

Using Public-Private Partnerships to Expand Subways: Madrid-Barajas International Airport Case Study

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Abstract: In the beginning of 2006, the regional government of Madrid decided to expand the subway network to the new Terminal T-4 in Madrid-Barajas International Airport using a public-private partnership (PPP) approach. Owing to the peculiar characteristics of this new access as the enlargement of an existing subway line, the PPP approach was based on separating infrastructure management from transportation service operation. The PPP contractor was entrusted with the infrastructure construction and maintenance while Madrid's public subway company remained in charge of operating the trains. This paper examines the theoretical foundation that justifies the implementation of different PPP approaches to deal with urban rail projects. The paper then explains the reasons why a nonintegrated PPP approach was ultimately adopted for the expansion of Madrid's subway network to the airport. From the outcome of the tender and the present operation performance, we find that nonintegrated PPP contracts have important advantages for urban rail PPPs, particularly for conventional subway networks. These advantages are notable in terms of encouraging economies of scale and density, boosting competition, and reducing the financial costs.

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Introduction

Metropolitan railroads in urban areas have gained significant importance in the last few years as a means of promoting sustainable transportation (Bottoms 2003; Greenberg 2004). However, funding those railroads is often unaffordable for local governments because of the large and burdensome investment that is required upfront. This is the reason why, over the past few years, private participation in funding and managing these systems through public-private partnerships (PPPs) has gained support among many local governments. However, urban rail PPPs face specific problems that may hinder their implementation. These problems are particularly large in the case of the extension of a subway line connected with the existing network.

This paper describes the particular case of the extension of an existing subway line (Line 8) to the new Terminal T-4 recently built in Madrid-Barajas International Airport. This subway line extension, implemented through a PPP approach, incorporates a set of contracting innovations that make this PPP different from many other urban railroad PPPs. Among such innovations, most noteworthy is the implementation of a nonintegrated PPP approach based on separating infrastructure construction and man-

agement from transportation service provision. According to this approach, the private partner was made responsible for the construction and maintenance of the infrastructure while the public company in charge of operating Madrid's metrosystem (Metro de Madrid) was entrusted with the operation of the trains.

This paper is divided into five main sections. First, the paper reviews the existing literature on the controversial issue of bundling or unbundling different tasks in infrastructure provision—particularly focused on PPPs—within the context of the theory of incomplete contracts. Second, specific constraints for the implementation of urban rail PPPs are described. Third, the PPP contract design implemented for the new subway line extension to Terminal T-4 is analyzed. Fourth, particular attention is paid to the outcome of the tender compared to other rail PPP contracts recently awarded in Madrid. Finally, on the basis of the theory of incomplete contracts and the data from this case study, some general conclusions are drawn regarding the design of PPP contracts for urban railroads.

Theoretical Framework

The foundations of PPP design are studied within the framework of the theory of incomplete contracts. Unlike the legal approach to contracts, the economic theory of contracts mainly focuses on how to design an “efficient” contract in economic terms. This approach assumes that the prime objective of partners making a transaction is to maximize their returns from such a contract.

Contract theory distinguishes between ex-ante and ex-post efficiency. Some contractual agreements that were designed to maximize the ex-ante efficiency may turn out to be inefficient ex-post because they oblige an exchange to happen regardless of the ultimate benefit to be achieved by the parties. As Scott and Triantis (2005) pointed out, the objectives of ex-ante and ex-post

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efficiency are in tension when parties contract under uncertainty. It may turn out, for example, that the value of the contract performance to the promisee is less than the value of the promisor's cost of performance. A solution to the dual objective of ex-ante and ex-post efficiency is setting up a complete contingent contract, which is able to specify obligations in each potentially possible state of the world and is enforceable according to its terms. Such a contract ensures that performance occurs when, but only when, it is efficient.

However, in practice many contracts are incomplete. From an economic point of view, "a contract is incomplete if it fails to provide for the efficient set of obligations in each possible state of the world" (Scott and Triantis 2005). In contract theory, incompleteness is often caused either by large transaction costs for the parties or by the unavailability of information at the time of signing the contract or by the cost to the parties to enforce in courts of law at the time of enforcement. According to Tirole (1999), incomplete contracts occur because stakeholders cannot determine in advance all of the contingencies that may arise in the future, so they have to be satisfied by signing a contract that does not explicitly refer to all eventualities. Although some contingencies might be identifiable, they could be so numerous that it would be too expensive to identify them in a contract.

PPP contracts are usually long term, often more than 25 years, and complex (De Bettignies and Ross 2004). Consequently, many PPPs are incomplete contracts since they can hardly take into account all events that may happen during the life of the project. This problem may be aggravated owing to the opportunistic behavior of individual parties in the contract (Ping Ho and Liu 2004).

