Case Study

Alternative Contractual Arrangements for Urban Light Rail Systems: Lessons from Two Case Studies

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Abstract: The need to improve urban transportation systems in order to decrease travel time and increase their reliability while keeping the costs at an affordable level has led governments to develop public-private partnership (PPP) arrangements in urban light rail systems. Many cities around the world have used the PPP model for the construction of urban light rail systems, particularly light rail, since it provides a quicker and easier answer to financing these large investments. However, different models have been adopted. In most cases a typical design–build–operate–transfer model, with long duration (e.g., 30 years), is used, but other innovative models have also been adopted (e.g., a hybrid model with different contracts for infrastructure construction and maintenance—a 20-year contract—and another for the systems operation—a 5-year contract). This paper addresses the advantages and disadvantages of these models, using one case study for each model. The conclusions show that the hybrid model has the potential to decrease the operation costs, but at the same time to mitigate the interface risk (operation <-> infrastructure). **DOI: 10.1061/(ASCE)CO.1943-7862.0000942.** © *2014 American Society of Civil Engineers.*

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Introduction

Political decision makers need to ensure that cities provide satisfactory living conditions and a proper level of accessibility and mobility to the population while also having to cope with increasing congestion and higher environmental standards (Strukton 2008). Therefore, transportation planners and political decision-makers must find affordable, environmentally friendly, and socially responsible transportation solutions that can support further development in urban areas. They are required to look at alternatives to improve transportation services in response to ever-expanding urban populations and changing spatial patterns (Feng and Li 2012) but also to a growing motorization rate (Yannis et al. 2012). Urban light rail systems (ULRS) can assist in developing long-term sustainable solutions since they are less polluting and require less urban space than road traffic, while providing rapid urban mobility and vital access to city centers from surrounding districts (World Bank 2010).

Nonetheless, an efficient ULRS can be a complex and expensive project. To answer the increasing need for mobility, and with government funding being increasingly limited, public-private partnerships (PPP) arrangements have been extensively used to maximize and enhance transport networks, taking advantage of the innovation, know-how, flexibility, and financing provided by the private sector (Bing et al. 2005; Cruz and Marques 2012). This public and private cooperation has already shown that it can provide several benefits when used wisely. PPP projects offer governments the opportunity to increase budgetary flexibility by avoiding the need to prefund large capital programs that require significant up-front financing (Engel et al. 2011).

As with any other tools, used wrongly, PPP arrangements can lead to significant adverse outcomes, e.g., increasing costs due to renegotiation (Guasch and Straub 2006; Cruz and Marques 2013). According to ERRAC (2009), despite the costs involved in ULRS—the cost of light rail construction varies widely, depending on the amount of tunneling and elevated structures required—the number of systems developed has been increasing. Comparing the evolution between 2004 and 2009 throughout EU-27, in 2004, 169 tram or ULRS were identified and, since then, 16 more tram or ULRS have been implemented, representing an increase of almost 10% of the total, proving that ULRS are still strong and have a high potential for development (Simões et al. 2014). This development potential can be explained by the ULRS's contribution to the protection of the environment, increased safety, economic growth, and reduced transit costs (UITP 2001). However, the current tendency is one of extending existing systems rather than creating new ones (ERRAC 2009).

The fact that the urban rail sector has historically been considered a sector that cannot be run profitably, whether publicly or privately owned, is often cited as one of the obstacles to successfully engage the private sector (J. F. Due, "A new look at urban transit: control vs. market approaches," working paper, Economics Department, University of Illinois, Urbana-Champaign, Illinois; Gomez-Ibanez and Meyer 1993). The difficulties arise from a number of factors: (1) expensive construction, operating, and maintenance costs; (2) inadequacy of fare revenue resulting in the need for direct and/or indirect public subsidies such as land development rights or direct public subsidies; and (3) complexities of creating and sustaining coalitions and partnerships necessary in rail transit privatization (Phang 2007). It is recognized that financial self-sufficiency is an important aid to privatization and that very few light rail

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systems can be self-financing, so it is not surprising that, according to ERRAC (2009), the level of privatization of the light rail sector in EU-27, represents only about 14%: in a sample of 79 companies, 68 are public companies, 4 are private companies and 7 operate with a shared ownership.

