north American cases by Knight and Trygg (1977); the Washington metro e.g. Damm, et al. (1980), Grass (1992); The Miami Metrorail (Gatzlaff and Smith, 1993); the Atlanta's MARTA rapid rail transit (Bollinger and Ihlanfeldt, 1997; Cervero, 1994; Cervero and Landis, 1993); the Chicago Midway line (McMillen and McDonald, 2004): Nonetheless the most notable of which is probably the San Francisco Bay Area Rapid Transit (BART) study (Webber (1976); Cervero and Landis (1995, 1997); Kitamura et al., (1997); and Cervero and Wu (1997), etc.).

When considered in aggregate, these various studies suggested that although there may be causal links between public transit investments and knock-on economic benefits, there have also been significant variations in the size and/or evidence of this relationship between the different studies. It would appear that a number of widely divergent exogenous factors are at play, including the type of public transport, local geography, the nature of the built environment, the pre-existing labour market and property and land uses, as well as issues associated with the methodologies used such as the timeframe for before and after studies, the included variables, the type of analysis used and so forth.

For example regarding methodology, Debrezion et al. (2007) carried out a meta-analysis making use of a wide collection of studies in an effort to understand the impact of railway

stations on property values for residential and commercial properties. They concluded that more realistic results would have been reported with the inclusion of more accessibility variables. Another example of methodological variability is the zero relationship found between 'before' and 'after' property prices in the Manchester Metrolink study (Forrest, Glen and Ward, 1996) while a later follow-up study found an important positive effect (Senior, 2009) .

Regarding exogenous factors such as the built environment, Cervero (2007) mentions that free-parking available around transit stations in the USA might diminish the benefits of transit-oriented development because it lessens the number of people passing-by retail stores. Another study carried out by Song and Knaap (2004) shows that the type of mixed land-use, preferable service-oriented businesses, and convenient size of commercial developments, in harmony with the size of the neighbourhood, and the importance of pedestrian access to it needs to be taken account of within impact analysis. Still other studies pay attention to the importance of street network design which can determine the attractiveness of transport stations because most riders access the stations by walking (Hsiao, et al., 1997, Gutiérrez and García-Palomares, 2008, Mejia-Dorantes and Vassallo, 2010, Handy et al., 2002, Handy, 1996).

In addition, a buoyant economic situation appears to be a relevant pre-condition for development growth. For example, Cervero and Landis (1995) concluded that BART's influence on office development in the East Bay has been limited to certain areas: its major influence was found in downtown San Francisco while in the East Bay was weak. They stated that employment growth occurred in non-BART-served corridors. The authors conclude that the areas where the effects are more evident are those that are influenced by other aspects such as: i) a regional vision on the importance of urban planning, ii) a political culture that supports public transport and iii) the use of other policy measures to encourage the positive effects (Cervero and Landis, 1997, Transport Research Board, 1996). Landis et al. (1995) also mention that the Santa Clara County Light rail system had no impact on land values due to the downturn of the economy; it took around ten years to revert this trend. Similarly, the type of infrastructure and its location play a major role.

With regards to location, the Greater Tel Aviv Metropolitan Area is a good example of how economic impacts may differ depending on how far the infrastructure is from central locations. Vaturi, Portnov and Gradus (2010) show that while central municipalities were benefited by train accessibility, peripheral areas were less benefited or even its attractiveness declined. The former was explained by the socio-economic structure of each municipality. In this respect, Lund et al. (2004) also found that people living near transit stations are five times more likely to commute by public transport than the average people living in the city. Transport-oriented developments (TOD) reduced the number of trips made by private transportation and increases the ones made by public transportation.

Despite these highly differentiated findings, some generalised trends can also be made across the different infrastructure project. It is towards these more generalised observations that we turn our attention in this paper, in order to develop an initial list of categories for inclusion in the typology based upon the 'key success factors' that have been observed across the various studies that were reviewed (see table 3, column 1).

