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Transport Reviews, Vol. 29, No. 2, 261–278, March 2009

Routledge
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70725

Public Transport Funding Policy in Madrid: Is There Room for Improvement?

JOSÉ MANUEL VASSALLO*, PABLO PÉREZ DE VILLAR*, RAMÓN MUÑOZ-RASKIN** and TOMÁS SEREBRISKY**

**Transport Research Centre (TRANSYT), Universidad Politécnica de Madrid, Madrid, Spain*
***Sustainable Development Department, Latin America and the Caribbean Region, Transport Cluster, The World Bank, Washington, DC, USA*

(*Received 31 January 2008; revised 12 June 2008; accepted 27 July 2008*)

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ABSTRACT *Public transport policy in the Madrid Metropolitan Area is often deemed as a success. In 1985, an important reform was carried out in order to create a new administrative authority to coordinate all public transport modes and establish a single fare for all of them. This reform prompted a huge growth in public transport usage, even though it reduced the funding coverage ratio of the transport system. Since then, Madrid's public transport system has been undergoing an increasing level of subsidization, which might jeopardize the financial viability of the city public transport system in the future. In this paper, we present a detailed analysis of the evolution of the public transport funding policy in Madrid in recent years. We found that the increasing level of subsidy can hardly be explained on the basis of equity issues. Moreover, we claim that there is still room for a funding policy that makes the efficiency of the system compatible with its financial sustainability.*

Introduction

While the benefits associated with urban public transport provision are well recognized in the extensive literature on urban transport, the design and implementation of funding policies still have many question marks and remain a challenge for municipal governments. One of the primary objectives of public transport pricing is to generate revenues that can ensure an efficient and adequate supply of public transport services (Gwilliam, 2002). In order to ensure that the financial model for public transport operation is able to cover the expenses associated with service provision, governments set fare policies and complement the direct revenues from public transport users with subsidies and other sources (advertising, retail space, among others). There is a widespread practice for urban transport operations to have low cost fares and to be extensively subsidized by the government. In most of the cases, these policies

Correspondence Address: José Manuel Vassallo, Transport Research Centre (TRANSYT), Universidad Politécnica de Madrid, ETSI Caminos, Canales y Puertos, C/ Profesor Aranguren s/n 28040 Madrid, Spain. Email: jvassallo@caminos.upm.es

0144-1647 print/1464-5327 online/09/020261-18
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DOI: 10.1080/01441640802383214

are justified by second-best allocation efficiency theories associated with the reduction of transport externalities (Elgar and Kennedy, 2005), and also by equity theories by which affordable, accessible and available transport is linked to the well-being of people (Estupiñán *et al*., 2007).

The case study of Madrid is of special interest. Previous research focused on the impact of the integrated public transport policy in Madrid on patronage and revenue (Matas, 2004), as well as the estimation of elasticities of public transport (Garcia-Ferrer *et al*., 2006). However, equity considerations associated with fare policies and the distribution incidence of subsidies have not been fully analysed as it has always been assumed that subsidies have progressive distribution effects. In this respect, Asensio *et al*. (2003) conducted an analysis of the redistribution effects of urban transport subsidies in different cities in Spain, which concluded that a subsidies policy is associated with a slight progressive effect. However, until now there have not been any studies providing a thorough analysis of urban transport funding and distributional issues in Madrid.

In this paper, we consolidate some of the key findings of the existing literature, and complement it with an additional level of analysis with a special focus on equity considerations. The paper is structured in four sections. In the first section, we give a description of the organization of public transport supply in the Madrid Metropolitan Area (MMA). In the second section, we analyse the recent history of fare and funding policies in the MMA, with an emphasis on the business model of the Consorcio Regional de Transportes de Madrid (Madrid's Public Transport Authority). The third section is an examination of the successes and limitations of the transport fare policy in the MMA; we analyse the set of subsidy policies in place with a special focus on efficiency and equity considerations. In the last section, we present the conclusions and the effects of the current fare and subsidy policy in the MMA.

One of the conclusions of our investigation is that, under the current fare policy, the percentage of household income allocated to transport across income groups is small. Another conclusion is that there seems to be an increase in public transport operating costs that is not being covered by fare revenue but with a notable increase in operating subsidies. This poses an important threat to the financial sustainability of the transport system. Since distributional concerns are probably not among the most pressing issues in the MMA, there seems to be room for a review of the fare levels without significantly affecting the household economy of the region.

Public Transport in the Madrid Metropolitan Area

Characteristics of the Madrid Metropolitan Area and Its Mobility

Six million inhabitants live in the Madrid Metropolitan Area, an area of 8000 square km with an average population density of 7.42 inhabitants/hectare. The MMA is made up of a huge economic and social pool (Madrid City with a population slightly over three million) at the centre and a set of small and medium cities around this pool, which are connected to Madrid City through private and public transport corridors. The spatial location of the population is strongly polarized. The density of population is very large in the centre of the Region, where Madrid City is situated, but it decreases as one moves further away from this central location.

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The GDP per capita of the MMA in 2005 was 30% above the average of the European Union (EU). However, the GDP per capita of the wealthiest municipalities and neighbourhoods is around twice the GDP per capita of the poorest. In spite of this, wealth distribution in the MMA, with a Gini Index of 16.5%, is fairly homogeneous compared to other cities. For example, most cities in the USA have Gini Indexes of approximately 30% and Latin American cities may be in the range of 40–60% (Estupiñán *et al*., 2007).