Nevertheless, this situation may change considerably in the coming years. The high costs inherent to the development of new transit systems may provide strong motivation in many developing countries for governments to seek private sector cofinancing, as has happened in Latin American cities like Buenos Aires and Rio de Janeiro, where services for urban rail lines were contracted out. Moreover, if we take into account what happened in areas such as water, energy, roads, and waste management, the trend in ULRS would also be the creation of PPP arrangements (Rebelo 1999, 2006). But why and how can ULRS be good candidates for using this procurement model? The answer lies with three main interrelated features: dimension, complexity, and capital.

ULRS are large systems dependent on the existence of heavy rail infrastructure, which raises two concerns: first, large and complex construction works, frequently involving tunnels in urban areas with high geotechnical risks and significant impacts on the surface (e.g., use of public space by the construction-supporting areas); and, second, intensive (and sunk) capital requirements. PPP projects are known for having better track records of on-time and on-budget delivery (Grimsey and Lewis 2002). This is particularly important when dealing with complex construction works (e.g., rail tunnels in urban areas) and also when the construction activities have severe impacts on the daily life of citizens (e.g., building rail stations in densely populated areas). From this perspective, PPP arrangements help delivering successful ULRS. Moreover, the question of capital scarcity is also an advantage of the PPP model, since it allows leveraging the project (totally or partially) on other sources of funding than the traditional public budget, which would have difficulties in accommodating the lump sums required to build a rail infrastructure. However, few urban transportation projects are entirely financed by the private sector, and generally comprise a mix of public and private financing.

Until now, the discussion has been centered on infrastructure, but it can be extended to operation activities. Operating these systems is a complex activity from the daily operation perspective, but also due to their capital requirements. Again, the highest degree of flexibility that can usually be found in most countries for the private sector labor market can be an important reason for adopting PPP arrangements, since it allows for decreasing the labor costs. The constraints and political interference with contracting public servants, or workers for public owned enterprises, can mean higher labor costs and less flexibility in allocating resources to services usually with strong peaks along the day. The principle of flexibility in managing complex systems under PPP arrangements is a key principle to extracting the full benefits of private management (Cruz and Marques 2012).

The purpose of this paper is twofold. First, it intends to provide an overview of the different PPP models for developing ULRS. This was supported in a literature review that proved to have few elements on this specific topic, and also through an international benchmark, supporting the theoretical framework with real case studies and real examples. Before presenting these distinct models, the paper provides a theoretical reflection on the reasons and potential benefits of developing PPP schemes in ULRS.

The second objective of the paper is to provide a more insightful analysis of alternative contractual structure for building, maintaining, and operating ULRS. Since the different realities in different countries can distort some analysis, as well as comparing projects developed in different time frames, two case studies were selected, with alternative contractual arrangements, developed in the same country and within the same period, which can provide important lessons and policy implications. The authors intend to analyze the effect of unbundling operation and infrastructure in ULRS PPPs. To fulfill this objective, the methodology followed a case study approach. Finally some conclusions and policy implications are drawn.

Alternative Models for PPP projects in Urban Rail

Overview

The emergence of PPP projects in ULRS is supported by the urgency of efficiency and effectiveness gains, decreasing overall costs in construction and operation. In some cases, these were not the main drivers, and PPP arrangements were used due to the fact that they were not accountable for public deficit calculation (Engel et al. 2011). The high investments required by these projects would place a significant burden on the state public budgets.

Although the bypass of public budgets should not be the main driver for developing these schemes, governments (central, regional, and local) were able to develop projects with a high impact on society, at zero short-term costs. Naturally, those costs will arise in the medium to long term, and some optimism in estimating the projects' revenues might jeopardize their economic and financial sustainability. Skamris and Flyvbjerg (1997) show evidence of inaccuracy of traffic forecasts with an evident trend towards excessive optimism, which is a major source of risk for the economic sustainability of these projects.