Although the literature identifies some broad categories that could be included within the typology, it was insufficiently conclusive to fully determine the pre-conditions necessary to encourage economic uplifts from major public transport investments in different contexts. In order to determine this and to make our typology framework more specific, we undertook secondary analysis of a large number of hitherto unpublished but publicly available web-based reports of the economic impacts of public transit infrastructure investment, namely the Jubilee Line Extension Impact Study (JLEIS) in the UK (University of Westminster, 1991-2004). Until now, the findings of these studies have hitherto remained largely unreported within the academic literature but offer considerable additional insights concerning the pre-conditions for securing economic uplifts from public infrastructure projects.
In the next section of the paper, we report on the main findings from our secondary analysis of these documents, the evidence from which was then used to develop our typology framework.

REFINING THE TYPOLOGY USING SECONDARY EVIDENCE FROM THE JUBILEE LINE EXTENSION IMPACT STUDY

The second stage of our research involved refinement of the initial typology list that was based on the above evidence the secondary analysis of the JLEIS consultancy reports that were commission by London Transport (now Transport for London) (see table 1 column 2). The original JLE impact study combined quantitative and qualitative methodologies and used a number of different survey instruments and analytical approaches to evaluate its impacts (see Lucas and Jones (1998) for more detail on the methodology). The different surveys were generally conducted in four 'waves' (one 6 months before the line opened, one 6 months after opening and one in 2001 and 2003). They focused on four broad impact categories, two of which we focus on for the purposes of this paper: the economic activity impacts and the property market and development impacts. Until now, the synthesised evidence results from these different impact evaluations studies have remained largely unreported within the academic and policy literatures.

Main characteristics of the JLE catchment areas

In 1998, The Jubilee Line Extension (JLE) was the first new underground line to open in London for over twenty years. It is approximately sixteen kilometres long and added eleven new stations to the existing line, six of which are in locations that were previously not served by the underground network. The main expectation from this major transport infrastructure investment by London Transport (now Transport for London) was that the JLE would produce substantial economic benefits from the property market uplift and regeneration of the South Bank and other station catchment areas and the creation of new jobs, mainly in Canary Wharf.
For the purposes of analysis, the eleven JLE stations were grouped in four geographical areas according to their land use characteristics. 1) Waterloo, Southwark and London Bridge stations on the South Bank were described as a new central London shopping and cultural quarter. 2) Bermondsey and Canada Water stations were referred to as the Surrey Quays area providing a large number of new private residential homes with good access to the

Canary Wharf new financial district. 3) Canary Wharf and North Greenwich stations can be referred to as the Canary Wharf Estate, which was specifically regenerated to act as the overspill area for the financial activities of the City of London. 4) Canning Town, West Ham and Stratford stations were identified as the East London area, which describes a corridor running through the three London Boroughs of Tower Hamlets, Hackney and Newham. The area is still characterised by large areas of low-grade public sector housing and repeated publicly funded regeneration initiatives to attract commercial development.

The main JLEIS was then subdivided according to a number of expected impacts (e.g. household, employment, property market, land use, etc. and a series of before and after surveys undertake around selected new stations in each of these four areas. Specialist consultants were commissioned to undertake the surveys and analysis of data pertaining to each of the different areas of impact with University of Westminster being responsible for coordinating the studies and undertaking any overarching final analyses (Lucas and Jones, 1998).

Summary of the economic activity impacts of the JLE

In the economic impact study report, Roger Tym and Partners (2002) found an increase in employment at twice the London rate across all station catchment areas in aggregate; 5,600 higher in terms of jobs than it would have been had it grown at the average rate for London as a whole. There were only three catchments that did not grow at above the London average: the Southwark catchment area, which was already quite densely developed and already had good public transport access; the North Greenwich catchment area, where activity was directly related to the as yet undeveloped Millennium Dome; and the West Ham catchment area, which was predominantly an area of social housing with little development opportunity. In the surveys, 39% of employers reported a change in employment, of which 29% reported a positive change and 10% reported a negative change. Not surprisingly, given that the JLE was specifically designed to support increased employment activity in the new Canary Wharf financial district, the greatest percentage of employers reporting increases in employment were in this catchment area. Canning Town in the more run-down East of London appeared largely unaffected by the JLE opening, with three quarters of the sample reporting employment to be broadly the same as before the opening of the JLE. For the Jubilee Line area as a whole, 31% more employers reported an increase than a decrease in turnover over in the 12 months after the JLE opened. A total of 47% of employers reported increases in annual turnover over the last 12 months; this was 5% higher than for the London reference area. Like London, the greatest reporting of increases in the JLE area were in the Financial and Business Services sectors.