Figure 1 shows both the four geographic zones (left) and the transport fare zones (right) in the MMA. The first two geographic zones (City Centre and Urban Periphery) correspond to the Municipality of Madrid City. The third zone (Metropolitan Ring) includes those municipalities around Madrid City with a strong origin-destination (O-D) pair relationship with the City Centre area, and is made up of several towns where many regular commuters live. The fourth zone (Regional Ring) represents the MMA outskirts.

Figure 2 shows a matrix of the geographic zones of Madrid with the percentage of public transport use per O-D pair and the increase or decrease of this percentage compared to the last survey carried out in 1996. It is worth noting how the relationships between the City Centre and the external zones are the ones with the greater use of public transport and, at the same time, the only relationship where the public transport market share has increased in the last eight years. However, analysing the relationship between peripheral zones, it is interesting to note how not only they have a lower rate of public transport use than the radial relationship, but public transport market share has decreased in the last eight years. Several aspects may explain this trend. First, the car ownership index grew by 18% between 1996 and 2004. Second, more than 277 kilometres of new suburban motorways were built in the peripheral area of Madrid. And third, public transport supply in peripheral relationships was not able to follow the high mobility growth within the outer areas of Madrid, especially at rush hours.

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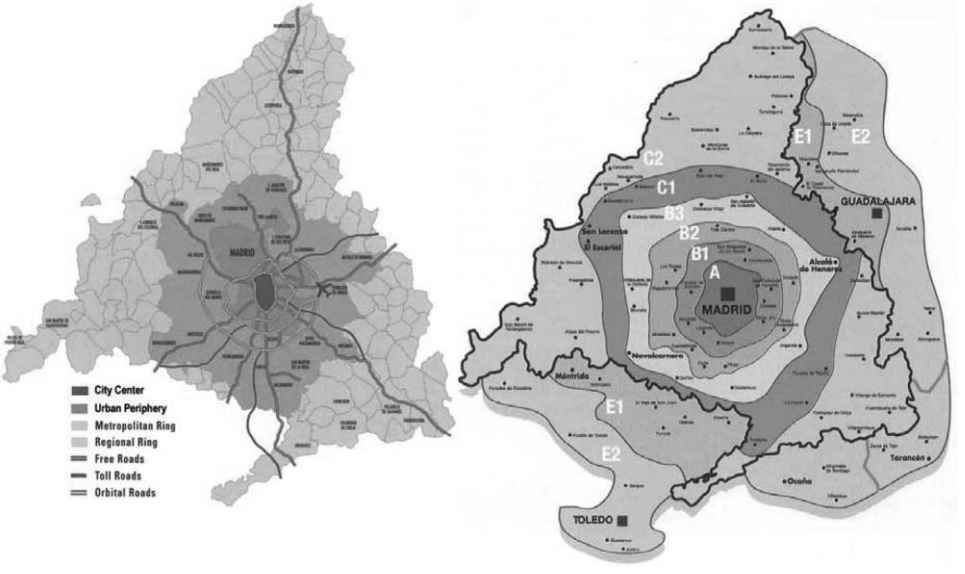

Figure 1. Geographic and fare zones in the MMA

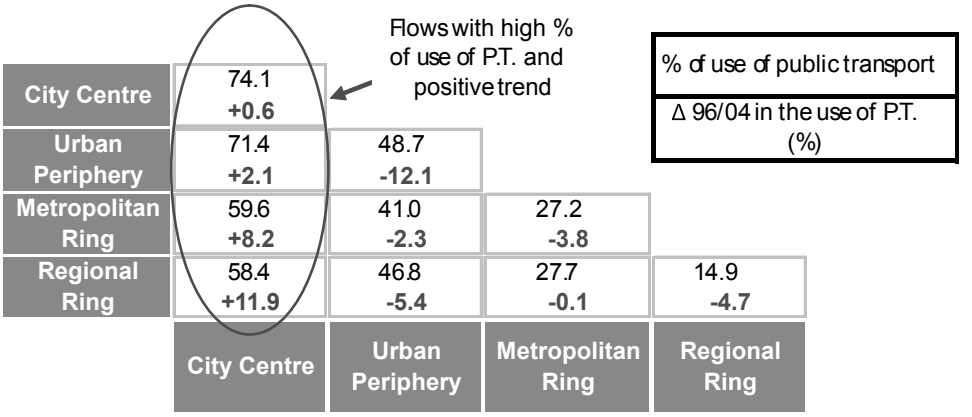

Figure 2. Percentage of public transport usage and variation 96/04 per O-D areas. *Source*: Authors' calculations from the 2004 mobility survey conducted by the CRTM

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Description of the Public Transport Supply

The public transport system in the MMA is made up of four modes. Two of them are the typical urban modes (underground rail system and urban buses), and the other two are mostly metropolitan modes (commuter rail and interurban buses). Urban buses are managed and operated by a municipality-owned company called 'Empresa Municipal de Tansportes' (EMT). The Municipality of Madrid is the owner of this company with 100% share ownership. The underground is managed and operated by a public sector company called Metro de Madrid (Metro). The shareholders of Metro de Madrid are the Municipality of Madrid (75%) and the Region of Madrid (25%). The commuter rail system is operated by 'Cercanías RENFE', business unit of the Spanish railway company (RENFE), which is owned by the Spanish Central Government. Interurban buses are mostly privately owned. The operation of each one of those lines is conducted independently under an exclusive concession contract, for which risk and operations are arranged on a case-specific approach with the government. Currently, there are 44 interurban concessions in the MMA operated by 33 different private companies.

Public transport demand reached 1.59 billion trips. The market share per mode was: underground 40.6%, urban bus 29.5%, interurban bus 17.3% and urban railway 12.5%.