There are several PPP models available for ULRS, particularly concerning the object (infrastructure versus operation) and the financing arrangement (including, or not, the financing of the infrastructure construction). There are no identical PPP arrangements, and across countries it is possible to find variations in each model. Nevertheless, it is possible to define large categories that allow some standardization. Next, we will use real cases to illustrate the most typical contractual arrangements for PPP projects in ULRS.

Design–Build–Finance–Operate

Design–build–finance–operate (DBFO) schemes are quite common, not only in ULRS but in several infrastructure sectors: roads, ports, water and wastewater, and energy, among others. Kuala Lumpur and Bangkok developed new ULRS through DBFO agreements. This scheme is particularly attractive since it allows shifting most responsibilities to the private sector. However, this does not meant that the private sector would assume all the risks. In the case of Kuala Lumpur project, there was no competitive tendering when the concessions were awarded. The government ended up assuming most of the risks associated with finance and ridership, bailing out its private sector partners when the project began to show problems.

In contrast, the Bangkok rail PPPs were subject to strong competition (Halcrow 2004). Nevertheless, the construction risks involved in the underground line project proved to be too high for the concessionaire to deal with. The project was subsequently unbundled, with the public sector responsible for construction, and only a concession to equip and operate the line put out to bid. The private partner assumed property acquisition and right of way delays risk, resulting in substantial delays and increased costs. DBFOs might be highly complex projects with long-term impacts (Halcrow 2004). The contract has to be carefully designed, since it has to address all the major risks (construction, demand, and financing) for a very long period, usually, not less than 30 years.

Dealing with construction, demand, and financing risks can be extremely difficult (Cruz and Marques 2012). There are high levels of uncertainty. The other problem with having all these risks within the same contract is that one risk can contaminate the entire project. This means that in cases where the construction risk is very high, even though this risk will disappear in the first three to five years of the contract (when the construction finishes), the internal rate of reurn and cost of capital determined in the initial contract (before the construction risk disappears) will be in place for the remainder of the contract. Any renegotiation due to traffic optimism, or any other reasons, will be constrained by a risk that does not exist anymore.

Operation Concession

The operating concession model is far simpler than the DBFO. The concessionaire assumes the risk for the operation [also called production risk, see more in Marques and Berg (2011)], and the demand risk can be either assumed by the concessionaire or by the grantor, or even shared between both. Since the financing and construction are not included in this scheme, the concessions' period is usually shorter than the one found in DBFO schemes, typically between 5 to 10 years. The duration can be longer if the concessionaire has to invest in rolling stock, but these assets are generally leased by the concessionaire to the grantor.

In Stockholm the option was to award contracts of 5–10 years for operating its three metro rail lines, the light rail system, and the suburban railway service, as well as commuter rail services. In Argentina, the urban commuter railroad services, which were previously operated by the state-owned railway company, were divided into seven separate lines and offered as 20-year concessions to the private sector (Rebelo 2006).

Unlike Buenos Aires, Rio de Janeiro was able to concession its systems without providing operating subsidies (Rebelo 1999). As compared to DBFOs, operating concession partnerships are less complex. In pure concession contracts, the concessionaire typically deals only with operations, and in some cases maintenance, but it can also deal with demand (partially or totally). To ensure that services would be provided efficiently, Buenos Aires and Rio de Janeiro both utilized competitive tendering to award the concessions.

The level of renegotiation in these concessions is lower, essentially due to two reasons: shorter contracts and lower levels of risk exposure. In cases where the system is already under operation and the demand levels are known and stable, designing an effective contract becomes easier than in those cases where the system is new and there is no prior information on demand (Guasch 2004; Cruz and Marques 2013).

Infrastructure Maintenance and Upgrading Concessions

Infrastructure maintenance and upgrading concessions are those that only include the infrastructure and all necessary ordinary maintenance and, possibly, the upgrading of some systems. In some cases, these contracts also include the expansion of the infrastructure, e.g., building a new line (e.g., the infrastructure concession in Rio de Janeiro).