The study authors identified six separate but related factors influencing the success of the JLE in terms of its reported economic impacts:

1. The new Line and stations were well-integrated with the existing London underground and over-ground rail network and wider access to stations enhanced by a planned network of feeder services,
2. The Line significantly enhanced access not only to local East London labour markets, but also encouraged reduced longer distance commuting times in the wider South East Region, as well as improved cross river connectivity (River Thames),

3. Local authority planning policies were in place to support residential and commercial developer activity, so that the JLE was part of a wider package of measures to regenerate this part of London,
4. The opportunity for public/private developer partnerships-led regeneration programmes in the catchments areas around some stations (e.g. at Canada Water, this was achieved through clearance of 1960s social housing estates and their replacement with new mixed tenure housing, whilst at Southwark station the JLE station was part of the new South Bank shopping and cultural quarter development)
5. The significantly enhanced image of catchment areas around some stations (e.g. Southwark and Canada Water) led to generally improved perceptions of these areas and improved investment confidence in this sector of the City. The JLE stations were of a high design standard and specifically intended to provide a focus for this regeneration and investment activities.
6. The period of the JLE opening was one of significant labour market development and economic buoyancy in London and the South East and much of this increased economic activity would probably have happened anyway, but maybe not in these specific run-down areas of London.

Summary of the property market and development impacts of the JLE

Two further consultancies were responsible for the property market and development activity surveys: Chesterton for the Property Market Activity study (Chesterton, 2003) and Tim Pharaoh Associates for the Development Activity study (Pharaoh, 2003).

Property Market Effects

In the South Bank area, average residential property prices rose by 3.8% over the first quarter of 2002 and by 11.8% over the full year. The 11.8% annual growth contrasted with a 0.9% price fall in Central North West London and an overall 4.2% increase across Central London as a whole (Cluttons, 2002). Analysis of the reasons for buying a residential property in the area in March 2002 showed that 41% were looking for a property as a result of job relocation compared with 13% in the previous year. The available data on residential and commercial property values in the east London area was extremely limited. The only reported impact is that residential rental values increased from £125-140 in 1998 to £170-190 in 2000 and that agents perceived the JLE to be a considerable factor in this uplift. According to the 2002 Chesterton report, these development investments and the new transport links are the key factors that have stimulated interest in a new buy-to-let market.

Development activity impacts

Pharaoh (2003) reported that the average number of planning applications in the JLE Corridor had increased from 22 applications per year in the pre-announcement period 1991-93 to 39 applications per year in the period following its announcement 1994-99. This

represented an overall increase of 77% compared to an increase of only 15% in the rest of Inner East London. However, this result was again varied according to the different JLE station catchment areas. The two reports identify five key constraining factors on greater property market and development in the areas that performed less well, which are worth considering in the context of this paper, namely:

1. Complementary land use policies: at the time the JLE was commissioned, local authority policies did not encourage higher density development around stations, nor reduce parking standards, although this is now changing

2. Non-vehicular transport: while much emphasis was placed on good bus/rail interchange, relatively little effort was put into ensuring good local access on foot or by bicycle

3. Social inclusion: it was assumed that local residents and businesses would benefit from regeneration along the route of the JLE, but there were no complementary policies to ensure that these benefits were maximised (e.g. by retraining local unemployed residents)

4. Sustainability: several of the Mayor's strategies now stress the importance of increasing the sustainability of activity in London. Again, in keeping with earlier the policy priorities, no sustainability audit was undertaken to assess the contribution that the JLE could make;

5. Land value capture: e.g. potential for compulsory purchase order by local authority.

These were important consideration to bear in mind in the development of our 'typology of success factors', framework to which we now turn our attention in the next section of the paper.

