WPS4665

POLICY RESEARCH WORKING PAPER 4665

Multidimensionality and Renegotiation:

Evidence from Transport-Sector Public-Private-Partnership Transactions in Latin America

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The World Bank
Finance, Economics and Urban Development Department
Economics Unit
July 2008

Policy Research Working Paper 4665

Abstract

Multidimensional auctions are a natural and practical solution when auctioneers pursue more than one objective in their public-private-partnership transactions. However, it is difficult to achieve auction efficiency with multiple award criteria. Using auction data from road and railway concessions in Latin America, the probability of renegotiation this paper estimates by a two-stage least squares technique with a binary selection in the first-stage regression. The findings show that auctioneers tend to adopt the multidimensional format when the need for social considerations, such as alleviation of unemployment, is high. This implies that such political considerations could hinder efficiency and transparency in auctions. The analysis also shows that the renegotiation risk in infrastructure concessions increases when multidimensional auctions are used. Rather, good governance, particularly anti-corruption policies, can mitigate the renegotiation problem.

This paper—a product of the Economics Unit, Finance, Economics and Urban Development Department—is part of a larger effort in the department to understand and examine efficiency and effectiveness in public infrastructure procurement. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The author may be contacted at aiimi@worldbank.org.

MULTIDIMENSIONALITY AND RENEGOTIATION: EVIDENCE FROM TRANSPORT-SECTOR PUBLIC-PRIVATE-PARTNERSHIP TRANSACTIONS IN LATIN AMERICA

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Key words: Multidimensional auctions; infrastructure development; private sector participation; corruption; governance.

JEL classification: D44; H44.

[¶] We are grateful to P. Legros, L. Lovei, S. Saussier, S. Tadelis and Jordan Schwartz for their insightful comments on an earlier version of this paper.

1. INTRODUCTION

Multidimensional auctions seem like a natural solution in practice, when auctioneers, governments in the context of this paper, pursue more than one objective in their auctions. In both theory and practice, however, whether multidimensional auctions improve the efficiency of the outcomes remains open to argument. Part of the problem stems from the fact that when multiple criteria are adopted to select a winning bidder, a difficult question to answer is how to aggregate those criteria in the bid evaluation process.

The issue is not only important but also quite current because auctions are becoming a common instrument to contract out public services to private operators under the public-private partnership (PPP) framework adopted by many developed and developing countries. Because PPP transactions are usually valuable, complicated and closely related to living standards of people, the authorities are induced to take advantage of the multidimensional format in designing PPP-related auctions. They generally want to enhance the service provision with a reasonable quality at the lowest costs. Here the objectives are already threefold. Simultaneously, governments may want to require more investment in advanced technology from operators. Often, in addition, governments also wish to protect employment of public enterprises being sold and limit staff reductions.

Some of these objectives are inherently incompatible with every other objective in the wish list of auctioneers. Any objective which increases costs, such as new investment requirements or minimum employment levels, can become a threat to the affordability of prices. This implies that the multiplicity of objectives can represent a risk from a social viewpoint. However, without appropriate investment, the quality of services cannot be improved which can also have a social cost. Similarly, if private operators are required to hire extra employees, the efficiency gains needed to cut costs and hence tariffs have only a limited scope, restricting the potential social payoffs of the PPPs.

As often happens, the challenges are in the implementation details for these auctions. Basic auction theory indicates several risks of implementing multidimensional auctions. This paper explores a set of possible necessary conditions to implement multidimensional auctions successfully. Using data on auctions for road and railway

concessions in Latin America, the impact of adopting multiple award criteria is estimated by a two-stage least squares technique with a binary probability selection in the first-stage regression. The results indicate that multidimensionality could increase the likelihood of ex post renegotiation, which is considered an indication of possible auction design flaws. It also shows why a stringent anti-corruption policy and sound regulatory framework are important to improve effectiveness of multidimensional auctions.

The paper is organized as follows. Section 2 offers a brief survey of the literature on multidimensional auction design. Section 3 summarizes the data available on auction design in transport PPP in Latin America. Section 4 looks at multidimensional auctions in practice. Section 5 presents the model we rely on for our analysis. Section 6 discusses the estimation results and their policy implications. Section 7 concludes.

2. A Quick Review of the Literature on Multidimensional Auction Design

Regardless of its potentially large implications for the real auctions, there has been little development in multidimensional auction theory; it is far from conclusive on how to design an efficient auction in the multidimensional context—more precisely how to weight more than one criterion involved. In theory, "quality" bids represent anything the auctioneer cares about—such as environmental and social consideration, technical reliability, and trustworthiness of contractors—other than bid prices.

There are only a few distinguished theoretical models in this area. In a pioneer study, Che (1993) shows that design competition is more important than price competition in auctions for highly heterogeneous goods or services, such as weapon systems for national defense. It finds that the first- and second-quality-score rules implement the optimal mechanism that maximizes the expected profits for the auctioneer, if bidders are required to submit both price and quality bids under the assumption that quality is costly for bidders and correlated with their private cost parameters. It also shows that the optimal scoring rule systematically induces a downward distortion of quality from the first-best level. To achieve the optimality, it is essential for the auctioneer to ex ante commit to the scoring rule.

A typical multidimensional auction format is the two-stage bid evaluation system, such as prequalification and the two-envelope procedure. These are widely used in public procurement. Under standard pre-qualification procedures for the selection of large-scale civil works contractors, the criteria relate primarily to general financial and technical competence of potential bidders before inviting bids. In addition, the more detailed technical evaluation of proposed specifications often takes place before the price competition. In theory, however, Cripps and Ireland (1994) show that separating the price competition from the quality qualification makes no difference; the results are the same regardless of whether quality or price is first examined, or even simultaneously. On the other hand, with firm preferences (e.g., costs) affiliated, the optimal mechanism would be a two-stage first- or second-score approach where in the first stage the auctioneer chooses the best bidder in terms of the score, and then negotiates with the selected firm to extract the optimal quality (Branco, 1997).