Between 2002 and 2003, the London Underground (LU), the entity responsible for the entire subway system, saw its responsibility over the maintenance and modernization of the London subway infrastructure being transferred to the private sector. This was done through a PPP awarded to two private consortiums, Tube Lines and Metronet. Three contracts were established with a 30-year duration, subdivided into four periods of 7.5 years each, to facilitate the review of their requirements and costs throughout the entire period of concession (Littlechild 2009). At the end of the 30-year period, the assets would be returned to LU (Grimsey and Lewis 2004). However, in 2007, Metronet became bankrupt and its two contracts were placed in public administration, revealing the true cost of Metronet's insolvency. Tax payers in the United Kingdom had to pay much of the debt, which damaged the argument that the PPP arrangements would place the risks associated with running the subway system on the private sector. This could be seen as a form of bailout of the concessionaire, which is not rare in PPP projects. Nevertheless, this model highlighted the complexity of developing concessions for complex infrastructure like an underground metro system, particularly, an old one, such as the LU.

Design–Build–Operate–Transfer

Design–Build–Operate–Transfer (DBOT) concessions are similar to DBFO, but without the financing. This means that the financing is not a direct responsibility of the private sector, but the capital will be provided by the government (central or local) or even through some governmental loan guarantees. Mumbai and Hyderabad (India) have undertaken DBOT concession agreements. In these cases, the concessionaire has to deal with the construction risk and also demand (totally or partially). The financing risk is not included. This has some advantages since the cost of capital for the private sector is higher than for the public sector (Esty 1999). Some of these models may have variations, and in most cases, even under DBOT schemes, the concessionaire has to ensure some minimum level of capital. This is important since this is a requisite to ensure that the private sector is fully engaged with the project. DBOT can also include the maintenance of assets. In that case, the DBOT should be called a design-build-operate-maintain (DBOM), although for simplicity purposes, most literature refers to DBOT, even when it includes maintenance, since it is assumed that if the partnerships includes the design–build and the operation, it also includes the maintenance.

In the next section, two particular and different case studies (light rail system of Porto and light rail system of Tagus South) will be presented, both projects in Portugal, which will support a discussion on their merits and disadvantages. In both projects, most of the financing was not included in the PPP arrangement. In the first case, a public company (Metro do Porto) assumed most of the loans in the financial market, accumulating a 2,000-million Euro medium-term and long-term debt. On the second case, the central government provided a significant share of capital covering most infrastructure investment costs. The light rail system of Porto is a particular case since the original contract was a DBOT scheme for 10 years. After this initial period, two separate contracts would be awarded: (1) an operating concession contract for 5 years, and (2) a maintenance and upgrading concession contract for 20 years. The light rail system of Tagus South is a typical DBOT scheme with a 30-year contract. This project faced several difficulties and ended up with significant cost increases for the public burden, as we will present and discuss next.

Case studies

Methodology

The methodology used in this paper is a case study analysis. The case study analysis method has been used frequently by researchers to analyze the outcomes of public policies and government interventions (Yin 2012). In PPP research, the specificity of each case and the existence of substantial influences of the social and political context in which they are developed makes it difficult to undertake

traditional quantitative analysis, especially when trying to assess the pros and cons of the choices made by political decision-makers (Noor 2008).

To allow a fair and accurate comparison, the authors selected two light rail systems, developed both in the same country—Portugal—in the same time period (late 1990s–early 2000s). The information was collected using the concession contracts, technical reports, and public information available about these two projects (e.g., annual accounts reports, monthly statistics on ridership, and technical information about the infrastructure available on the companies' websites). Using the date collected, the authors performed an analysis on the main benefits and pitfalls of these contractual arrangements.