TESTING THE TYPOLOGY OF SUCCESS FACTORS

In the third and final stage of our research for this paper, we took the results from economic impact analysis of the Madrid Metrosur undertaken as part of a doctoral study by one of its authors (see table 3, column 3). The aim was to use the findings from this research to populate and thus operationalize and test the typology we had created. Although it is not the intention to report on the various models that were developed for the purpose of impact assessment, for ease of reference we have synthesised the modelled results in tables 1 and 2. More information on the precise methodology for the economic impact assessment can be found in Mejia-Dorantes et al., (2011); and Mejia-Dorantes et al., (2012).
Before interpreting these results within the typology, it is important to first have a contextual understanding of the Metrosur case study areas. The five municipalities are connected to Madrid City by both private (road) and public transport (rail, interurban buses and metro) links. Together these five municipalities have a total population of about 1 million inhabitants, and each municipality has a population close to 200,000 inhabitants. Each one has different

socio-economic characteristics. In the last three decades before the crisis, Madrid City had characterized by high real estate prices. As a result, some municipalities outside of, but surrounding Madrid City, have promoted large real estate developments in order to increase the supply of affordable housing and space for firms. Therefore, these municipalities, which were once small towns, became dormitory towns with a lack of important local economic activities within their own boundaries. Prior to the introduction of Metrosur, the public transportation systems in these towns focused on connecting these municipalities to Madrid City through both commuter trains and regional buses. As noted by different reports, the public transportation networks linking these municipalities had been extremely poor, basically focused on highways and on the connection provided by the commuter rail lines (Oficina de Planeamiento Territorial y de la Dirección General de Economía y Planificación, 1988; Melis, 2003).

It is worth highlighting that the five municipalities are also served by different commuter train lines and interurban bus services into Madrid City, as this is an important consideration for our research findings. In addition to the Metrosur, Alcorcon is also served by metro line 10, which is one of the largest metro lines in Madrid, serving the north of the Metropolitan area of Madrid to the south (lately extended). It is also served by a light rail line that recently started operating through the west of Alcorcon and has only two stations; still it does not cover the urban area. It is worth noting that the Madrid metropolitan area has one of the highest rates of kilometres of highways per habitant in Europe.

Another important consideration is that the five municipalities have different ticket fare structures. Madrid transportation network is divided into different fare zones (known as A, B1, B2, B3, C1, C2, E1 and E2). As soon as one gets farther from the core of Madrid (zone A) the ticket fare becomes more expensive. While the core of Madrid is located in zone A; Alcorcon, Getafe and Leganes are located in the fare B1 zone, whereas Fuenlabrada and Mostoles are located within the B2 fare zone. The monthly travel pass allows users to take any transport mode (buses, metro and commuter train) within its validity range. Moreover, the percentage of people with a monthly travel pass living in zone A is equal to 28.8%; it decreases farther from the core of Madrid: the percentage of people living in zone B with a travel pass is equal to 20.7% and equal to 17.2% in the case of zone C (TARYET & IMOP, 2005). This executive report also states that people are more prone to have a travel pass if their trips are multimodal. The Metrosur line was used as an origin trip by 135,149 passengers/day in 2003, this number increased by 157,478 in 2004 and raised until 171,830 in 2007 (CRTM, 2005, Metro de Madrid, 2008). However, if we analyse into more detail the areas served by Metrosur, there are important differences on the impacts.