In practice, a clear shortcoming of multidimensional auctions is that the award process tends to be less transparent and more vulnerable to corruption. In multidimensional auctions, it is easy for the authorities to exploit their excessive discretion (Klein, 1998). Because of this, prospect firms are normally motivated to influence the auctioneer's decision on award criteria. As the result, there would likely be various interactions between politicians and lobbying firms before calling for bids.[1] An auction model indicates that if a corrupt agent has large manipulation power, bribery makes it costly for the truly efficient bidder to secure a win; the efficient firm will lose the contract with positive probability (Burguet and Che, 2004).

Empirically, Cabizza and De Fraja (1998) find that in a multidimensional auction with a few bidders, there is a systematic risk of awarding the object to an inefficient bidder. However, it is also found that this adverse selection can be mitigated when a number of bidders participate in the auction. Notably, a discretionary technical and experiential evaluation may jeopardize the transparent nature inherent to auctions. For

[1] In the railway industry, for instance, it is a common sense that if the evaluation rule has a preference to the diesel locomotive system, European railroad companies would have relative advantage. On the other hand, with more importance attached to the electric train system, Japanese railroad companies may have the advantage. As the result, both parties involved have a strong incentive to influence the government decision of the technical evaluation method.

example, too restrictive pre-requirements are always questionable from the corruption perspective (Ware *et al.*, 2007).

Nonetheless, it is worth noting that a well-designed multidimensional auction might be conducive to excluding prospect firms and consortia having insufficient technical and financial capacity to implement the agreed contract. The main reason for the public system requiring the prequalification process is that prequalification is expected to help to examine the reliability of prospective bidders on the basis of their experience, human and physical resources, and financial positions. In addition, through the prequalification process the public agencies can assess the potential interest from qualified firms and save the amount of work and time in evaluating bids from unqualified contractors (ADB, 2006).

Significantly, in PPP infrastructure transactions many contracts have been renegotiated within about two years after their awards (Guasch, 2004). About 30 percent of concessions granted in the Latin American and Caribbean region during 1985–2000 underwent renegotiation. Why does renegotiation so often take place, regardless of careful preparations for PPP transactions during several years?

There are a number of reasons for this phenomenon. First, auction theory suggests that if bidders are asymmetry—i.e., either weak or strong—a weaker (fringe) bidder tends to bid more aggressively in the presence of a strong (incumbent) bidder (Maskin and Rileys, 2000). Their proposition is supported by the evidence in the road construction auctions (De Silva *et al*., 2002, 2003). This bidder asymmetry may partly explain such frequent renegotiations. This is the case when private operators are turned out too optimistic about the demand forecast for undertaken services. In the context of road concessions, fringe contractors may tend to overestimate the future traffic; however, lower-than expected traffic would easily make them go into bankruptcy.

Second, given the expected hold-up problem of auctioneers, bidders may have a strong incentive to submit unrealistic low bids, which is referred to as “low balling” (Ware *et al*., 2007). This strategic behavior must of necessity result in an increase in renegotiation.

Finally, the other alleged reason is a failure in designing the multidimensional evaluation framework to select the most efficient firm. In the PPP infrastructure context,

a variety of criteria have been used to allocate infrastructure concessions, such as the minimum tariff, minimum duration of concession, minimum subsidy, highest payment to the government, and largest investment value criterion (e.g., Kerf, 1998). While 60 percent of concessions awarded based on the lowest tariff criterion were renegotiated, 11 percent of contracts granted on a highest-payment basis underwent renegotiation (Guasch, 2004).

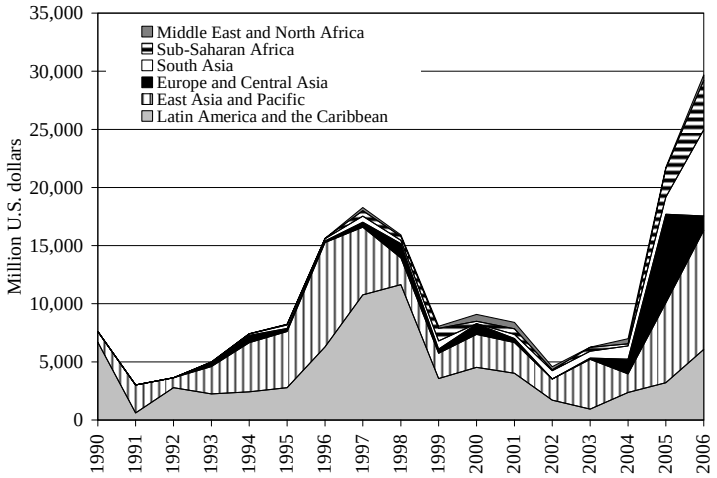
It remains inconclusive whether the impact of adopting more than one criterion on the incidence of renegotiation. In Guasch's (2004) regressions, the coefficient associated with multi-criteria auctions is almost always insignificant. The results may or may not be reasonable given the expected positive and negative impacts as mentioned above. The current paper readdresses this question by performing an endogenous selection model with data on concession auctions in the road and railway sectors. It cannot be overemphasized that the adoption of multidimensional award criteria is an endogenous variable, which is affected by not only project characteristics but also governance and social circumstances, such as prevalent poverty, inequality and unemployment. This point is not controlled for in Guasch (2004).