The Threefold Integration

A key element of the public transport supply in the MMA is its integrated policy. Before 1985, public transport use in Madrid was declining because of several reasons including lack of coordination among urban transport modes, scarce levels of investment in the network and poor quality of service provided by the transport operators. In 1985, an important reform policy was introduced in Madrid aimed at improving the performance of the transport system in order to boost the use of public transport. The reform was based on fostering integration in three levels: public authorities, fare and modal. The result of this reform was a success in terms of patronage increase and user perception of quality of service (Matas, 2004).

The first level of integration was the administrative level. The integration of the different public authorities involved in the transport system was reached through the creation of a new public entity called 'Consorcio Regional de Transportes de Madrid' (CRTM). This new entity assumed many of the roles belonging to public transport that were dispersed in many public administration institutions. The second level of integration was the fare structure. To this end, a fare valid for all the public transport modes in the Region of Madrid was established. This fare was designed in the form of a monthly travel pass that enables its owners to take any transport mode in Madrid in its range of validity. The third level of integration was the physical integration among transport modes. Since the creation of the CRTM in 1985, large infrastructure investments have been carried out to improve the physical connection among modes (metro, railroads and buses) through the construction of modal exchange stations. These facilities have substantially contributed at improving coordination among modes.

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Analysis of the Public Transport Fare and Subsidy Policy

Fares

Besides the typical single and multi-ride (ten-trip) tickets, a travel pass is available representing the greatest level of fare integration. The travel pass is a monthly flat fare suitable only for frequent users. This pass can be used during its period of validity (generally one month though there is also a travel pass for one year), and it is associated with the ring-shaped fare zones (A, B1, B2, B3, C and so on) defined in Figure 1. The holder of a travel pass can make unlimited trips in the ring zone associated with the travel pass and its inward zones.

There are two kinds of travel passes which are issued to potentially vulnerable groups. Travel pass for young people (up to 21 years old) and travel pass for the elderly (from 65 years old). Both passes have a high level of acceptance among the targeted groups since 54% of young people aged between 18 and 21, and 43% of elderly people aged between 65 and 74 buy them regularly.

The use of a travel pass is associated with an array of advantages, as described by Wilson (1993). In Madrid, a travel pass means an important implicit subsidy for frequent users. Table 1 presents the characteristics of all travel passes available, and the monetary savings their users enjoy when compared with the use of the ten-trip ticket. We should take into account that a number of extra trips made with the travel pass would not have been made at the ten-trip ticket fare (White, 1981). Hence, the figures shown in Table 1 may overestimate revenue lost by the operator as a result.

As an example, Zone A (Madrid City), where the most important transport modes are Metro and EMT, had in 2005, fares of 1.00 for a single ticket, 0.58 for the ten-trip voucher and an average cost of 0.37 with the travel pass. According to CRTM data, the operation cost per trip, excluding investment in infrastructure and vehicles, was 0.87 per trip. Consequently, the only ticket that covers the full operation costs is the single ticket, which is scarcely used. In spite of that, the single ticket does not cover any capital expenditure, which is fairly significant, particularly because of the expensive underground infrastructure.

The travel pass is much more convenient for multi-stage travellers than for single-stage travellers since multi-stage travellers who did not purchase a travel pass would have to buy a single ticket as many times as the number of stages of

Table 1. Characteristics of the different types of travel passes

Type of travel pass	Monthly travel pass price 2005 (€)	Price per trip with ten-trip ticket (€)	Monthly trips needed to make the travel pass worthwhile	Average number of trips made by travel pass users monthly	Average money saved per trip for travel pass users (%)
Normal A	37.15	0.58	64.05	86.03	25.55
Normal B	47.60	0.75	63.47	93.47	32.10
Normal C	62.86	1.23	51.11	82.39	37.97
Youth A	24.45	0.58	42.16	71.39	40.95
Youth B	29.40	0.75	39.20	83.75	53.19
Youth C	40.52	1.23	32.94	70.91	53.54
Third age	9.55	0.58	16.47	39.15	57.94
Total	33.95	0.67	49.47	76.76	35.55

Source: CRTM

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each trip. According to the 2004 mobility survey in the MMA, commuters from the outer suburbs to the City Centre are often multi-stage travellers. For this reason, the travel pass had been more frequently used for radial trips to the City Centre than for peripheral or intra-zone trips. In fact, the highest use of the travel pass among public transport users takes place in O-D pairs linking the outer zones of the Region with the City Centre. For these O-D pairs, the percentage of public transport trips that are made with the travel pass is around 68% while within the City Centre it is only 53.4%. The percentage of trips made with the travel pass inside peripheral zones is even lower (45.5% within the Metropolitan Ring and 17.1% within the Regional Ring). The explanation of this fact is twofold. First, the percentage of commuters making peripheral trips is lower than those making radial trips, and second, the farther the validity zone of the travel pass is, the more expensive the travel pass is, regardless of the zone where users ultimately travel to. This may also explain why, as Figure 2 shows, the percentage of use of public transport is lower in peripheral trips among the outer zones than for radial trips. In this respect, the fare structure adopted for the travel pass in Madrid contrasts with other European cities, such as London, where a higher rate is paid for travelling within the central zone reflecting higher costs, while lower fares are charged to trips made within the suburbs.

The criteria adopted in the MMA to annually raise public transport fares have been mostly budgetary and political, with no direct link with changes in operating costs. It is notable that in the last ten years, the growth of transport fares in Madrid has been above the consumer price index but below the GDP growth in the MMA (see Table 2). The fare growth implemented has been insufficient to cover the raising transport operation costs. The rise in public transport costs has been prompted by two causes. First, the large investments carried out to expand the underground network. And second, the rise of labour costs caused by the rapid increase of real income. According to CRTM data, labour accounts for 33.7% of the operating costs of Metro and 68.7% of the operating costs of EMT.