Under such premises, Hart (2003) analyzes the optimal structure for a contract regarding the integration of construction and operation. In order to shed some light on this problem, Hart developed a model in which he compared two different contracting structures used by the government for constructing and operating infrastructure assets. The first approach is based on conventional contracts, in which the construction of the asset is unbundled from the service provision. The second approach is based on the model of a contract, which includes not only details as to the construction of the asset but also makes provision for subsequent services to be supplied by this asset.

The latter approach is identified by Hart as a PPP agreement. This identification is a little bit coarse since the features that characterize PPPs are far more than the mere integration of construction and operation. A good definition of the main characteristics of PPPs can be found in the Green Paper on Public-Private Partnerships and Community Law on Public Contracts and Concessions (Commission of the European Communities 2004). For the European Commission, the elements that normally characterize PPPs are the following:

- The relatively long duration of the relationship, involving co-operation between the public partner and the private partner on different aspects of a planned project.
- The method of funding the project, in part from the private sector, sometimes by means of complex arrangements between the various players.
- The important role of the economic operator, who participates at different stages in the project (design, completion, implementation, funding). The public partner concentrates primarily on defining the objectives to be attained in terms of public interest, quality of services provided and pricing policy, and it takes responsibility for monitoring compliance with these objectives.

- The distribution of risks between the public partner and the private partner. The precise distribution of risks is determined case by case, according to the respective ability of the parties concerned with assess, control, and cope of the risk.

In addition, PPP contracts do not require that the contractor carry out all the operation tasks linked to the use of the infrastructure facility, but only those tasks that are directly related to the maintenance, and management of the facility. For instance, a PPP to provide a prison has to include the construction, maintenance, and management of the building, but not necessarily other tasks such as security and so on.

Once this clarification has been made, hereinafter in this paper we will identify PPP agreements as contracts in which the private sector is entrusted with both the construction and management of an infrastructure facility. The service provision, however, does not necessarily have to be included in a PPP contract. For instance, following this definition, a rail PPP contract does not have to include necessarily the operation of the trains, though if the contract does it, the contract is also regarded as a PPP.

In PPPs, the contract often specifies quality requirements to be met by the contractor throughout the life of the contract in such a way that the better the performance of the contractor, the larger the revenues the contractor will make. Hart's model suggests that the choice between PPPs and conventional provisions depends on the feasibility of specifying the monitoring of either, or both, construction and service provision. According to this statement, conventional construction contracts are desired when construction quality can be well specified and easy to monitor, but quality of service is not so easy to specify or monitor. In contrast, PPP contracts will be suitable when construction quality is difficult to monitor and quality of service can be well specified and monitored. These results are similar to those reached by Grout (1997) and Bentz et al. (2001), using a model based on asymmetric information between the contracting parties.

According to Riess (2005), the integration of construction and management along with private ownership provide a powerful and enhanced incentive mechanism for cost savings over the life cycle of the infrastructure. However, in a world of incomplete contracts, cost savings might compromise the fulfillment of public-interest objectives such as service quality.

In the field of land transportation, the suitability of PPP projects is different for roads and for railroads. In the case of roads, transportation services are by nature independent from infrastructure management. However, infrastructure construction and management are easy to integrate in the same contract since specifying and monitoring quality of service—referred basically to infrastructure management and maintenance—seems to be feasible in practice (Vassallo 2007). Therefore, the implementation of PPP contracts seems to be suitable, in general, for road projects.

However, the case of rail projects, particularly urban ones, is not clear enough. The construction stage is often more problematic for rail projects than it is for road projects. First, infrastructure works in the case of rail projects—most of them underground—are quite risky and difficult to specify in detail. And second, rail works include such technological issues as electrification and communication facilities, which can become challenging for the private contractor. On the contrary, rail infrastructure management and maintenance seem to be feasible to specify and monitor. Consequently, according to Hart, PPPs would be more suitable than conventional construction contracts for rail projects. However, there is an important difference between rail and road projects. Unlike roads, transportation opera-

tions can be integrated within rail PPP contracts, but this is problematic owing to, among other aspects, the increasing demands regarding safety of railroads. For Bennett and Iossa (2004), there are certain kinds of investments at the building stage that, while being in the public interest, raises operating costs. An example of these investments are new safety features in rail systems. When infrastructure building and transportation service operation are bundled under one contract, it would be risky and costly for the builder operator to implement this kind of socially beneficial type of investment. In spite of it, the fact is that most of the rail PPPs implemented to date include both the infrastructure management and the transportation service operation. This is perhaps the reason why, notwithstanding the potential for the implementation of urban rail PPPs, these contracts are less common than road PPPs.

In the next sections, we will provide a more detailed analysis of the specific features for urban rail PPPs. In particular, we will study the case of the enlargement of subway Line 8 to the new Terminal T-4 of Madrid's Airport, where all these considerations have been borne in mind.