3. PPP IN TRANSPORT INFRASTRUCTURE AND AUCTION DESIGN

Since the 1990s the private sector has invested 180 billion U.S. dollars in transport infrastructure (airports, railroads, roads and seaports) of developing countries (Figure 1). The total number of private participation transactions recorded reaches about 1,000 by 2006. About 30 billion U.S. dollars flowed in these sectors for 2006 alone. By region, Latin America is the leading region, having 40 percent of total transactions. By (sub)sector, the majority are road projects, followed by the railroad sector. In terms of the amount of investment, the road and railroad sectors amount to 47 percent and 20 percent of private participation experiences in developing countries, respectively.[2]

[2] In terms of the number of transactions, the road-sector is still dominant, having 48 percent. However, the second largest area is seaports (30 percent). The railroad-sector private involvement accounts for 10 percent.

Figure 1. Private Sector Participation in Transport Sector



In road-sector private participation, concession contracts and greenfield projects are two typical types of private sector participation (Table 1). Most road transactions aim to contract out highway construction, operation and maintenance for 20–30 years. For railroads, the private sector's experience has concentrated on concessions in Latin America (Table 2). There are a certain amount of divestiture experiences, such as partial freight privatization in Chile and Jamaica, partial passenger railway privatization in China, and full passenger privatization in Estonia. But these are relatively minor cases. Many Central and Eastern Europe countries have adopted some short-term private sector management, but the contracts last less than one year and are not clearly separated from government fiscal operations (Toet, 2007).

Table 1. Private Sector Participation in Road Sector

Region	Management/ lease contract	Greenfield project	Concession	Divestiture	Total
East Asia & Pacific	0	84	82	18	184
Europe & Central Asia	0	2	7	0	9
Latin America & the Caribbean	6	53	120	0	179
Middle East & North Africa	0	1	0	0	1
South Asia	2	32	59	0	93
Sub-Saharan Africa	4	3	3	0	10
Grand Total	12	175	271	18	476

Table 2. Private Sector Participation in Railroad Sector

Region	Management and lease contract	Greenfield project	Concession	Divestiture	Total
East Asia and Pacific	1	12	0	3	16
Europe and Central Asia	2	0	0	4	6
Latin America and the Caribbea	0	2	48	3	53
Middle East and North Africa	0	0	1	0	1
South Asia	0	2	1	0	3
Sub-Saharan Africa	4	3	12	0	19
Grand Total	7	19	62	10	98

Our sample does not cover all these transactions but originally includes 131 road-sector projects and 37 railroad contracts for 11 countries in the Latin America and the Caribbean region: Argentina, Bolivia, Brazil, Chile, Colombia, Guatemala, Mexico, Panama, Peru, Uruguay and Venezuela. Some of them are not used for our analytical work because of missing data. In our sample some road contracts cover over 1,000 km of roads for operation. There is a tendency that countries having more experiences of private sector involvement in this area, such as Argentina and Brazil, would likely deal with larger-scale of transactions (Figure 2). It can be interpreted to mean that countries need to be experienced in contractual affairs.

Railroad contracts are generally enormous. The average contract size for passenger services is about 500 km. On the other hand, freight service concessions involve 3,000 km on average (Table 3). The largest contract is the Ferrocarril Pacifico-Norte Project in Mexico undertaken by Grupo Ferroviario Mexicano (Ferromex), which covers 8,000 km of railway network. But rail-sector contracts are commonly large in other countries, e.g., Argentina, Brazil and Colombia.

Figure 2. Length of Roads under Private Sector Operations

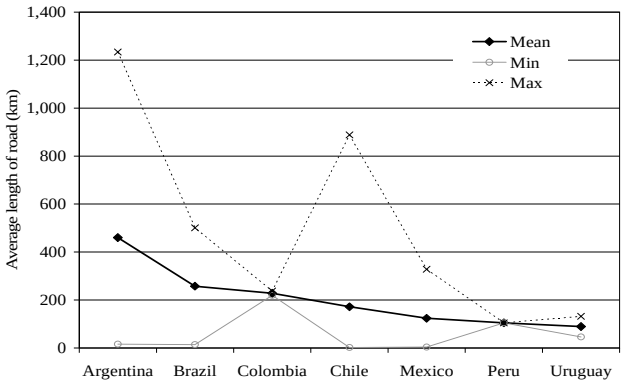


Table 3. Length of Railroads under Private Sector Operations

	Obs	Mean	Std. Dev.	Min	Max
Freight	22	2,910	2,327	184	8,029
Passenger (intercity, local)	9	484	773	35	2,270

Partially due to this scale effect, the transport sector seems to face with some serious problems of effectiveness of PPP contracts. Guasch (2004) shows that renegotiation was especially common in transportation concessions (Table 4). Our sample is broadly consistent with his results; the renegotiation rate is 57 percent of total road concessions. Renegotiation is less likely to occur in railroads; the probability is estimated at 32 percent.

Table 4. Incidence of Renegotiation

	Incidence (% of total contracts)	
	Guasch (2004)	Our sample
Total	41.5	
Electricity	9.7	
Transport	54.7	
Roads		57.3
Railroads		32.3
Water & sanitation	74.4	

Sources: Guasch (2004); and authors' calculation.

One possible reason for frequent renegotiation in the transport sector is a lack of competitive nature. The degree of competition for transport is normally relatively limited compared with energy and telecommunications. The other reason is that the transport sector might involve greater uncertainty beyond the reasonable assumptions accounted for in the contract. For instance, the demand forecasts for road traffic may be systematically more difficult those for electricity. It could also be attributed to the possibility that transport transactions might be more vulnerable to corruption and collusion, which would materialize as a renegotiation incidence.