Table 1 – Changes in firms' location patterns from 1998 to 2007 using Kernel density estimates

	Manufacturing (BC1)	Construction (BC2)	Retail (BC3)	Food (BC4)	Transport (BC5)	Finance & Real Estate (BC6)	Health & Social Services (BC7)
Alcorcon	=+	+	+++	+	++	++	++
Mostoles	=-	++	++	+	++	++	++
Fuenlabrada	=	=+	++	=+	=	++	++
Getafe	-	+	=+	=	=	+++	=+
Leganés	=	=	=	=	=	+++	+

decreased (-) slight increase (=+) notable increase (+++)
slight decrease (=-) increase (+)
similar (=) important increase (++)

Table 2 – Coefficient sign of the different Multinomial logistic models carried out

	Manufacturing	Construction	Retail	Food	Transport	Finance & Real Estate	Health & Social Services	Other activities
METROSUR	BC1	BC2	BC3	BC4	BC5	BC6	BC7	BC8
Alcorcon	-	-	-	-	-	-	-	-
Mostoles	-	-	-	-	-	-	-	-
Fuenlabrada	+	-	+	-	-	+	-	-
Getafe	+	-	+	+	-	+	+	+
Leganés	-	-	-	-	-	+	-	-

CERCANIAS	BC1	BC2	BC3	BC4	BC5	BC6	BC7	BC8
Alcorcon	+	+	+	+	+	+	+	+
Mostoles	+	+	+	-	+	+	-	+
Fuenlabrada	+	-	+	+	-	+	-	-
Getafe	-	-	-	-	-	-	-	+
Leganés	+	-	+	-	+	-	-	+

INTERURBAN BUS	BC1	BC2	BC3	BC4	BC5	BC6	BC7	BC8
Alcorcon	+	-	+	-	-	-	-	-
Mostoles	+	-	+	-	-	-	-	-
Fuenlabrada	+	-	-	-	-	-	-	-
Getafe	+	+	-	-	-	-	-	-
Leganés	+	+	-	-	-	-	-	+

(+) Positive coefficient
(-) Negative coefficient
Coefficient not significant at 5%

DISCUSSION OF METROSUR IMPACTS IN RELATION TO OUR TYPOLOGY

In this section of the paper, we discuss in more detail the findings from the primary modelled analysis of the impacts of the Metrosur in the five different station locations under the various themed groups as they were presented within our typology. This helps us to identify some overarching recommendations for policy decision making for major public transport investment projects, as reported in the final conclusions section of the paper. Each of the sub-sections below corresponds with the key categories that were identified in table 3, column 3.

Summary of the pre-exsiting conditions for Metrosur

Background economic conditions

ECONOMIC SITUATION: By the time Metrosur was built and started operations, the economic situation was generally good. Therefore, many people bought their houses in this area (it was less expensive than Madrid city) and enterprises located in these areas (many due to agglomeration economies, rather than the benefit of Metrosur).

Land use factors

HIGH-DENSITY NEIGHBORHOODS: The old areas have mixed land use in the downtown of each municipality, however, newer areas were built as low density ones with semi-detached or semi-detached housing and not TOD.

Pre-existing transport factors

ROAD CONGESTION: There are not important congestion problems in the area, since the region of Madrid has lately increased the kilometers of highways (according to the Fundacion de la Energía CM (2010) report, it has one of the highest rates of kilometers of highways per habitant in Europe, equal to 174 km per million inhab. Higher than Berlin, London or Paris. It is therefore, not surprising that people prefer to commute by car.
INTEGRATION WITH PUBLIC TRANSPORT NETWORK: The municipality most benefited by Metrosur is Alcorcon, which is the closest to Madrid City and at the same time enjoys a better connectivity to the Madrid public transport network.

Supportive planning policies

PROMOTION OF POLYCENTRIC AREAS: No major polycentric areas were fostered. Therefore, riders use specially the station “Puerta del Sur” which connects to the Madrid metro network to commute to more central locations. They also use the six interchange stations with the commuter rail to commute to Madrid downtown, hence these are still primarily dormitory areas.
AGREEMENTS WITH PRIVATE DEVELOPERS: No major agreements were made with urban developers to improve this situation. It was expected that some areas like Manuela Malasaña station could be benefited with land development projects in the near future. This has not been the case.