Specific Restrictions of Urban Rail Public-Private Partnerships

As stressed above, the implementation of PPP contracts for transportation infrastructure is rather complex, not only because of the technical challenges inherent to the construction and operation of the infrastructure, but also because of the difficulty of specifying contract terms for a long period of time. In the case of urban rail PPPs, we find a set of circumstances that make these arrangements even more difficult:

- Transportation networks have large economies of size and density (Braeutigam 1999). In this respect, the larger the integration of the network, the lower the average cost. If a new line is intended to be built and operated by an external firm through a PPP contract, these economies of size and density can be lost. This fact is particularly notable in conventional subway networks where operation systems are centralized.
- The previous point is reinforced by the fact that in many cities, for historical reasons, a single public operator has been in charge of managing and operating the whole network. This public operator holds important advantages over a new private operator. First, it has a very good knowledge of the system. Second, it has greater experience about how to manage the network. And third, this operator owns warehouses, control centers, telecommunication networks, and so on.
- Difficulties in implementing an integrated fare policy are also an issue. Very often, governments of metropolitan areas establish fare policies to promote a greater use of public transportation through discounts targeted to frequent users and so on. Consequently, fares are different depending on the type of user, and for some of them may in the end be highly subsidized. Rail PPPs in urban areas have either to establish a nonintegrated fare, which does not appear to be good for the whole system, or to share the integrated fare of the network system, which often implies that the government has to subsidize the PPP contractor. In this second solution, part of the revenues will come from the government, meaning that one of the major advantages of PPPs would be lost.
- Construction of urban railroads is large and risky, especially for urban underground networks. Geotechnical risks are added to the multiple affections and risks derived from proximity to

already existing buildings. This fact makes necessary an intelligent risk-sharing approach between the private and the public sector for this type of contract.

We notice how these problems are particularly sensitive to heavy underground rail lines well connected to the existing network. This fact explains why most of the urban rail PPPs implemented in the last few years are trams or light rails that circulate on the surface and provide access to new suburbs of metropolitan areas (Bottoms 2003; Greenberg 2004; Perrot and Chatelus 2000). Light rails and trams are less susceptible to the aforementioned issues. First, they are much less connected to the conventional heavy subway network so their operation by a different company is not such an issue. Second, as technical standards for both infrastructure and trains are different from the conventional subway network already existing, economies of scale and density are not that important for this case. Third, as they are separated from the main network, specific fare approaches can be implemented. And fourth, as they are mostly constructed on the surface, investment amounts and construction risks are much smaller.

However, budgetary constraints have encouraged governments to implement PPPs not only for light rail systems, but also for the enlargement of conventional subway networks (Zamorano et al. 2004). One of the first experiences is the case of the subway access to the new terminal T-4 of Madrid-Barajas International Airport, implemented through a PPP approach.

Case of the Expansion of the Subway to Madrid-Barajas International Airport

Madrid-Barajas International Airport is an airport with one of the highest traffic growth rates in Europe. According to ACIs data (Airports Council International 2008) for the period 2000–2006, the average annual growth rates in the number of passengers in the five largest airports in Europe were 0.7% in Heathrow (London), 2.8% in Charles de Gaulle (Paris), 1.1% in Frankfurt, 2.5% in Schiphol (Amsterdam), and 5.5% in Madrid-Barajas. As the old terminals of the Madrid-Barajas airport became insufficient to attend to the growing air traffic, a new terminal, named T-4, was built in order to accommodate Madrid's air traffic needs for the next 20 years. This new terminal was not a mere expansion of Madrid-Barajas International Airport for two reasons. First, the capacity of the new terminal is larger than the capacity of the three old terminals (T-1, T-2, and T-3) put together. In fact, it is envisaged that, in only a few years, the volume of passengers in Terminal T-4 will include 65% of the total number of users of the airport. To have an idea of the importance of such a terminal, Iberia, the largest Spanish air carrier, together with its allies of the "one world alliance," has moved all of its Madrid operations to this new terminal. Second, owing to land availability problems, the new terminal is separated by a significant distance from the old ones, so a connection inside the airport between the old terminals (T-1, T-2, and T-3) and T-4 was rather complicated.