However, the most fundamental issue is that it should take long time for private operators to be motivated to invest in infrastructure (i.e., network) and recover their investments with sufficient revenues. During the long contract periods many exogenous and endogenous factors would change. Interestingly, however, the rail franchising experience in U.K.—which is a pioneer in this area—shows that aggregate revenue

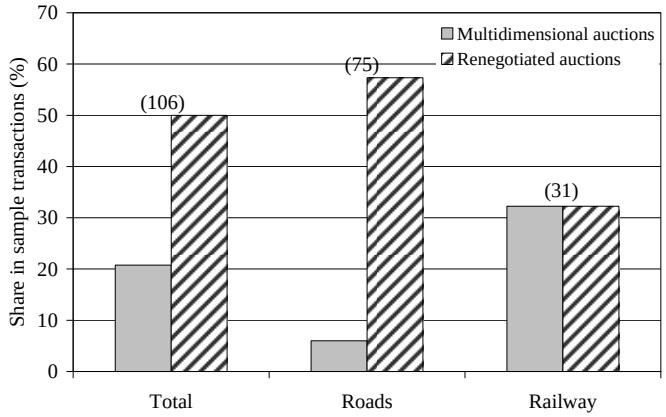
growth for all three major segments exceeded the revenue projections set at the bidding stage (Kain, 2007). Thus, the reason for renegotiation is not always that bidders were too optimistic about the future demand. But Kain also mentions that the operating cost increase was also greater than expected. Nash and Smith (2007) also show that wage increases in the passenger rail sector after the private sector involvement were in sharp contrast to the bus industry where wages sharply fell.

In our sample, the reason for relegation in Colombian road concessions was mainly the deficits of concessionaires, which caused by higher-than expected costs and lower-than-expected traffic. Many road contracts in Mexico for the 1990s were affected by the currency crisis. In some cases, more-than-expected investment requirements triggered off renegotiation. In Brazilian road concessions, redefined investment plans were the main reason for renegotiation. Investment requirements are in general one of the most powerful determinants of renegotiation; the renegotiation rate is 70 percent where any investment commitments are stipulated in the contracts (Guasch, 2004). Unexpected tariff changes also ruined financial viability of private operators. Argentina typically had the same tariff problem. In the railway sector, lower-than-expected demand and suppressed tariffs are two common reasons.

Given these problems anticipated, governments are naturally motivated to introduce some auction mechanisms to rein renegotiation in the future. An example is multidimensional auctions. In our sample, about 20 percent of concession auctions in the road and railway sectors applied more than one criterion to award the contracts (Figure 3).[3] The road-sector concessions are less likely to use the multidimensional format than the railway sector. This is intuitively reasonable, because road concessions are *relatively* simple and there are a larger number of prospect firms who are qualified for the provision of road operation and maintenance services. Therefore, through intensified competition at the auction stage the authorities can expect high efficiency in service delegation even under a simple award mechanism. About 95 percent of road concessions adopted a single criterion method, mostly the lowest tariff rule in our sample. It is followed by the minimum duration and highest canon criteria.

[3] Our sample includes 106 transactions in eight countries: Argentina, Bolivia, Brazil, Chile, Colombia, Mexico, Peru and Uruguay.

Figure 3. Multidimensional Auctions and Renegotiation in Road and Railway Concession Transactions



Note: The numbers of observations are shown in parentheses.

By contrast, more than 30 percent of railroad concessions adopted the multiple criteria award rule. Presumably, the design for railway concessions may be more complicated, because the possibility of horizontal unbundling is much limited in railroads. Even if some routes—typically in rural areas—are non-profitable for private operators, the railway system needs to be kept bundled to take advantage of network economies on a much broad basis. For the same reason, despite private participation a number of projects continue dependent on government compensation of losses. Even after 10 years of experience in U.K.—including several setbacks such as a security problem raised by the 2000 Hatfield accident and several bankruptcies and renegotiations—most passenger train operators still need subsidies (Nash and Smith, 2007).

Any auction mechanism has both advantages and disadvantages. Multiple award criteria will generate wasteful rent seeking and lobbying for arbitrary selection of winners. On the other hand, a single criteria rule makes little sense when several policy objectives need to be taken into account. However, notably, auction competition tends to be limited in the infrastructure sector. It is obvious that transparency is essential in auctions and too many requirements i.e., criteria, might reduce transparency and discourage potential bidders from participating in the bidding process, diminishing competition. Particularly in the rail industry, competition has been very limited even under fairly open circumstances for entrants (Alexandersson and Hultén, 2007). In our sample, the average number of bidders participating in competition for railway contracts

is only 2.2 (Figure 4). For road concessions, we can expect more participants; it ranges mostly from 2 to 7 bidders per auction with an average of 3.4 (Figure 5).[4]