Table 3 – Main typology factors from the background evidence

TYPOLOGY FACTORS	JLE	METROSUR	Relevance
General & geographical description			
Opening year	1998	2003	
Type of intervention	Underground extension	Underground metro line	
Lenght & number of stations	16 km long; 11 new stations	45 km, 28 stations. Circular line	
Enhaced image & design of public transport stations	Yes	Yes	
Zone	Links Green Park to Stratford through south and east London (metropolitan)	Suburban: 5 municipalities connected. Connected to the Madrid metro system through 1 line and 6 commuter rail interchanges	
Polycentric area	Yes	Minor polycentric. The main pole of economic activities is in Madrid city	*
Dormitory areas	No	Yes	
Type of neighborhoods in the area	Mixed	Mixed land use in old areas. New neighborhoods built as low density areas (detached or semi-detached housing) not TOD	*
Availability of developable land	Yes (Bermondsey and Canada Water). Not in East London	Yes	*
Congestion problems or other factors limiting vehicle velocity in highways	Yes	Moderate to not existing	*
Transport related			
Transit fare and integration	Yes	More expensive than in downtown. If raiders do not have the monthly pass, it is not possible for them to change to other transport systems (like commuter rail/bus)	*
Pedestrian accessibility (Walking factor)	Main mode to get to stations	Main mode to get to stations. Good in municipalities' central areas. Bad in new neighborhoods. Not enforced	*
Mobility culture in the area	PT-oriented	Suburban areas use private transport as main mode in the Madrid region	
Political culture for public transport	Fostered	Minor reinforcement	
Previous Public Transport infrastructure and integration with existing network	DLR (insufficient),buses and Metro system (far). Integration occurred	Regional buses and commuter rail lines to connect these municipalities to the capital	*
Economic			
General economic situation	Good	Upward trend (until 2007)	*
GDP	Areas with higher GDP than others	Lower than in the region of Madrid; and B1 zone better than B2. Not a big difference among them	
Public funded	Yes	Yes (mix of authorities: Municipal, regional authorities and Transport authorities)	

Table 3 – Main typology factors from the background evidence (cont.)

TYPOLOGY FACTORS	JLE	METROSUR	Relevance
Public policy			
Parking restriction policy	High. No bicycle promotion strategies	No. People usually own a car in the suburban zone. The analysis showed the importance of parking space. However, public parking areas are available	*
Anti-low density strategies	Yes	None	*
Housing proximity to stations	Fostered by different strategies	Car-oriented neighborhouds were built, pedestrian accessibility to stations was not promoted	*
Polycentric growth induced shorter commutes (major decentralization of jobs/housing)	Yes	No (Major economic poles are still in Madrid): Average of people house owners really high, which limits mobility	*
Public/Private agreements	Yes	Minimum. It was expected that some areas like Manuela Malasaña station could be benefited with land development projects in the near future. This has not been the case	*
Strategies with actors and stakeholders	Governmental support for residential and commercial developers activity and public/private partnerships	None	*
Complementary land use policies	Land-value capture through compulsory purchase orders	None	*
Density bonus or similar strategies	It happened but was not encouraged	Did not happen, not encouraged (many new detached housing developments were built)	*
Regeneration initiatives	In some areas. Specially around Stratford station and Canada Water	Old commuter stations were rebuilt to become interchange stations	*
Social inclusion initiatives	No (only special fares for elderly, dissable and children)	Only special fares for elderly/handicaped/students buying the monthly pass	*
Long term sustainability	Built in longevity	Built in longevity	
Impact outcomes			
Job-housing balance	Good	Not achieved	*
Main mode of transportation of employees living outside, coming to the area to work	Public transport	Private transport	*
Impact on house-market	Positive although not detailed info exist. However the South Bank area had an uplift of 11.8% in 2002. Canada Water got to a general 20% increase. Rental values slipped by just 1.6% while Central London fell to a 5.2%	Increased price of apartments, especially in the B1 area (a difference of 31,000€ with the Metrosur B2 zone). Other infrastructures more benefited (commuter rail line)	*
Impact on business-activities	Good. Huge financial sector (Canary Wharf). In many sites relocation of firms occurred.	The location of economic activities differed among municipalities. Some, in general terms like industry, diminished, but others increased. In many cases the former is a response of agglomeration economies	*

ANTI-LOW DENSITY STRATEGIES: No strategies were planned to limit this type of urban developments.
FARE INTREGRATION ACCORDING TO LOCAL GDP: The monthly ticket is more expensive than in the downtown. If raiders do not have the monthly pass, it is not possible for them to change to other transport systems (like commuter rail/bus).
FIRMS' LOCATION STRATEGIES: No strategies were evaluated.