Light Rail System of Porto

In 1993, the allocation of the light rail system in the Porto metropolitan area (2.5 million inhabitants) was granted exclusively to Metro do Porto, S.A., for a period of 50 years. Metro do Porto is a publicly owned company that would have responsibility for establishing concession contracts with a concessionaire, working as a mediator between the government and the concessionaire (Fig. 1). An international call for tender for a contract to design, build, and operate that system would be awarded to Normetro in December 1997. The initial contract had a duration of 10 years, subsequently extended for one more year due to changes to the network's design and to problems pertaining to its implementation and operation. After this initial contract, in March 2009, a new public tender was launched for the subconcession of the operation and light maintenance. This was granted to the Via Porto consortium for a period of five years. The tender for the phased construction of the new extensions and for general heavy maintenance, foreseen to be conducted in July 2009, and which would accompany the system's operation, was never launched due to lack of funds and is still waiting for governmental authorization (Metro do Porto 2008). This second concession would include infrastructure maintenance and upgrading, as well as the construction of new lines in the future, and would be awarded for a period no shorter than 20 years.

Upon contract termination with Normetro, it was possible to modify some conditions related to the initial tender, which would later be signed by Metro do Porto and Via Porto. The base price for the operation was lowered in this second tender and, in addition, the winning bid presented a price 8% lower than the second best bid (presented by the incumbent operator, Transdev). After the first contract, the grantor has been able to calculate a more efficient cost per vehicle kilometer, and set a base price (the maximum price for any bid) lower than the previous operating cost. The overall cost savings were close to 40%, demonstrating the enormous potential for decreasing the operation costs.

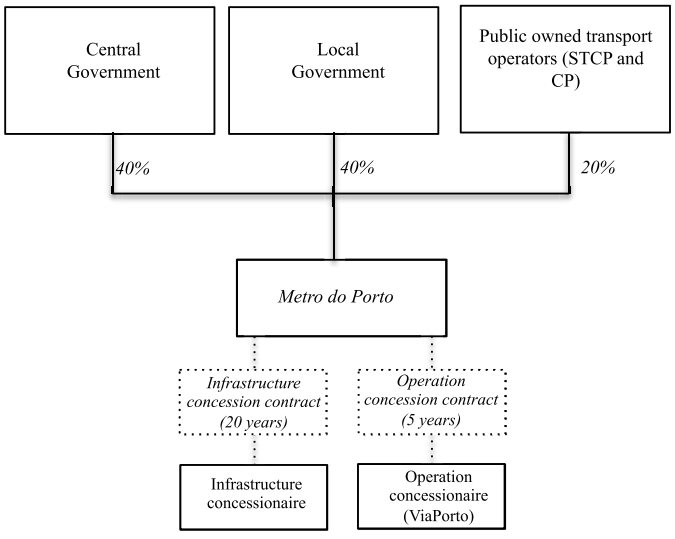

Fig. 1. Organizational structure of the light rail system of Porto

With this new contract, the grantor was also able to increase the service quality offered and attained better conditions in risk-sharing: the operational risk was placed on Via Porto, and the demand risk became shared through a band system. Moreover, the private partner's remuneration—up to that point a flat rate, previously established, corresponding to the execution of all necessary works established as subject of the contract—was associated with the performance evaluation of the new subconcessionaire, Via Porto, which allowed both partners to align their goals.

Another benefit of having shorter operation contracts is that it allows recalibrating demand. The problems with optimism bias affecting transport systems are well known, particularly when contracts have a large duration. This shorter contract has allowed the grantor to recalculate and adjust demand forecasts. By doing this, it ensures that the real demand is not significantly different from the forecasted demand, which also allows allocating more risk to the concessionaire.

Light Rail System of Tagus South (Almada)

The light rail system of Tagus South project has always been related to a certain political dimension, as it was an emblematic project for the South Bank of Lisbon (400,000 inhabitants), leading to various governments, regardless of the political party, committed to bringing this project into reality. Although this was a project essentially of local dimensions, the concession was given directly by the central government to the concessionaire. The role of the local government was ensured simply through a protocol signed between the municipalities and the central government. In September 1999, an international public tender was launched for the design, construction, and operation of the light rail system of Tagus South. However, only two competitors placed bids, which may be explained by the great dispersion of international groups at the time, the reduced dimension and viability of the project, and by the fact that certain possible competitors felt that Barraqueiro Group (one of players), being based on the South Bank, would have an a priori advantage.