At the beginning of 2006, the Regional Government of Madrid decided to accept the challenge and the responsibility of building a new subway access to the new Terminal T-4 of Madrid-Barajas International Airport by means of a PPP approach. The regional government entrusted to MINTRA, a public authority in charge of managing the subway infrastructure network in Madrid, the task of arranging the tender and regulation of the contract. This access required the construction of a new segment of the underground that enlarges the existing Line 8 to the new Terminal T-4, thereby

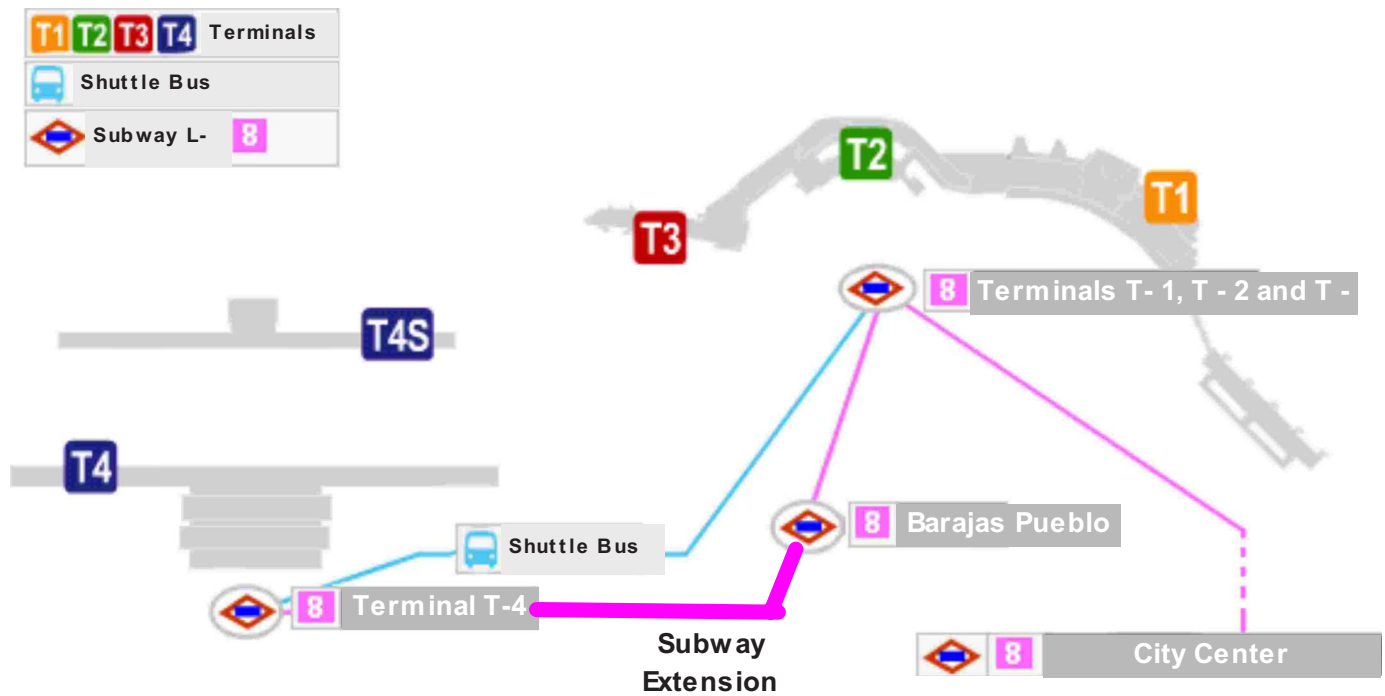


Fig. 1. Map of the subway access to the new Terminal T-4

connecting this new terminal to the city center. The Subway Line 8 already has a stop that enables users to get to Terminals T-1, T-2, and T-3, but reaching Terminal T-4 from this subway stop is quite inconvenient, since it is necessary to get off the trains, to walk for a while, and to take a shuttle bus to the new Terminal T-4. In between the subway station at the old terminals (T-1, T-2, and T-3) and the new station at Terminal T-4, there is another station (Barajas Pueblo) that gives access to a suburb of Madrid close to the Airport. From this station, the airport cannot be reached. Before the line was enlarged, this station was the last station of Line 8. Fig. 1 shows a map that describes the positions of the terminals and the extension of Subway Line 8.

Characteristics of the PPP Contract Design

One of the main challenges of designing this PPP contract was how to manage the connection with the existing Subway Line 8. This line is operated by the public company Metro de Madrid, which is in charge of operating the whole underground subway system in Madrid. In the first stage, two solutions were approached. The first solution raised was to design an integrated PPP contract in which the private sector had the obligation to build and maintain the infrastructure facilities and to operate the trains between the last station of Line 8 and Terminal T-4. This solution implied that users would have to get off the conventional subway train at the last stop of Line 8 and take another train, operated by the PPP contractor, to Terminal T-4. This design was envisaged as a way to facilitate the users' connection by enabling the trains to stop at both sides of the same platform.

Such a breakdown can be justified in a context where the number of users decreases drastically from that breakdown point on, because the necessary frequency of trains to satisfy the demand is much lower. However, that was not the case for Terminal T-4, since demand forecasts suggested a significant transfer of the activity to the new Terminal T-4. On the other hand, from a func-

tional point of view, such a transfer would cause passengers some annoyances, especially for users carrying luggage.