The rise in public transport costs is the reason why despite the annual increase in transport fares, subsidies are steadily increasing and the coverage ratio of public transport in the MMA is continuously decreasing (see Table 2). This fact means that, in future, if this trend continues, there will be a significant threat to the financial sustainability of the public transport funding system in Madrid.

Table 2. Evolution of fares and subsidies in the MMA

	1995–1998	1999–2002	2003–2005
Average annual fare increase (%)	3.86	5.34	4.77
Average annual inflation increase (%)	2.73	3.40	3.18
Average annual GDP increase (%)	7.24	7.81	7.60
Average annual operation costs (Million €)	722.13	967.25	1478.94
Average annual subsidies (Million €)	322.69	449.98	804.19
Average annual coverage ratio (User revenues/operation costs) (%)	55.31	53.48	45.62

Source: Authors' calculations

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Public Transport Funding Approach

The funding of the public transport system in Madrid is rather complex since several public authorities and transport companies are involved in the process. Moreover, the sophisticated fare structure and revenue allocation produces complicated cross-subsidies between different kinds of users.

The transport system incurs costs to carry out their activities. These costs can be divided into capital costs (investment in infrastructure, vehicles and rolling stock), operation costs and administrative costs. These costs are to be covered either by fares paid by users, by other revenues (such as revenues from advertising and so on) or by contributions from the central, regional and local governments, which can be allocated either to fund investments (capital costs) or to subsidize operation costs.

Most of the infrastructure facilities in the MMA are directly provided and funded by the administrative authority that owns them. However, governments have progressively required transport companies to pay a fee for infrastructure use, which usually covers only a percentage of the infrastructure cost. An application of this policy is the recent creation of MINTRA by the Regional Government of Madrid. MINTRA, an agency in charge of building and maintaining new underground infrastructure, charges a fee to Metro for using its infrastructure. The total revenue from Metro's fee only covers a fraction of the infrastructure cost incurred by MINTRA.

The economics of transport operators. In this subsection, we consider the costs transport companies have to bear, and the way they fund these costs. Since infrastructure costs are mostly funded by the administrative authorities from general tax collection revenues, transport operators have to cover operation costs and some capital costs such as rolling stock and minor infrastructure investments.

Each public transport company has several revenue sources. In a simplified way, we can distinguish (1) fare revenues; (2) other operating revenues (advertisement, property leasing, etc.); (3) transfers received from the CRTM on compensation for those fares (mostly the travel pass) directly collected by the CRTM; and (4) other subsidies provided either by the CRTM or by other regional authority, mostly for the acquisition of vehicles and rolling stock.

The CRTM collects the revenues from travel pass sales, so transport companies do not receive any direct revenue from travel pass users. In compensation for this, the CRTM pays to the public transport companies the number of trips annually

made with the travel pass times an 'equilibrium fare'. This fare is calculated and set to cover the operation costs per trip allocated to the travel pass users. The CRTM and the transport companies negotiate this fare per trip for a short period of time, usually two to three years.

For the two transport modes, Metro and urban buses (EMT), the CRTM is in charge of collecting not only the revenues coming from travel pass users, but also the revenues from the other two fare types—the ten-trip ticket and the single ticket. Moreover, on behalf of the respective authority, the CRTM provides Metro and EMT with capital subsidies to buy vehicles and rolling stock. The reason why the CRTM has such a large control over Metro and EMT lies in the fact that they are owned by the Regional Government of Madrid and the Municipality of Madrid, who are also the main shareholders of the CRTM.

The commuter trains, operated by the public national company RENFE, and the interurban buses, operated by private companies on the basis of concession contracts, maintain a different kind of relationship with the CRTM. Like Metro and EMT, these companies reach a formal agreement with the CRTM, whereby the latter has to pay the former an 'equilibrium fare' times the number of trips made with travel passes, but unlike Metro and EMT, these companies collect the revenues coming from other types of tickets.

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The CRTM funding model. The CRTM economics is characterized by a set of costs (expenditure) and revenues (income) to finance the MMA transport system. The CRTM outlays cover four items:

(1) Payments to each transport operator in the MMA for those passengers who use a transport mode with a travel pass (the 'equilibrium fare' negotiated with each company times the number of annual passengers who travel with the travel pass).
(2) Payments to Metro and EMT for the use of the ten-trip ticket and the single ticket.
(3) Resources to cover some of the capital investments incurred by Metro and EMT.
(4) The administrative costs of the CRTM.

Table 3 shows a summary of CRTM income and expenditures. The CRTM needed a total amount of 1.749 billion in 2005 to fund its activities. By mode, Metro was allocated 55.8% of the resources, EMT 19%, the interurban bus concessionaires 15.3% and RENFE 6.1%. The rest of CRTM costs are administrative expenses (2.1%) and other needs (1.6%).

To cover these costs, the CRTM has two main sources of income: first, revenues raised from users of the transport system which are directly collected by the CRTM (41.6%), and second, direct transfers from different levels of government (55.6%). If major infrastructure investment were included in this balance, the direct transfers would account for a much larger percentage.