Supporting transport policies

WALKING-FACTOR: A number of these newly developed areas around the stations are designed for private transport with longer and wider roads, which considerably limit pedestrian access to the stations. In many cases, especially in new developments, stations are not easily reachable by walking since they were built private transport-oriented neighbourhoods instead of TOD. No cycling strategies were planned.
PROMOTION OF PUBLIC TRANSPORTATION AMONG FIRMS AND PARKING RESTRICTION: No agreements with firms were made to promote the use of public transportation among employees. Parking restriction policies were not taken into account. In fact, the analysis carried out, showed the importance of parking space.

Other supporting policies

REGENERATION AND SOCIAL INCLUSION INITIATIVES: Apart from the improvement of metro-commuter train interchanges, these analyses were never carried out.

Impact outcomes

HOUSE PRICE INCREASES: Better accessibility to Metrosur has different impacts on house values depending on the municipality and on transit fares. One of the most interesting findings was that the distance to a commuter rail station was economically more important that the distance to the Metrosur station, i.e. house prices went up more in the immediate catchment area to the Cercanias stations than in the areas around the Metrosur stations. Elsewhere, the impact on house prices importantly decreases if the house is located in a more expensive fare zone.
FIRMS' LOCATION CHOICE: The accessibility change brought about by the new infrastructure affected locational decisions and generated a preference to locate near Metrosur stations depending on the geographic location of each municipality and on how relevant it is the service provided by other types of transport infrastructure, such as the commuter rail or the interurban buses. However this pattern is also a consequence of agglomeration economies and other neighbourhood characteristics such as the location around places with a higher population, which may be seen as zones with more potential clients or a higher labour force. Interestingly, the economic impact of commuter rail stations is not so important in the case of firms' location. The municipality most benefited, both in terms of housing appreciation and firm location, is Alcorcon, which is closest to Madrid City. It is also the area best served by different transport infrastructures; therefore the population living or working around these stations are benefited by better accessibility through more interchanges (Metro line 10, commuter rail and Metrosur). At the same time, firms are benefited by lower land prices and more land availability than in Madrid City.

JOB-HOUSING BALANCE: There is a general lack of a two-way interaction in the area. People living around Metrosur stations are probably more prone to commute to Madrid City and it is likely that people from outside the area are using in many cases other means of transport such as cars and buses to get to their work at firms located within these municipalities, especially the ones farthest away. Riders commute from these five municipalities out of these areas. Therefore, in general terms, in the case of entrance stations, the peak time occurs in the very morning while in the case of stations as destination, the peak time occurs from 16:30 hrs to 19-59 hrs (except in the case of Universities, hospitals and transfer stations) (Metro de Madrid, 2008).
SUSTAINABLE TRAVEL: The results in the hedonic analysis and on the household mobility survey (Jordá, 2009) sustain that people living in the area are still relying on cars to commute, which means that the new transport infrastructure is not efficiently exploited. It seems that a job-housing balance is not taking place in the area.