To solve these problems, a second PPP approach was raised. This approach was conceived as an extension of Line 8 of Madrid's subway, without breaking up operations at the former final stop. Consequently, this approach consisted of unbundling the infrastructure construction and management of the new stretch of Line 8, which becomes the subject matter of the PPP contract, from the service operation, which will remain in Metro's hands. This way, Metro will continuously operate trains from the beginning of Line 8 up to Terminal T-4. So, in the users' view, the service will be provided in a continuous way from the beginning of Line 8 up to the new final stop of Line 8 at Terminal T-4. The PPP scope was, thus, about the construction, upgrading, maintenance, and management of the new 2.5 km section during the entire concession period. The operation of the transportation service was entrusted to Metro de Madrid, which is already operating the trains in the line. This PPP approach, even though from a conceptual point of view it was innovative for urban railroads, it is not that different from highway PPPs, in which the PPP contractor does not undertake to carry out any transportation services.

We found a precedent for this approach to urban rail infrastructure in some PPP contracts in the UK in 2002 that were entered into for the purposes of modernizing the London Underground. Those PPP contracts were designed to exclude the operation of trains. The reason for the implementation of those contracts was that there had been a significant underinvestment in London's subway network, though the railroad service provision by the public operator had been fairly satisfactory (National Audit Office 2004).

For this reason, three PPP contracts were signed with two private firms (Tube Lines and Metronet). The private contractor was in charge of upgrading and maintaining the infrastructure, the

Table 1. Distribution of Tasks between the PPP Contractor and the Railroad Transportation Service Operator

Tasks taken on by the PPP contractor	Tasks taken on by the transportation operator
<ul style="list-style-type: none"> • Construction of civil infrastructure • Maintenance of civil infrastructure in tunnels and station • Maintenance of the track • Maintenance of lighting inside tunnels • Maintenance of pumping systems • Cleaning of station and facilities • Maintenance of access control machines • Maintenance of water supply and drainage • Maintenance of fire protection systems • Maintenance of ventilation systems 	<ul style="list-style-type: none"> • Railroad transportation service • Management, maintenance, and cleaning of trains • Security and surveillance in trains and station • Fare collection and ticket office staff • Maintenance of electric systems and energy supply • Maintenance of signaling • Maintenance of communication systems

network facilities, and the rolling stock, while the existing public transportation operator (London Underground Ltd.) continued to operate the trains. The required investments are to be financed by the private sector through the raising of equity and issuing of debt, while the firms Tube Lines and Metronet would be paid by the public sector according to performance-based specifications.

The contract concerning the new access to the new Terminal T-4 in Madrid offers some differences from the PPP contracts designed for the London Tube. First, while the new access to Madrid-Barajas International Airport is a greenfield project on a relatively small section, London Tube PPPs focuses on the maintenance and upgrading of the existing network so construction problems are different in both cases. Second, the investment committed because of the new access to Terminal T-4 is rather small (63 million euros) compared to the investment that is called for by the contracts for the London Tube, which is expected to reach (in present value) 9,700 million sterling pounds (approximately 14,400 million euros) during the first seven and a half years of the contract. The explanation for this huge difference is that the PPP contracts implemented in London intend to deal with the entire network, whereas the PPP implemented in Madrid deals only with the enlargement of an existing line. In spite of those differences, from a contractual point of view, the solutions adopted in the two cases are quite similar.

Although at first glance, the separation of tasks between the infrastructure manager and the transportation operator seems to be straightforward, this division is not so clear for urban subway lines. For instance, the management and operation of the electricity networks could be assigned either to the infrastructure manager or to the transportation operator. Table 1 shows the ultimate division of tasks between the infrastructure manager (the PPP contractor) and the transportation operator (Metro de Madrid) for the case of the extension of the subway to Terminal T-4.

The PPP contractor assumed responsibility for the construction of both the public works and their adjacent facilities. The public works included the construction of a new tunnel 2.5 km long and the track in that tunnel. The PPP contractor assumed most of the maintenance tasks. However, it was thought that some maintenance tasks—energy supply, signaling, and communication—would be better provided by the transportation operator (Metro de Madrid), which remains also in charge of maintaining and operating the trains. These tasks were assigned to Metro de Madrid because of the economies of scale stemming from the connection of this new stretch to the rest of Line 8.

Funding and Charging Approach

Another key issue of this PPP contract is its funding and charging approach. The PPP contractor has to fund the works up front by raising equity and issuing debt. The PPP contractor is supposed to recover its investment from a surcharge that was imposed on the users of the system, since the regional government of Madrid insisted that no subsidy would be provided to fund the new access. This surcharge is not applicable to two kinds of users: first, the people who work in the airport; and second, the owners of the “monthly travel pass,” which is a flat fare for frequent users in Madrid that enables them to use the metropolitan transportation system of Madrid for a whole month. For a more detailed analysis of the public transportation fare policy in Madrid, see Vassallo and Pérez de Villar (2007).