Following several stages of the tender, the project was awarded to Metro Transportes do Sul (MTS), owned by the Barraqueiro Group, on March 14, 2002, with the concession contract being signed on July 30 of the same year, with a 30-year duration. However, the start of that period had to be postponed until December 12, 2002, due to the inclusion of the Environmental Impact Analysis in the negotiation stage.

The concession model approved for this project included, in a single contract, all the foreseen investments in order to achieve greater speed and not for any technical and/or financial convenience. The truth is that by bringing all investments into a single contract, the need to have separate tenders for each specialty and for the operation would have prolonged the project in time as well as its outset.

This contract represents a model of public procurement financially attractive for the private sector, since its feasibility depends on a guarantee by the State, which has to assume directly most of the projects' investment and financially compensate the concessionaire in case of traffic deficits. The tariffs in place by the concessionaire do not support the operational and financial costs of the

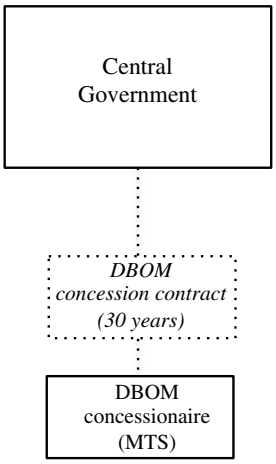

Fig. 2. Organizational structure of the MTS (light rail system of Tagus south)

project, making its economic viability impossible without State support.

Moreover, the State defined traffic to be around 80,000 passengers per day—an amount that was clearly inflated to allow for lower fees and fares and the consequent viability of the concession. The reality was different, and real traffic did not reach half of the forecast figure. Fig. 2 shows the light rail system of Tagus South (Almada) organization structure.

The operation of the system, which was expected to start in 2005, only began in 2008 due to the dispute between the Almada Municipality (AM) and the State. The central government was the grantor but the AM had to make available urban space to build the system. The municipality used this leverage to require compensations from the central government, particularly the financing of local parking lots. There was a dispute that resulted in a reimbursement to the concessionaire around 77.5 million Euro (in a 283-million Euro investment).

Regarding risk-sharing in this concession model, the core risk—that of demand/traffic—is on the grantor's side, because, as mentioned previously, during the years that passenger traffic is below the minimum limit of the reference traffic established, it will have to financially compensate the concessionaire. The system operates according to bands: a reference band for which there is no compensation paid to the concessionaire, and two additional bands, an upper and a lower, in which case the concessionaire shares the gains or the losses, respectively, with the grantor. This system mitigates the concessionaire's exposure to risk. The real demand was around 40% of the forecasted demand, in the first couple of years of operation. In 2011, this project had already suffered an increase of around 35.4% in the initial public investment. The State expenses, with the first stage of the project, were split into long term infrastructures (283 million Euro, entirely from public funding), financial recovery agreement (77.5 million Euro), and compensatory allowance for traffic deficits (27 million Euro). The financial recovery agreement was due to the delays in the construction, as a result of the dispute between the Central and the Local Government.

It was clear that the system was operating below expectations, which could bring financial difficulties of the concessionaire. But the bankruptcy risk was never real, since the risk sharing agreement, particularly regarding demand, ensured that the concessionaire was entitled to compensation if the demand was lower than the forecast.

In order to structure an analysis to both systems, the next section will present an analysis of the benefits and pitfalls.

Main Benefits and pitfalls

Main Benefits

Light Rail System of Porto

The light rail system of Porto has an innovative contract structure for ULRS development. Unbundling infrastructure maintenance and operation allows for constraining the construction and maintenance risk into a specific contract, and not contaminating the operation with these risks. Each critical risk (construction/maintenance and operation/demand) is isolated in a specific contract. In addition, it allows obtaining shorter contracts for the operation, with the advantage of pressuring the incumbent to become more efficient. This lower contract duration also allows improving the contract design, including demand forecasts, considering the real data of the operations and the flaws identified in the previous contract.