Subsidies come from different governmental levels: the Central Government of Spain, the Regional Government of Madrid and the municipalities of the MMA, particularly Madrid City. The Region of Madrid is the major contributor since it provides 61.5% of the total CRTM subsidy. The City of Madrid provides 22.6%, the Central Government of Spain provides 15.4% and the rest of the municipalities of Madrid provide 0.5%. The Municipality of Madrid and the Regional Government

Table 3. Summary of the sources and allocation of funds of CRTM, 2005 (Million €)

Income				Expenditure			
Revenues raised (A)	Travel pass	445.7	25.5%	Metro	Free compensation	667.7	38.2%
	Other fares	218.3	12.5%		Capital subsidy	308.6	17.6%
	Other revenue sources	64.4	3.7%		Total metro	976.3	55.8%
	Total (A)	728.4	41.6%	EMT	Fare compensation	301.6	17.2%
Subsidies (B)	Central Government	150.2	8.6%		Capital subsidy	30.5	1.7%
	Region of Madrid	597.7	34.2%		Total EMT	332.1	19.0%
	Madrid City Council	219.3	12.5%	Total pass compensation RENFE		107.1	6.1%
	Other	5.1	0.3%	Total pass compensation interurban bus		267.6	15.3%
	Total (B)	972.3	55.6%	CRTM administrative expenses		37.1	2.1%
Remainder of previous years (C)		48.2	2.8%	Other needs		28.7	1.6%
A+B+C	Total	1748.9	100.0%	Total		1748.9	100.0%

Source: Authors' calculations

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of Madrid equally cover the subsidies—not covered by the Central Government—assigned to Zone A. However, the Regional Government of Madrid covers 100% of the subsidies for Zones B and C. The rest of the municipalities cover the subsidies for urban services inside their cities. The public transport operation subsidy accounts for 4.8% of the aggregated budget of the Regional Government of Madrid and the Municipality of Madrid.

Overall income of the public transport system comes from three different sources: travel pass revenues, revenues from purchase of other Metro and EMT tickets, which are directly collected by the CRTM, and other sources of revenues. The most important source of revenues is the travel pass. However, this only covers 25.5% of the CRTM costs.

It is interesting to assess the level of subsidies for the different transport modes in Madrid. To that end, we compared the percentage of operation costs which were covered by fares paid by users. This calculation requires allocating the revenues from the travel pass to each transport mode. Each year, the CRTM makes a proportional allocation relying on the number of travel pass trips in each mode. The ratios fare revenues/operation costs are 45.72% for Metro and 67.97% for urban buses (EMT). There is no official estimation of the coverage ratio for interurban buses and commuter rail. However, by data mining their balance sheets and profits and losses accounts, we estimated a coverage ratio of 70.2% for interurban buses and 50.26% for commuter rail. It is worth noting that Metro is the most subsidized mode, particularly if we consider that the infrastructure costs for the underground are larger than for all other modes.

Unraveling Successes and Limitations of the Transport Fare Policy in Madrid

Public transport in Madrid is highly subsidized. From a welfare economic point of view, the public sector serves four main goals: efficiency, equity, financial balance and macroeconomic stabilization (Ress, 1984). According to Elgar and

Kennedy (2005), the potential economic rationale for subsidizing urban public transport results from increasing returns to scale, positive externalities and second-best pricing. Two reasons have usually been given to justify this high level of subsidy: allocative efficiency, particularly linked to the reduction of external costs, and social equity issues.

Efficiency

Efficiency can be classified as technical, scale, structural and allocative efficiency (Fare *et al.*, 1994). Technical efficiency is achieved when production is made on the boundary of the production possibility set. Scale efficiency refers to the ideal production size. Structural efficiency occurs when production takes place in the uncongested or economic region of production. Finally, allocative (or price) efficiency refers to setting prices that minimize total costs within a system.

One of the main reasons argued to justify the high subsidy to the public transport is allocative (or price) efficiency. In this respect, economic theory establishes that prices should be set at social marginal cost to maximize social welfare. If a sector in a market does not set prices according to marginal cost, the outcome will be an inefficient resource allocation. Subsidies to urban public transport are often justified on the grounds of a second-best pricing policy to reach allocative efficiency when private cars are not priced at their social marginal cost (Elgar and Kennedy, 2005). However, the low cross-elasticities found between private vehicles and transit modes suggest that this second-best policy might not always be effective (Glaister and Lewis, 1978).

Public transport has the potential to be more efficient than cars in terms of energy consumption, infrastructure use and pollution. Consequently, promoting the use of public transport within a framework that makes these investments environmentally sound brings about a better resource allocation from a social point of view. This is the most important argument to justify large subsidies to public transport for the CRTM, as stated by Matas (2004). Ideally, subsidies should be set by taking into account the positive externalities associated with public transport, while correctly pricing alternative transport modes, in particular private car use. In reality, policy-makers face a budget constraint that forces them to compromise between the reduction of externalities and the financial sustainability of the system.

Monzón and Guerrero (2004) estimated the social and health costs of transport-related air pollution in Madrid. Their research shows that cars (both private cars and taxis) account for 96.7% of those costs, buses (both urban and interurban) account for 3.1% and metro and commuter rail account for 0.2% of those costs. Cars represent 50.6% of the trips in MMA, buses both urban and interurban 23.15%, and Metro and commuter rail 26.25%. Their research paper recommends charging the use of cars, or as a second-best alternative to subsidize public transport if a first-best policy is not feasible.