This surcharge was also imposed on the users who take or get off the subway at the existing station that provides access to the old terminals of the airport (T-1, T-2, and T-3). The measure was adopted in order to avoid discrimination among the users of the different terminals of the airport. This surcharge was not applicable to the users who take or get off the subway at the intermediate station (Barajas Pueblo) since this station does not provide direct access to the airport.

The surcharge was one of the key issues to decide the winner of the tender. The winner offered a surcharge equal to €0.91, which was lower than the regional government of Madrid had expected. In order to round up the surcharge, the regional government of Madrid ultimately decided to fix it at exactly €1. Because of this adjustment, the PPP contractor was obliged to give 9% of the revenues collected because of the implementation of the surcharge to the regional government of Madrid.

The level of this surcharge was added to the normal fare applied to the users of Madrid’s subway network who do not own the travel pass. Thus, applying the fare to a single ticket (which is 1 euro), the passenger who originates from, or is going to, the airport, has to pay a total fare of 2 euros, considered reasonable by users, particularly if compared with fares paid to travel by subway to and from other major European airports. Users could either buy a special €2 ticket to the airport at the beginning of their trip, or to enter the subway network with their €1 ticket and pay the €1 surcharge at the subway stations of the airport.

Demand studies, conducted as a part of the PPP feasibility study, showed that the number of users that are expected to pay the surcharge account for approximately 45% of the total number of passengers. This means that there is a much higher percentage

of nonfrequent users than in the rest of the network as, owing to the large percentage of airport users who do not live in Madrid, one would expect.

Relationship between the PPP Contractor and the Transportation Operator

The revenues of the PPP contractor are linked to the number of users who are obliged to pay the surcharge to take or get off the subway at the stations of the airport. This is not substantially different from toll road PPPs where the private contractor does not carry out any transportation activity. However, there is an essential difference between the PPP we are dealing with in this paper and toll road PPPs. In the case of the new subway access to Madrid-Barajas Airport, there is only one transportation operator, while in the case of toll road PPPs, there are multiple operators. This is the reason why regulating the relationship between the PPP contractor and the transportation operator (Metro de Madrid) was a crucial issue in the design of this PPP contract.

As the revenues of the concessionaire depend on the ultimate number of users that take or get off the subway at the airport's stations, the operation of Metro, which is independent of the PPP agreement, can have a large influence on the profit of the PPP contractor. For instance, if Metro de Madrid workers provoke a strike and consequently no train circulates for some days, the PPP contractor would lose an important amount of revenues, and the same can happen in reverse: the maintenance of the infrastructure, which is entrusted to the PPP contractor, can affect the quality of service rendered by the transportation operator (Metro de Madrid).

With regard to the first aspect, a clause in the PPP contract was established, which guarantees that the concessionaire will receive a compensation (to be paid by Madrid's Transportation Authority, which owns Metro de Madrid) if Metro de Madrid fails to comply with the frequency, quality, or safety requirements agreed upon in the contract, and this failure affects the demand in the PPP contract section. Regarding frequency, the contract established that a breach occurs when the real frequency falls below 85% of the frequency stipulated in the contract by Madrid's Transportation Authority. This limit was established to avoid a situation in which any minor reduction of frequency could be used to require compensation to the PPP contractor.

Regarding the correct maintenance of the infrastructure for which the PPP contractor is responsible, a system of penalties depending on a set of quality indicators was established. Such indicators referred to the infrastructure maintenance, the maintenance of different technical systems, the maintenance of the track, and the airport station cleaning operations. The failure of the PPP contractor to provide guaranteed levels of quality can prompt a reduction on the ultimate amount of revenues to be received by the contractor, up to 12% of the total amount collected in a given time period.

Demand Risk Mitigation

Finally, another significant characteristic of this PPP contract is that it establishes both an upper and a lower threshold to mitigate demand risk. If actual demand falls above the upper threshold, the economics of the concession have to be rebalanced in favor of the government through a reduction in the agreed contract term, or a reduction in the surcharge. The other way around, if actual demand falls below the lower threshold, the economics of the concession have to be rebalanced in favor of the concessionaire.

These mechanisms to mitigate demand risk have already been put in place in some countries (Vassallo and Sánchez Soliño 2006). What is new in this case is that, according to the current Spanish legislation, the initial demand limits were not fixed by the government in the tender, but they are to be proposed, within a range established in the initial bidding terms, by the bidders in the tender.