Figure 4. Degree of Auction Competition for Rail Projects

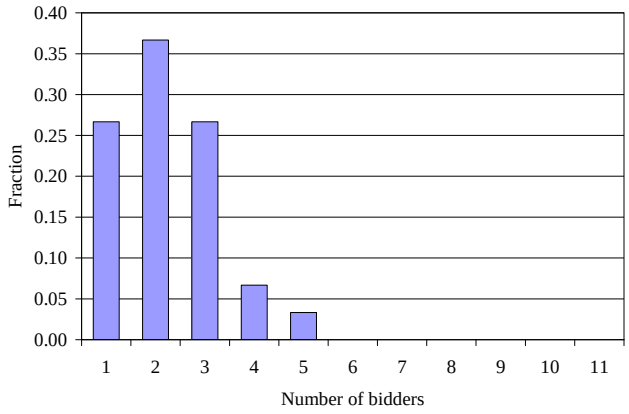
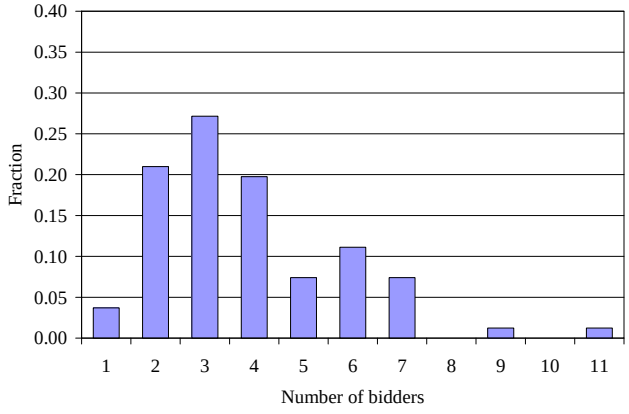


Figure 5. Degree of Auction Competition for Road Transactions



4. MULTIDIMENSIONAL AUCTION PRACTICES IN INFRASTRUCTURE

Infrastructure development usually has multiple objectives; the authorities are keen to increase the quantity of services and improve the quality as well. From the social point of view, at the same time, they might desire to ensure affordability for services, especially in developing countries. The governments may also have an intention to

[4] It is noteworthy that this competition effect is not involved in the following analysis, because it is considered—in theory—irrelevant to our analytical framework where the multidimensional auction decision and the likelihood of renegotiation are examined. The auction design, including multidimensionality, is given at the bidding stage, and renegotiation is not *directly* affected by how many firms participated in the prior bidding process. In our sample, the simple correlation coefficients between renegotiation incidence and the number of bidders are low at 0.22 for rail and 0.05 for roads concessions.

reduce their budgetary expenses through spinning off their public infrastructure operations. On top of that, in many developing countries the public sector is among the largest employers in the economy. If this is the case, the authorities, mainly politicians, are likely to be sensitive to a possible reduction in employment after the contracts.

A stylized fact about general private participation in infrastructure may be that the network size (such as connections) tends to be enhanced and the unit operating cost would likely decline. Private management also increases labor productivity (such as delivered services per employee). This improvement typically stems from retrenchment in excess employees. The quality of services would also improve. Tariffs may or may not increase.[5] Gassner *et al*. (2007) also shows that the improved performance of electricity (and water) utilities involving private sector participation is largely associated with an increase in labor productivity. In railways, the Estonian divestiture experience where a national railway company was vertically unbundled and privatized indicates that labor strength has reduced by 37 percent and labor productivity increased dramatically. It became four times as high as that of the EU countries (World Bank, 2006).

As far as transport concessions are concerned, this employment effect may be a crucial issue to implement PPP transactions successfully. State-owned railway companies usually absorb a large number of employees. Under these conditions, the number of firms participating in the bidding process is expected to be small. Then, the governments would become even more cautious about other project aspects than prices. In our sample, about 32 percent of railway sector concessions relied on multidimensional auctions, possibly to accomplish more than one policy objectives simultaneously.

As per Estache *et al*. (2002), in the Argentine railway freight concessions during the 1990s, the winning bid was selected based on the weighted score of future investment, staff accession and service quality. It is pointed out that the inclusion of the staff transfer criterion was clearly a political compromise. In the U.K. experience, Nash and Smith (2007) indicate a similar concern; wage increases in the passenger rail sector after the private sector involvement were in sharp contrast to the bus industry where wages sharply fell.

[5] For instance, the benchmarking data for the electricity distribution sector in LAC 1995-2005, http://info.worldbank.org/etools/lacelectricity/home.htm

A key question to be asked is this: Why do the authorities decide to use the multidimensional format? Given that decision, what is the quantitative impact of introducing multiple evaluation criteria on the incidence of renegotiation?

An important factor which should be accounted for to answer those questions is governance. This is because one of the clear shortcomings of multidimensional auctions is that including various types of bids to be evaluated would endanger transparency and public credibility—especially when adopted criteria are contradictory to each other and the auctioneer cannot pre-commit to the prior agreed evaluation rule. Whether the multi-criteria method can choose the most efficient firm is dependent on some elements of public governance, such as government effectiveness (i.e., the quality of public services and the competence of civil servants), regulatory soundness and anti-corruption policies. Without good governance, multidimensional auctions are highly likely to fail.

Particular attention is also paid to employment. If unemployment is high and the public enterprise to be sold is the employment center in the economy, it is highly likely that politicians would require the evaluation system to include an employment criterion, which is based on the number of retained workers after the transaction is concluded. Whether or not to have the ability to protect auction efficiency and transparency from political interferences is again dependent on public governance.

The Swedish spectrum right case—though it did not take the competitive bidding format—clearly shows the difficulty and lack of transparency in evaluating multiple *bids*. The reason for the authorities' decision not to use the auction format was that they wanted to pursue multiple objectives, such as more investment, broader coverage, faster transmission speeds and further technological development (Andersson *et al*., 2005). As demonstrated in Table 5, however, the awarding decision is very sensitive to the weight attached to individual factors. Suppose that bidders were ranked by each of these major criteria and the rankings are equally weighted. Then, Europolitan, HI3G Access, Mobility4Sweeden and Orange Sweden would have been awarded. If Mobility4Sweeden—which was in reality disqualified due to its financial irresponsiveness—is excluded, Tele2 would be additionally selected. This result is the same as the government selection. Nonetheless, suppose that only the three criteria used for the second stage evaluation are adopted. Then, the award result would change, again.

With reason the government decision was actually contested in court, by Reach Out Mobile, Telia, and Telenordia.