CONCLUSIONS AND RECOMMENDATIONS

It is clear from both our empirical research and the evidence of the numerous previous studies that we have referred to in this paper that there is clearly no easy solution as to when or where it is most appropriate to invest in major new public transit infrastructure projects. Often this will be a political decision that primarily rests outside of the influence of evidence-based policy-making. Nevertheless, it is in the interest of investors and policy-makers alike to attempt to deliver the maximum economic benefits from such investment, as well as to ensure the new infrastructures contribute to sustainable urban development in the areas they serve. Our research can only hope to offer some new insights to the already well-trodden path of transport impact assessment and does not claim to revolutionise previous methodologies. However, application of the typology that we have developed and tested using the Metrosur case study could assist policymakers and other key decision-makers in their appraisal of whether such investments can achieve the economic outcomes they desire within the context in which they are to be delivered. It can also be used to offer some policy recommendations for improving the success ratings of major public transport investments based on our research.
Firstly, it can be recommended that enforceable land use policies need to be already in place to address the increase of urban density or a mixed land use. These should be integrated with complementary measures to make car travel more expensive and slower in order that people do not perceive an advantage when using the car for these longer trips. Policies such as the Dutch A-B-C policy around stations would definitely have benefitted the Metrosur municipalities by discouraging the use of private car and to promote the use of public transport together with cycling and walking. It is evident that people working in the Metrosur municipalities will continue to use their car since their travel time by using public transportation cannot compete with that of the private transportation. Moreover, bigger enterprises provide extensive parking areas for employees or for shopping purposes. Finally, new areas discourage pedestrians or cyclists.
The Metrosur case also suggests a conclusion that urban planning and design play a vital role in the uptake of public transport. For example, a dense street network in order to reach

easily the stations encourages its use, whereas if one looks into more detail the new urban developments in those zones are car-oriented. It seems possible to assume that it is not only important to have a station in close proximity to a neighbourhood a but also a combination of other factors such as the optimization of economic resources and other political agreements along with the correct urban policies to foster the usage of public transport. Even if there is also no way to a change in street patterns in the current development areas around stations, this should be a major consideration for future projects. Moreover, it should be kept in mind for future projects strategies such as the ones related to the decoupling of "house-parking": Many TOD projects restrict parking spaces in buildings close to stations; therefore it is more likely that people visiting, living or working in the area will use public transport instead of private transport.

In the case of Metrosur, since the urban areas are totally flat, it is a good option to implement different bicycle infrastructure and equipment such as cycling lanes, and bike parking areas in order to improve accessibility to the Metrosur system. The traffic within the urban areas is not impressively high; therefore, it does not discourage the use of bicycle. The promotion of this sustainable mode of transport should be fostered by the different authorities concerned with the Metrosur project. Moreover, velocity limits should be discussed and deeply monitored in order to balance the use of private/public transportation.

A gap in the competences of different planning authorities (for instance, municipal, regional and transport authorities) also acts to limit efficient and integrated urban and transport plans, and therefore its economic impacts. Political factors, efficient implementation and economic conditions should come together in order to efficiently exploit an infrastructure, for the sake of a more equitable economic growth. We clearly are not arguing for a massive suburbanization of firms, but rather that if new public transport infrastructure is built in these suburban locations it is essential that an ordered location of firms in areas close to the Metrosur stations takes place. To this end, it is necessary for all the municipal authorities to develop a strategic plan together, in order to attract firms to the area in a systematic way. Tax benefits might be needed to attract firms and at the same time, measures to promote the use of public transportation and to penalize the use of cars should be contemplated. For example, the firms in the region of Paris contribute with the 50% of the monthly travel pass of their employees and similar polices could be adopted in this instance.

On the basis of these findings, we conclude that such a typology would desirably be utilised at various points during the planning and development of major new transport investments projects to improve not only their economic success but also in order to achieve more sustainable development and land use polices in the areas they serve. Initially, at the early ex ante decision stage, proposers of major new transport infrastructure projects, such as politicians and development financiers, could useful use the typology to consider whether the areas which they are propose as potential development sites offer the optimal background conditions for these projects. Secondly, at the high level planning stage, planners and policy makers can make use of the typology to understand what supporting plans and policies need to be put in place in advance of the line announcement and its development in order to maximise it economic and development benefits. Thirdly, at the stage of more local level and detailed planning stages, it can be used to pin-point more specific areas for integrated planning between various levels of planning authorities and partnership working between

different private and policy sector agencies and key local stakeholder groups. Finally at the post hoc project evaluation, the typology can be used as a performance check list in order to assess the extent to which investments have represented value for money in comparison with other similar projects elsewhere and offer a transparent justification for more specific impact outcomes.

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