Regarding technical efficiency, this is based on providing a service at the lowest cost for a certain quality level. This issue has much to do with governance structure related to the incentives that the regulator imposes on the transport operators to increase their productivity. De Borger *et al*. (2002) conducted a survey of the literature on production and cost frontiers for public transit operators. They found that the organization of the market, contract design, and the degree and nature of the regulatory regime are all important determinants of

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technical efficiency. Many studies conclude that competition for the provision of urban transport services promotes technical efficiency since the greater the competition the greater the incentives for transport operators to increase productivity and innovation in order to reduce costs. For the Italian local public transport, significant impacts of regulatory constraints on the technical efficiency of public transport companies were found (Piacenza, 2006). Other works suggest that privatizing public transport companies can improve technical efficiency. A study conducted in the City of Indianapolis reported an annual 2.5% reduction in operating costs since privatizing the management of its public transit system (Karlaftis and McCarthy, 1999). An analysis of technical efficiency of bus services in 73 cities of the world shows that competition, total or partial, is effective in controlling costs (Pina and Torres, 2006). Hidson and Müller (2003) compared trends in public transport in 30 large EU cities during the 1990s. Cities using controlled competition attracted most new passengers and had the best financial performance. Amaral *et al*. (forthcoming) conducted an interesting research comparing the auction procedures and competition in urban bus transport in London and France. In London, auctions take a multiple-unit auction format, whereas in France only one company operates each network, so bidders submit bids on an entire network. To conclude, the London model offers better results by using transparency of auction and the discretionary power of the regulator to foster competition for the market.

Regarding the efficiency related to economies of scale, some studies at the international level show that there are few or no economies of scale in local bus services (Gómez-Ibáñez and Meyer, 1990; Berechman, 1993). For the case of urban bus companies in Spain, Matas and Raymond (1998) found that there are no significant returns to scale in the long term. This fact led them to suggest that introducing competition in the market could be feasible and can lead to a considerable reduction in operating costs.

The distribution of subsidies among the different modes and operators in the transport system in the MMA has some features of an incentive-based regime. Revenues of transport operators in Madrid depend on the ultimate number of passengers that they move each year. Consequently, they have a strong incentive to achieve the greatest number of passenger trips since the subsidies per trip do not guarantee the coverage of the full operation cost if the demand is ultimately lower than expected. This mechanism encourages transport companies to reduce costs and increase the number of users to make greater profits. In addition, transport operators are free to manage shopping areas and advertising spaces that belong to their facilities. This way, operators have proper incentives to manage this business in the best possible way.

However, incentives are different for private and public companies. Private companies such as interurban bus concessionaires have private shareholders whose ultimate goal is to maximize returns, whereas public sector companies such as Metro and EMT mostly reinvest their profits. This fact has the disadvantage that public sector companies have less incentive to be technically efficient than private companies where profits are distributed among their private investors.

Moreover, there is another substantial difference between public sector and private companies in terms of incentives to reach the highest technical efficiency. Private companies, mostly interurban bus concessionaires, set up their 'equilibrium fares' through a competitive tender where they compete for the concession. This fact encourages bidders to be innovative and productive in order to reduce

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costs and optimize the operation of the system if they want to have any chance of being granted the concession. Unlike private companies, public sector companies such as Metro and EMT negotiate their 'equilibrium fares' without competition with other companies.

An analysis of the coverage ratio of some urban bus companies in Spain using data taken from the Observatory of Urban Mobility in Spain (Monzón *et al*., 2007) shows that most of the coverage ratios of the private urban bus companies that operate under a concession agreement with a municipality are higher than the coverage ratios of public companies. This observation can not be explained by lower fares set when the service is provided by a public company since, as Monzón *et al*. (2007) show, transport fares set in cities where the services are provided by public companies are on average higher than when the service is provided by private (operating under concessions) companies.

Effect of Fares on Revenues

The most important way of promoting public transport in Madrid has been providing subsidies frequent users through the implementation of the travel pass. Even though in terms of promoting trips, this kind of subsidization can be deemed as a success, it had a negative effect on the revenues collected by the system from the users (Matas, 2004). This effect has also been noticed in an empirical study conducted by Pucher and Kurth (1996) regarding the implementation of travel passes in five different European metropolitan areas.

The estimation of price elasticities for different types of public transport fares shows very heterogeneous results depending on the city, the nature of the data, the specification of the model and the type of fares, among other factors. White (1981) provides some arguments for travel pass price elasticities being small, which are empirically supported by Hensher (1998) and confirmed for Madrid by Garcia-Ferrer *et al*. (2006) who found a elasticity of –0.013 for the use of the regular travel pass, even though this result is not significant at a 5% confidence level because of the high multicollinearity between price changes of the ten-trip ticket and the travel pass.

Price elasticities of multi-ride and single tickets show a larger dispersion among different case studies (see Dargay and Pekkarinen, 1997; Hensher, 1998). In Madrid, Garcia-Ferrer *et al*. (2006) found a robust elasticity of –1.03 for the use of the metro with the single ticket and –1.06 for the use of the bus with the single ticket. For the ten-trip ticket, they found elasticities of –2.17 for the metro and –0.52 for buses, whereas Matas (2004) found an elasticity of –1.07 for the ten-trip ticket. Regarding cross-elasticities in Madrid, Matas (2004) reports positive cross-price elasticities, around 0.21 and 0.31, between the ten-trip ticket and the travel pass.

The previous results enable us to claim that there is room for a more efficient fare policy in Madrid. This result was advanced by Matas (2004) and stated by Garcia-Ferrer *et al*. (2006). As the price elasticity of the travel pass is low, a moderate increase in the price of the travel pass should hardly impact public transport demand, thus contributing to increase in the coverage ratio and reduction in the growth observed in the amount of subsidies allocated to funding public transport in the MMA.

The effects stemming from an increase in the prices of the single and ten-trip tickets could have on public transport demand is, however, uncertain. The single ticket covers operation costs, but it is scarcely used. The estimated ten-trip ticket

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elasticity varies between –1 and –2, so the effect on total revenue expected as a consequence of raising its price is negative.