The unbundling of infrastructure and operation leads to a more attractive contract for transport operators that can bid for their specific core business, and not enter into a consortium with construction companies, thus increasing the level of competition and fostering innovation. The adoption of the negotiation stage in the tender process allows for an increase in competitive pressure and a better decision regarding the bids. The benefits of the model were seen the first time the operation contract was subject to competition—a new operator had a more advantageous proposal than the incumbent—thus supporting the rationale that greater competition can lead to lower costs.

Light Rail System of Tagus South

The concession contract for the light rail system of Tagus South is a straightforward DBOT contract, based on a single tender procedure, unlike the light rail system of Porto, which is based on two tenders. This leads to lower transaction costs. First, there is only one tender, instead of several tenders in the case of the light rail system of Porto—there are two tenders for the operation and the infrastructure—and given that the operation contract is shorter (five years), there will be more tenders during the project lifecycle. Simultaneously, there is the fact that this is a more typical contract structure and it decreases the interface risk (operation <-> infrastructure). Finally, the long duration of the contract, which could be seen as a weakness given the lack of competition of that period, could also be seen as a strength since it allows developing a long-term relation with the concessionaire and can allow for a stronger commitment of the concessionaire.

The inclusion of all specialties in a single contract allows the private entity to expand its capacity and experience, providing it with tools to reach for additional business opportunities and new markets. The group with the winning bid, being comprised of several companies from different fields of action, has the possibility to attain greater market power. The granting of the project to MTS, belonging to the Barraqueiro Group—a large operator on the South Bank—allows new synergies between the group's rail and road operations.

Main Pitfalls

Light Rail System of Porto

The inadequate and ill-productive application of the funds distributed as subsidies, as well as the nondetailed contracting, has come to penalize Metro do Porto, dragging it into a situation of growing debt. Furthermore, the lack of guarantee of a financing model based on alternative sources and on percentages that ensured its financial viability and the large bank loans for paying the investments all

come together in aggravating its situation of deficits and lack of capital. Nevertheless, this was not created by the type of contract, but by the general governance model of the system.

Light Rail System of Tagus South

The small scale of the project, its doubtful viability, the dispersion of international groups at the time, and the inclusion in a single contract of all specialties are some of its weak points. The nonseparation of the operation of the rail system from its remaining components results in its exposure to demand risk. Regarding risk sharing, the weak points pertain to the assumption of the demand and financing risks by the grantor. Revenue is based on the traffic band model, which is not a problem unless the forecast is unrealistic, which was clearly the case.

The unilateral changes are costly for the taxpayers. The reduced level of competition harms the project both economically and in terms of the proposed solutions. The fact that the project development is not solely within the scope of the project manager—the State led to abuses of its dominant position from AM, which delayed the entire project and forced the State to pay large compensation to MTS. As for risk sharing, a significant threat for the public partner lies in the overestimation of the demand for rail. The grantor takes over all of the demand and financial risks, becoming dependent on future political decisions. The concessionaire supports the risk from accessory revenue, which is a non-controllable risk, and for this reason it is dependent on the evolution of the economic-financial environment, which was entirely overvalued by the grantor.

Case Study Discussion

The two projects presented previously have structural differences regarding the business model and contractual arrangement. Table 1 provides a summary of the main features of each project.

The contractual model of the light rail system of Porto is innovative and provides several relevant lessons. The bundling of infrastructure and operation in the first years of the project ensured that the interface risk (infrastructure <-> operation) was mitigated. This interface risk is often perceived as the main threat to the unbundling of the infrastructure, particularly in rail services. There is a strong potential of conflict between the operator and the infrastructure manager regarding operating conditions, excessive wear of the rolling stock due the infrastructure, and impacts on operation due to infrastructure unavailability, just to mention some examples. This interface risk is particularly relevant in rail systems, given the strong physical interaction between the rolling stock and the rails. But this contractual structure allows testing the infrastructure, rolling stock, and all telecommunications and signaling systems; only then does the vertical unbundling occur, ensuring each tender to be more focused, which led to lower prices, greater quality, and a higher level of innovation.