Table 5. Multiple Criteria in Swedish Beauty Contest for 3G Licenses

Bidder name	Swedish government evaluation							Author's hypothetical scenario 1/			
	1st stage			2nd stage				(1)		(2)	
	Criteria		Decision	Criteria			Decision	Equal weights over five criteria		Equal weights over last three criteria	
	Number of stations	Invest-ment (SEK bil.)		Area coverage (km2)	Population coverage (%)	Roll-out speed		Ranking	Decision	Ranking	Decision
Broadwave communications AB	4,700	14.7		32,750	81	09/2002		6.8		6.3	
Europolitan AB	20,000	27.5	Qualified	165,259	100	01/2001	Awarded	2.8	x	3.3	
HI3G Access AB	20,814	36.9	Qualified	224,724	100	01/2002	Awarded	2.8	x	4.0	
Mobility4Sweden AB	8,760	15.3		395,520	100	01/2002		3.2	x	2.3	x
Orange Sweden AB	8,635	19.7	Qualified	364,528	100	08/2001	Awarded	2.8	x	2.0	x
Reach Out Mobile AB	5,238	15.8		259,944	100	04/2001		4.6		2.7	x
Tele 2 AB	10,186	17.7	Qualified	112,666	100	10/2001	Awarded	4.2		4.7	
Telenordia Mobil AB	7,200	14.0	Qualified	181,346	98	01/2002		5.8		4.7	
Telia AB	4,100	6.8		308,661	100	01/2002		5.8		3.0	x
Tenora networks AB	7,550	11.2		290,038	100	01/2002		5.0		3.3	

Source: Andersson et al. (2005); and author's calculation.
1/ The hypothetical scenarios do ignore bidders' financial miscalculations and technical infeasibility, which were accounted for in the actual evaluation by the Swedish Government.

Guasch (2004) also describes a similar story in the context of Guatemalan mobile telecommunications auctions. The award decision was based on the new technology development, area coverage and payment to the government. In the first evaluation, the winning firm was not an entity incorporated. The authorities seem to have changed the evaluation method, given the winning firm's financial and operational uncertainty of the firm. But the second highest bidder was not selected in the second round evaluation (Table 6); the reason remains unclear. The top two losers filed lawsuits.

Table 6. Multiple Criteria Evaluation for Second Mobile Operator in Guatemala

Bidder name	First round evaluation	Second round evaluation	Decision
Mastec	88.75	Disqualified	
Londrina	84.90	84.49	
Guacel	69.01	85.46	x
Companias Electricas	51.42	56.10	
Unicom	Disqualified	33.37	
Semelec	Disqualified	33.20	
BSC	Disqualified	Disqualified	

Source: Guasch (2004).

Another example is provided by Torta (2005), which investigates an Italian new highway (Brescia-Milan) contract. It is found that the implied construction cost to obtain a single point of construction period might be overestimated. In this case, there were only two bidders. Two criteria were dropped from the originally announced list. This is

already a violation against the theoretical proposition that pre-commitment to the scoring rule is important to implement the optimal mechanism. Five criteria were used for evaluation: tariff level, concession period, construction period, return, and revenue transfer quota to the government (Table 7). A one-month advance of the delivery of the infrastructure seems too costly compared with the total expected construction period of four years.

Table 7. Weights on Multiple Criteria in Brescia–Milan Toll Road Auction

	Weights		Implied cost of one point (euro mil.)
	Original	Revised	
Operation procedure	20		
Technical evaluation	12		
Tariff level	18	26	10–15
Concession period (year)	16	24	30–40
Construction period (month)	15	22	2–3
Economic return	10	15	…
Revenue transfer quota	9	13	…
	100	100	

Source: Torta (2005).

These episodes are sufficient to realize the fragility of multidimensional auctions against ambiguity of evaluation weights and political interventions. Transparency in setting and assessing requirements is essential. It is not recommendable that too many dimensions are used as evaluation criteria. They will create more room for rent-seeking activities, whence corruption and collusion. If necessary, auction theory may support the two-stage approach with a few criteria. However, note that how to evaluate those criteria should be predetermined before inviting bids (Che, 1993). Ex post adjustments would be especially inappropriate. Therefore, good governance and sound government policies are required to implement multidimensional auctions successfully.

5. EMPIRICAL MODEL AND DATA

To estimate the impact of multidimensional auctions on renegotiation, the following two-stage least squares technique is employed (e.g., Wooldridge, 2002). The basic reason is that the decision of whether or not to use a multiple criteria rule is endogenous in the sense that the multidimensional format might be selected in particular auctions with certain unobserved characteristics, which would in turn affect the

possibility of renegotiation. Our two-stage technique follows the treatment effect model with a binary probability selection in the first-stage regression:

$$E[D_{RENEG}|D_{MULTI}] = X'\beta + \gamma D_{MULTI} + E[\varepsilon_1|D_{MULTI}] \quad (1)$$

and

$$D_{MULTI} = \begin{cases} 1 \text{ if } D^*_{MULTI} = Z'\delta + \varepsilon_2 \geq 0 \\ 0 \text{ otherwise} \end{cases} \quad (2)$$

where D_{RENEG} is a dummy variable for the incidence of renegotiation. D_{MULTI} is a binary variable for the adoption of the multidimensional format, which is potentially an endogenous variable in Equation (1). It is the government policy decision based on project characteristics, social circumstances and the degree of governance, all of which are included in *Z*. The likelihood of renegotiation is assumed dependent on the award criteria decision and other control variables in *X*.