Social Equity: The Role of Public Transport in Madrid

According to Just *et al*. (2004), equity has to do with how goods are fairly distributed among individuals. The distribution of wealth in the MMA is quite homogeneous and public transport expenditure may not a burden for families in Madrid, even for the least wealthy. This fact can be observed in Table 4, which shows an analysis of the Continuous Survey of Household Budget of the National Institute of Statistics for the Region of Madrid, which estimates expenditure taking into account the number of household members according to the Oxford Scale. In the last column, we show household expenditures on urban public transport by income quintile. The share of household expenditure on urban public transport remains close to 1% for all quintiles. Table 4 also shows that household size increases with income. This fact may help explain why the percentage of household expenditures on urban public transport remains constant throughout the first three quintiles and becomes a little bit higher for the fourth quintile where household size is the largest.

One of the problems of using the Continuous Survey of Household Budget is that only aggregate data is available, since it is not possible to access household level information. Given that public transport is not a compulsory expense for all households, it is expected to follow a wide variance of expenditure levels on urban public transport, with some households spending nothing while others spending much more than the average 1% of disposable income across quintiles. Following the approach outlined by Carruthers *et al*. (2005), we estimate the worst possible affordability case of urban transport in Madrid by assuming that only the head of household is working for a minimum wage, and is the only person in the household who uses public urban transport. The minimum wage in Spain in 2005 was €560 and the price of the travel pass for Zone B1, where most of the population of public transport users in Madrid is located, was €43.1. In this scenario, which is the worst case scenario, public transport expense would be 7.7% of household income, a relatively low percentage.

Table 4 shows also how the lower the level of income the larger the household expenditure on food. However, the percentage for urban transport is relatively constant and far smaller than household expenditure on food. This data demonstrates that regardless of the level of income, expenditure on public transport is neither significant nor regressive and that public transport is used by people

Table 4. Expenditure on public urban transport by income quintile

Quintile	Monthly income (€)	Number of household members	Expenditure in food (%)	Expenditure in urban public transport (%)[a]
Quintile 1	<855	217	16.61	1.03
Quintile 2	855–1269	281	17.18	1.03
Quintile 3	1269–1556	300	16.30	1.03
Quintile 4	1556–2321	388	14.60	1.20
Quintile 5[b]	>2321	362	12.15	0.99

[a]The expenditures have been adjusted using the Oxford scale.
[b]The results for this level of income have little representativeness.
Source: Authors' calculations

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across the entire income spectrum. Consequently, we can claim that, in the range of 2005 fare levels, other variables rather than income per capita—such as accessibility, parking availability, etc.—determine the use of public transport in Madrid.

As the travel pass is the most highly subsidized fare, we analysed how the use of the travel pass varies with income level and zone. Figure 3 shows the relationship between the use of travel pass (vertical axis) and income per capita (horizontal axis) for the districts and municipalities in the MMA that are larger than 5000 inhabitants, grouped in geographic zones. This figure shows how travel pass use and income level have a different correlation depending on the zone of the MMA. In Madrid City (City Centre and Urban Periphery), the income level explains fairly well the use of the travel pass (their R^2 coefficients are respectively 0.63 and 0.49). Consequently, in Madrid City, where accessibility to public transport is ubiquitous, the lower the level of income the higher the use of the travel pass. In this case, the travel pass subsidy is well targeted towards the least wealthy people even though the difference in wealth is not substantial. This result is consistent with the outcome presented by Asensio *et al*. (2003) who studied redistributive effects of subsidies in urban public transport in Madrid. They found that, even though public transport subsidies were found to be progressive, the size of the redistributive effects was rather small.

However, as we move away from the City Centre, the correlation between the level of income and travel pass use is almost non-existent. In the outer zones of the MMA (Metropolitan Ring and Regional Ring), the use of the travel pass is associated with public transport supply (accessibility and availability) rather than with income level (Vassallo and Pérez de Villar, 2007).

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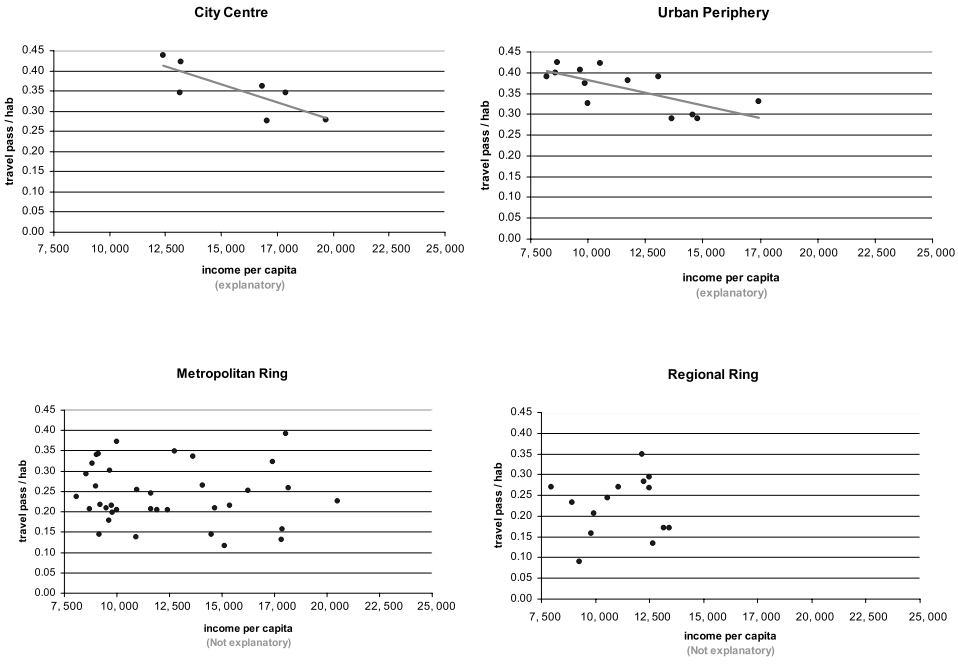