Analysis of the Outcome

Result of the Tender

The tender for the PPP contract for the new subway access to Terminal T-4 took place in April 2006. The selection process was based on an open procedure. Unlike the negotiated procedure, the open procedure consists of awarding the PPP contract to the bidder who achieves the higher score according to a set of criteria fixed by the government in the tender call. Each bidder had to submit both a technical proposal for the project and an economic offer. The tender of the contract established a score for the different proposals according to the following criteria:

- Technical offer (450 points).
 - Personnel assigned to the contract (30 points).
 - Construction program (260 points).
 - Infrastructure management program (160 points).
- Economic offer (550 points).
 - Extra-charge level (300 points).
 - Demand limits (120 points).
 - Consistency and feasibility of the proposal (130 points).

The winner was chosen in July 2006 and the contract was signed in August 2006, only four months after the tender call was published. The deadline for the completion of the envisaged works was only nine months from the date of the contract signing, hence, the new section was envisaged to be up and running in May 2007, just as it actually turned out to be. One of the reasons why the process went so fast is that the MINTRA had already completed the final design of the project. The tender was fairly competitive. Six bidders, which is quite a large number for this kind of PPP contracts, competed to be awarded the contract.

Table 2 compares some key parameters offered by the grantee of this PPP contract with the same parameters offered by the grantees of two light rail PPP projects awarded in Madrid at the same time as the contract for building the new subway access to the airport. These other two projects demonstrate two substantial differences with the new access to Terminal T-4. First, the rail system was an independent light rail instead of the enlargement of an existing conventional subway line, and second, for the two light rail PPP projects, the contract integrated the operations of both infrastructure management and transportation operation. Since the three PPP contracts were implemented by the same government in the same location and at the same time, Table 2 enables us to compare the two approaches, with and without operation of the service incorporated, with hardly any bias.

Table 2 compares three different criteria: the project IRR estimated by the grantee of the PPP contract, which reflects accurately the cost of capital, the demand limits set up according to the specifications of the bidding terms, and the number of bidders who ultimately attended the tender. First of all, it is clear that the IRR is much lower for the first PPP than for the other two light rail PPPs. Two reasons can explain this fact: the greater competition in the tender, and the fewer risks perceived by the private sector since the operation will be provided by Metro de Madrid.

Table 2. Outcome of the Grantee of the Tender for Different Urban Rail PPP Contracts in Madrid

Name of the project	Project IRR ^a (%)	Demand limits		Number of bidders
		Lower (%)	Upper (%)	
Project 1: Access to Madrid-Barajas International Airport, new Terminal T-4	6.70	0	100	6
Project 2: Light Rail, line Pinar de Chamartín-Sanchinarro-Las Tablas	9.53	68	125	1
Project 3: Light Rail, lines Colonia Jardín-Pozuelo and Colonia Jardín-Boadilla	11.23	68	100	2

^aInternal rate of return offered by the grantee of the contract.

The demand limits described in Table 2 were established by each bidder as a percentage of their traffic estimates. In this respect, if the lower limit is, for example, 70%, this means that the economics of the contract will be rebalanced in favor of the concessionaire if in the end real traffic falls below 70% of the expected number of users estimated by the grantee of the contract. The same thing happens at the other end: if the upper limit is for instance 125%, this means that the economics of the contracts will be rebalanced in favor of the government if real traffic falls above 125% of the expected number of users.

The natural incentive of the bidders is to set the lower limit as high as possible in order to be covered in case an unexpected downside occurs, and the upper limit as high as possible to take advantage of any conceivable but unexpected upside that might occur. However, according to the bidding terms, the bidders achieve a better score if they place both limits at the lowest level permitted since this means that they are bearing a larger risk and hence the government is assuming less risk. This is the reason why bidders have a trade off between the level of demand risk that they bear and their competitiveness in the tender.

Analyzing the two light rail PPP projects (projects 2 and 3 in Table 2), we observe that the estimated IRR for project 3 is higher than it is for project 2. This difference can be explained by the fact that in project 3, the contractor is committed to give up larger profits than in project 2 in case an upside emerges because a lower top demand limit has been offered. However, in contrasting projects 2 and 3 with project 1 (the new subway access to the airport), the IRR demanded by project 1 is considerably lower. In addition, the demand risk profile chosen by the ultimate grantee of project 1 is much less favorable for the PPP contractor than the profiles adopted by the contractors of projects 2 and 3. In other words, even though the nonintegrated approach is bearing a higher demand risk than the integrated approaches, the cost of capital of the nonintegrated approach is lower than the cost of capital of the integrated approach. Consequently, the financial cost of the project is much lower for the nonintegrated approach.