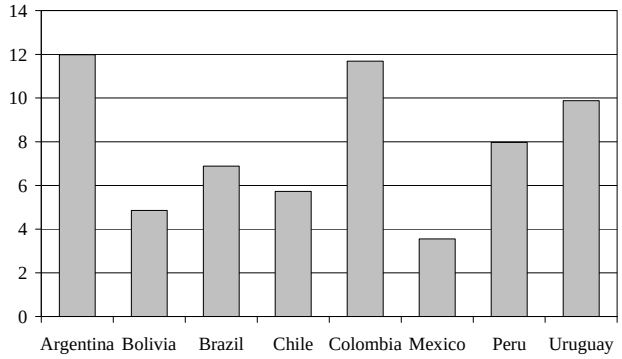
The ordinary regression (e.g., probit) of Equation (1) of primary interest would generate an unbiased estimate of the multidimensional auction effect, γ, if there was no correlation between the decision, D_{MULTI}, and the disturbances ε_1. This conceptually requires that a complete set of factors determining the likelihood of renegotiation could be included in determinants *X*. However, this is not likely in our data, because many institutional factors are not perfectly observable by econometrician, such as governance and tacit collusion. The typical concession contracts which were awarded through the multiple criteria method might be more (or less) likely to be renegotiated regardless of the selected auction design.[6] Therefore, the first-stage regression in Equation (2) aims at identifying possible determinants of auction formats. Given the predicted probability of multidimensionality $\hat{D}_{MULTI}$, Equation (1) of interest can be estimated as the second regression. This is expected to provide an unbiased estimate of γ.

The determinants of multidimensionality choice include the rate of unemployment, governance indices and project characteristics. The unemployment rate is

[6] As will be seen, in fact, the ordinary probit with the endogeneity of the auction format ignored generated a stronger effect on renegotiation incidence. This can be interpreted to mean that endogeneity matters.

supposed to capture the need of some—though certainly not all—social considerations from the political point of view.[7] High unemployment is likely to induce the authorities to adopt multiple criteria to take various social aspects into account. Our sample includes eight countries in Latin America: Argentina, Bolivia, Brazil, Chile, Colombia, Mexico, Peru and Uruguay. Note that Figure 6 reflects the average unemployment rates from 1990 to 2000. However, in our following regression analysis the unemployment variable is time-variant. Because there are annual unemployment data available, it has a variation among transactions in each country.[8] Bolivia, Brazil, Chile and Mexico had relatively low unemployment rates; thus, these countries are supposed to have less incentive to employ the multidimensional auction format, holding other conditions constant.

Figure 6. Average Unemployment Rates in the 1990s



Source: *World Development Indicators.*

Three governance indices are borrowed from the Worldwide Governance Indicators (WGI): government effectiveness, regulatory quality, and control of corruption. These measures are deemed particularly relevant to the infrastructure concession contracts. First, to select a set of award criteria and evaluate them effectively,

[7] One might think that it is too much simplified to make the unemployment rate represent all socio-economic issues behind the government' multidimensionality choice. Alternatively, the Gini coefficient may represent the degree of inequality in the economy, and the poverty headcount ratio may indicate the extent to which the governments should account for social impacts for the poor in proceeding with the PPP infrastructure transactions. However, these variables are not available for every year; thus they can only capture their country-level effect that is identical over time.

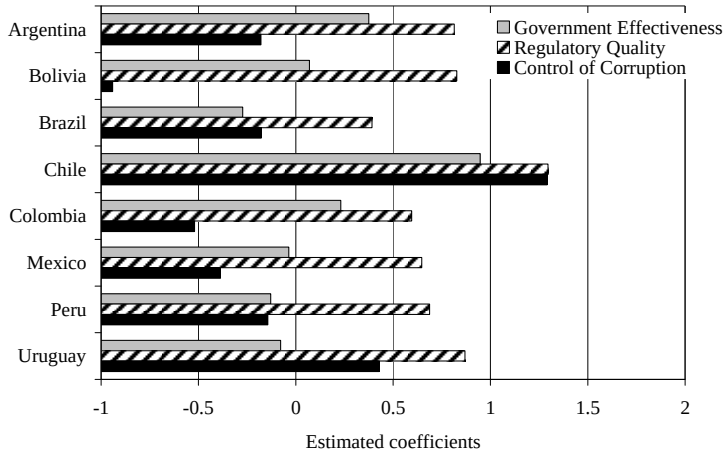
[8] From the econometric point of view, the advantage of using this time-variant variable is that we can identify the unemployment impact separately from other country-specific characteristics, such as governance indices, or even country-specific unobservables. A disadvantage may be the government decision on whether or not to use the multidimensional rule might not be so sensitive to annual changes in unemployment rates. However, suppose that a government desires to contract out a rail freight operation when the unemployment rate is 12 percent. The government would be more concerned about the employment reduction plans of prospect private operators than the case where it could auction the transaction under the unemployment of 1-2 percent, holding other conditions constant.

the quality of public services and the competence of civil servants—both of which are measured by the government effectiveness index—need to be high. Second, the infrastructure sector is highly regulated, and thus a sound regulatory framework is essential. Finally, anti-corruption policies may play an important role to prevent potential political interference when the multidimensional format is adopted.

Unlike the unemployment variable, the governance indices are time-invariant country-specific variables, because it is reasonable to consider that it takes long time to improve governance. In fact, there is little variation in the governance variables over time. Since our sample covers transactions concluded from 1989 to 1999, the WGI in 1996 are used.

Among our sample countries, Chile is the best performer in terms of governance (Figure 7). Brazil, Colombia and Mexico may suffer from a severe corruption problem. But the government effectiveness of Colombia is not necessarily unacceptable at least by regional standards. The quality of regulation in Mexico is relatively high in our sample. In general, nonetheless, all the sample countries, except Chile, have a relatively weak governance structure by global standards. In that sense, they may risk failing the PPP concessions with multiple award criteria, because of lack of governance.