Figure 3. Relationship between travel pass use and income level by geographical zone. *Source*: Vassallo and Pérez de Villar (2007)

According to these results, several paradoxes in terms of social equity are worth noting in the MMA. First, the use of the travel pass, which is highly subsidized, is greater among people who live in the City Centre than it is among people who live in the periphery, whereas people who live in the City Centre tend to be wealthier than people who live in the periphery. Second, the bulk of the travel pass subsidy is allocated to the City Centre because of the large subsidies associated with the high costs of the underground infrastructure. Third, the use of the travel pass in peripheral suburbs is better explained by public transport accessibility than by household income. Paradoxically, the peripheral municipalities with better levels of accessibility are wealthier than other peripheral municipalities with poor levels of accessibility. And fourth, as the travel pass prices are higher for the outer zones of the MMA, the use of travel pass is not as attractive for intra-zone trips in the outer zones of the MMA, where the least wealthy people of Madrid usually live.

A more detailed analysis of these paradoxes would require estimating the transport subsidy per zone. This ratio is not provided by the CRTM, and it is difficult to estimate since users of the public transport system move throughout the network regardless of where they live. On the one hand, it is clear that travel pass users in the suburbs often take several transport modes—including the underground—to get to their destination. But on the other hand, the transport modes to get from the city centre to the periphery—in particular interurban buses—are not as highly subsidized as the transport modes in the city centre.

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Conclusions and Policy Recommendations

The key determinant of the success of the public transport system in Madrid is its threefold integration: administrative, fare and modal, which has encouraged the use of public transport and improved its perception among users. Perhaps, the most positive aspect has been the creation of the travel pass, which has meant a complete modal integration and a fare subsidy for frequent public transport users, boosting the use of public transport in Madrid. The evidence shows that the use of travel pass is also popular among the young and the elderly, as special passes designed for these groups have a very high ratio of use.

Despite the impressive growth in patronage since the creation of the CRTM in 1985, the public transport system in Madrid is heavily subsidized and subsidies have been steadily growing. The government justifies the observed high level of subsidization in the benefits that promoting public transport has in terms of social equity and allocative efficiency with their associated effect on welfare. However, as far as we know, a rigorous quantitative assessment on the effects that subsidies have both in social welfare and social equity has never been conducted.

The main conclusions and lessons of this paper are as follows:

- The case of Madrid shows that a threefold integrated public transport policy is crucial for promoting public transport. The creation of a travel pass for frequent users in Madrid can be considered a success in terms of boosting the use of public transport.
- However, the success of the travel pass and the increase in the patronage of the public transport system have had a negative financial consequence: the coverage ratio (revenues from users/operation costs) of the public transport

system in Madrid has been decreasing over the years so the amount of public subsidies has been progressively increasing. This trend threatens to become a serious burden for the public budget of the MMA in the coming years in the shape of a vulnerability to a potential negative phase of an economic cycle.

- In addition, the geographic distribution of the travel pass fare is neither efficient nor equitable since the present structure encourages radial trips and hinders peripheral trips when the least wealthy people mostly live in the periphery. In fact, the use of public transport compared to private transport in peripheral O-D pairs has been decreasing in the last few years. A proposal to improve this could be to implement a solution similar to the one implemented in London. There, relatively high prices are charged for travel passes involving Zone 1 (the City Centre), whereas the travel pass fares for Zones 2 to 6 are lower. This way, a higher fare is paid for the City Centre reflecting higher costs, while more competitive fares are charged within the suburbs.
- Even though fares have grown more than inflation, their growth has been lower than income per capita growth in the Region of Madrid. In other words, the percentage of public transport expenditures among Madrid households has decreased in the last few years.
- There is no substantive evidence that subsidies provided to public transport users, particularly to travel pass users, substantially contribute to promote social equity in the MMA. First, public transport expenditure represents a minor share of income for households in Madrid—with an average of approximately only 1%—and it does not substantially decrease with the level of income. Second, there is no clear evidence that poor people are the most intensive users of the travel pass. And third, the least wealthy people live in neighbourhoods with low accessibility where the travel pass use rate is rather low. A better analysis of the incidence of subsidies on income distribution would require to estimate the subsidy level by zone and obtain travel data by household, but unfortunately this information in not available yet. These analyses could be conducted in future research work from information obtained through surveys.
- The previous statement leads us to conclude that the public transport fare levels in Madrid could also be rearranged by increasing prices without compromising equity. A review of the analysis of public transport price elasticities and cross-elasticities enables us to conclude that the price of the travel pass can be raised without expecting a substantial reduction of public transport demand at the current fare levels. Moreover, this measure is not against equity since there is no clear evidence that the incidence of subsidies is significantly progressive. That is, it does not benefit disproportionately more low-income households in Madrid.
- From only the equity point of view, it would seem reasonable to raise the price of the ten-trip ticket in the City Centre. First, the underground is the most expensive transport mode, and second, the City Centre is among the wealthiest zones in the Region of Madrid. However, the implementation of this measure is constrained by the high elasticities estimated for this type of fare.
- Regardless of the previous analysis, the available evidence tends to suggest that the transport system in Madrid could increase its technical efficiency. One way would be the promotion of a greater participation of the private sector in managing and operating transport companies. This measure could promote cost reductions that would contribute to reduced subsidies. However, it is

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necessary to take into account that while the experience of private operation and competitive tendering for bus companies is widespread, this experience is much more limited for underground train services.

Acknowledgements

The authors would like to thank the Consorcio Regional de Transportes de Madrid for making the relevant information available to the authors, and the World Bank for funding the preliminary research that gave rise to this paper.

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