As has been observed in the last column of table 2, the number of bidders in the tender was much higher in project 1 than in projects 2 and 3. The main reason was the different kind of prequalification criteria required to be met by the bidders in the two different approaches. Indeed, while for project 1, a particular level of experience in construction and maintenance of infrastructure and railroad track maintenance was required, for projects 2 and 3, experience in the operation of rail transportation was also demanded. Undoubtedly, such a requirement restricted the number of potential candidates. Therefore, the level of competition was quite low for the integrated approach.

Project Performance up to the Present

Once the airport access PPP contract was awarded, the works were implemented on schedule. In the end, the ultimate total investment by the PPP contractor totaled 63 million euros, which was approximately 20% larger than estimated. This cost overrun is explained because of the fact that the PPP contractor in the end had to carry out some nonenvisaged works in the airport station. As those works were imposed by the MINTRA after the contract was signed, the contract terms states that the economics of the project will have to be rebalanced to compensate the private contractor. At the time of writing this paper, the proper way to compensate the contractor had not yet been established.

Regarding the operation stage, not enough time has passed to assess the performance of the PPP contract. We can advance the view that the total demand for the subway access to all the terminals of the Madrid-Barajas Airport is growing as expected by the public authority. This confirms that the demand elasticity to the surcharge seems to be rather small. However, the distribution of passengers between the old terminals (T-1, T-2, and T-3) and the new Terminal T-4 is not as expected. Paradoxically, once the new terminal has been in operation, the growth rate of passengers in the old terminals is recovering, and the traffic growth in the new Terminal T-4 is not as high as expected. The reason is that most of the low cost air companies have remained in the old terminals, and this is the segment of air transportation market with the highest growth. Consequently, the demand behavior for the new subway access to the new Terminal T-4 is below the expectations of the contractor during the first months of the contract.

Regarding the maintenance of the infrastructure and the quality of the service, no significant problems have stemmed from the PPP contract up to now, but it is still too early for a deep evaluation of the arrangement in place.

Conclusions

In this paper we have discussed, in the first place, the theoretical foundations for the design of PPP contracts, starting from the literature on incomplete contracts. From this point of view, unbundling infrastructure construction and service provision is suitable when construction quality can be well specified and it is easy to monitor, but quality of service cannot be easily specified or monitored. In particular, this can be applied to transportation infrastructure projects.

In addition, the results obtained in the paper show that integrated PPP contracts (those contracts that include both infrastructure management and transportation operation) have some

drawbacks for urban rail projects, particularly for the extension of conventional subway lines connected to existing networks whose transportation services are operated by a single company. First, the need to comply with tough qualification requirements limits the number of potential bidders, and consequently reduces competition at the tender stage. Second, bidders perceive larger risks in integrated contracts so the cost of capital they require is larger. And third, integrated PPP contracts entail the loss of important economies of scale and density inherent to transportation networks and, as it happens, with urban subways. These three issues often lead to higher costs for the users. On the one hand, little competition in the tender reinforces the monopolistic power of private companies encouraging bidders to offer higher prices. On the other hand, a greater cost of capital implies large financial costs. Finally, the loss of economies of scale and density ultimately becomes more expensive.

Therefore, nonintegrated PPP contracts are an interesting option to consider by governments in crafting urban rail PPPs. This option seems to be particularly appealing when the project to be implemented has a significant connection to an already existing transportation network that is operated by a single operator. The empirical outcome obtained from the case study analyzed in this paper seems to confirm this idea.

On the other hand, it is noteworthy that the IRR demanded by the grantee of the PPP for the new subway access to the Madrid-Barajas International Airport (placed well below profitability ratios demanded in other urban railroad projects, as has already been pointed out) is similar to the profitability demanded by private promoters in the latest toll highway PPP tenders held in Spain. In those tenders, project IRRs before taxes were around 6.5–7% (Vassallo and Sánchez Soliño 2007). This fact seems to confirm that the PPP approach established for the subway access to the new terminal of Madrid-Barajas International Airport is closer to toll highway PPPs than to traditional integrated urban rail PPPs. In other words, a PPP such as the new subway access to Madrid-Barajas would be mostly a business for construction firms and financial institutions rather than for transportation operators.

From the point of view of the government, nonintegrated PPPs have the advantage of boosting competition in the bidding process, and subsequently reduce monopolistic power. In spite of that, in using nonintegrated approaches, the government excludes the possibility of new transportation operators entering the market. This fact substantially reduces the possibility of contrasting the performance of the public transportation operator with other private companies. From the point of view of the users, apart from the reduction of prices, nonintegrated approaches have the advantage that they do not entail a breakdown in the transportation service. As users strongly penalize transportation changes, this fact increases welfare and promotes a greater use of public transportation.

To sum up, we conclude that the implementation of nonintegrated approaches for PPPs, which have until now rarely been put into practice for urban railroads, may have a greater potential of encouraging greater willingness by the private sector to participate in the construction and management of urban subway networks while retaining economies of scale and density derived from the existence of a single transportation operator.

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