The adoption of a negotiation stage in the tender allowed selecting the bidder whose proposal presented the most beneficial set of advantages in order to ensure lower prices for the customers, as well as minimal expenses for the State, without jeopardizing the guarantee of a safe and quality transportation system.

With the adopted business model, it became possible to increase efficiency levels, benefit from the advantages resulting from the fact that the system was operated by the same concessionaire that built it, and reduce public spending with the project through a new tender. The increased risk taken on by the private partner stands as one of the best practices of this project. The new contract for the operation and light maintenance allowed an increase in service quality offered by the new sub concessionaire, thus sharing the demand risk and taking on a large portion of the operational risk.

Regarding contract management in the case of the Porto subway, the private partners' revenue was associated with a performance review mechanism. It worked as an incentive towards offering quality of service by the subconcessionaire, since it places its own revenue at stake. To avoid any fines for noncompliance, the qualitative requirements presented in the contract persuaded them to offer quality of service.

Employment contracts of the operational sector are the private partner's responsibility. This was another best practice, as private management is much more flexible and financially viable when compared to public employment contracts.

In the case of the light rail system of Tagus South, placing the expropriation risk with the private partner was a good general principle since it would allow managing possible delays in those expropriations, guaranteeing greater flexibility in the planning, but the final outcome was not positive. Some of the land was held by AM, which refused to hand it over, and considering the State (grantor) did not have power of expropriation against AM, it was unable to provide the land to the concessionaire until the dispute with AM was solved.

Conclusions

PPP arrangements can help delivering more efficient ULRS. Nevertheless, the incomplete nature of the contracts along with the complexity and uncertainty of these projects can raise several problems, as previously described. The case of the light rail system of Tagus

Table 1. Main Project Features of the Two Case Studies

Feature	Light rail system of Porto	Light rail system of Tagus south
Investment	Approx. 2,200 million Euro	Approximately 283 million Euro
Business model	A—Initially a single DBOT contract B—The initial contract was latter split in two separate contracts: one for the operation and the other for the infrastructure maintenance and expansion	DBOT contract
Year of contract signature	1997	2002
Contract duration	A—Initial contract—10 years B—Operation contract—5 years Infrastructure maintenance and expansion—20 years	30 years
Main risks supported by the concessionaire	Operation and maintenance (political, financing and legal risks are entirely assumed by the public sector and the demand risk is mitigated by a band system); the construction risk was initially supported by the concessionaire under the first contract	Construction, Operation and maintenance (political, legal risks are entirely assumed by the public sector and the demand risk is mitigated by a band system)

South is a clear example of an inadequate governance model that resulted in delays and high compensation to the concessionaire. These compensations were even higher due to the problem of optimism bias in the forecasts. Unfortunately, this is a well-known problem affecting most transportation and utilities concessions.

All around the world, urban rail systems have been developed using this procurement model, with different contractual structures. Some models intend to extract the benefits and synergies of an integrated development (light rail system of Tagus South), while others adopt a vertical separation in order to develop more specific, tailor made, solutions for each contract (light rail system of Porto).

Acknowledging that there is no such thing as a one size fits all model, the innovative contract of the light rail system of Porto seems to present several advantages. The operating costs decreased considerably, increasing its expenses coverage ratio by 10% (from 59.6% to more than 70%). This was also possibly due the benefits of competition brought by shorter contracts for operation.

In greenfield ULRS projects, with significant demand risk, the hybrid model adopted in the light rail system of Porto can provide a good alternative to deal with demand risk. The associated problems with forecasts for 30 years are strongly mitigated since it is possible for the grantor to fine-tune the forecasts in each tender. As previously mentioned, this innovative model does not come without a cost. It comprises higher transaction costs given the complexity of the model, and the number of tenders that it requires, when compared with bundled 30-year contracts.

However, it is important to notice that for small ULRS projects, these transaction costs may not compensate the benefits of competition for shorter contracts. Furthermore, in cases where the demand risk is not so high, e.g., some brownfield projects, and where there are not relevant construction risks, the hybrid model may not provide any significant advantage. But when facing large investments with high demand uncertainty, this model has the potential to decrease operating costs, as the case study demonstrated.

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