Figure 7. Governance Indices in 1996



Source: *World Governance Indicators* .

Three variables control for heterogeneity among transactions: length of roads (km), total length of tracks (km), and duration of concession (year). These are contract-specific. Obviously, given a transaction, either road length or track length must be zero; there is no transactions covering both sectors.

In the second stage regression (Equation (1)), these three contract-specific project characteristics are included in X. The governance indices are also included, because governance affects not only the award criteria selection but also the possibility that either party involved would call for renegotiation. D_{MULTI} is replaced with the predicted probability given by Equation (2).

Table 8 summarizes the dependent and independent variables in our sample. It contains 106 concession transactions in the road and railway industries. The contract size differs considerably. The average size of road concessions is about 190 km with the maximum of over 1,200 km. Some railway concessions involve 8,000 km of tracks in total. The duration of concession varies from 8 to 40 years. Table 9 shows simple correlation between variables in our model.

Table 8. Summary Statistics

	No.	Mean	Std.Dev.	Min	Max
D_{RENEG}	106	0.50	0.50	0	1
D_{MULTI}	106	0.21	0.41	0	1
Road length (km)	106	189.97	259.80	0.00	1234.00
Track length (km)	106	645.07	1581.95	0.00	8029.00
Contract duration (year)	106	22.02	6.88	8.00	40.00
Unemployment (percent)	106	7.62	3.51	2.10	20.00
Govt effectiveness	106	0.17	0.42	-0.27	0.95
Regulatory quality	106	0.73	0.30	0.39	1.30
Control of corruption	106	0.01	0.58	-0.94	1.29
Memorandum items:					
Country dummy					
Argentina	106	0.28	0.45	0	1
Bolivia	106	0.02	0.14	0	1
Brazil	106	0.30	0.46	0	1
Chile	106	0.16	0.37	0	1
Colombia	106	0.03	0.17	0	1
Mexico	106	0.16	0.37	0	1
Peru	106	0.03	0.17	0	1
Uruguay	106	0.02	0.14	0	1
Sector dummy					
Roads	106	0.71	0.46	0	1
Railway	106	0.29	0.46	0	1

Table 9. Simple Correlation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(1) D_{RENEG}	1															
(2) D_{MULTI}	-0.08	1														
(3) Road length (km)	0.44	-0.27	1													
(4) Track length (km)	0.00	-0.04	-0.14	1												
(5) Contract duration (year)	-0.19	-0.26	-0.22	0.38	1											
(6) Unemployment (percent)	0.10	0.00	0.02	-0.02	-0.03	1										
(7) Govt effectiveness	-0.03	0.27	0.10	-0.11	-0.14	0.13	1									
(8) Regulatory quality	-0.12	0.21	0.06	-0.10	-0.10	-0.09	0.94	1								
(9) Control of corruption	-0.15	0.05	0.10	-0.09	-0.07	-0.07	0.76	0.81	1							
(10) Argentina	0.48	-0.07	0.37	0.10	-0.15	0.39	0.27	0.18	-0.06	1						
(11) Bolivia	-0.09	-0.11	-0.07	0.06	0.23	-0.13	-0.03	0.06	-0.21	-0.07	1					
(12) Brazil	0.07	-0.39	0.12	0.11	0.15	0.09	-0.56	-0.60	-0.07	-0.23	-0.07	1				
(13) Chile	-0.23	0.14	0.01	-0.11	-0.04	-0.13	0.82	0.86	0.96	-0.18	-0.06	-0.19	1			
(14) Colombia	-0.02	0.34	-0.16	-0.09	-0.05	0.46	0.08	-0.18	-0.29	-0.19	-0.06	-0.20	-0.16	1		
(15) Mexico	-0.23	0.10	-0.27	-0.05	-0.04	-0.64	-0.34	-0.16	-0.33	-0.31	-0.09	-0.33	-0.26	-0.27	1	
(16) Peru	-0.02	-0.04	-0.05	0.04	0.15	0.03	-0.11	-0.01	-0.01	-0.07	-0.02	-0.07	-0.06	-0.06	-0.09	1
(17) Uruguay	-0.07	-0.08	-0.01	-0.03	-0.08	0.06	-0.06	0.06	0.09	-0.05	-0.01	-0.05	-0.04	-0.04	-0.07	-0.01

6. ESTIMATION RESULTS AND POLICY IMPLICATIONS

Four models are performed by the two-stage least-squares method; the first stage probit results are shown in Table 10. This essentially reveals why the governments decided to use the multidimensional auction format in their PPP transactions. As expected, higher unemployment is strongly associated with the decision to adopt multiple award criteria. It means that auctioneers are using the multidimensional format to respond to the need for social considerations. This evidence can be interpreted as a risk of jeopardizing auction efficiency due to political compromise.

On the other hand, there is no evidence that multidimensional auctions would be preferred under more corrupt circumstances. Such a worst-case scenario is not true in our estimation results. Rather, the governments are more likely to take advantage of multiple criteria when the government effectiveness and the quality of regulation are high. This may reflect the fact that without effective and sound government systems it would be impossible to manage multidimensional auctions for contracting out PPP infrastructure transactions.

Table 10. First Stage Probit of Multidimensional Auction Selection Equation

	(1)	(2)	(3)	(4)
Road length	-0.0016	-0.0016	-0.0019	-0.0016
	(0.0011)	(0.0012)	(0.0012)	(0.0011)
Track length	0.0005 **	0.0004 **	0.0004 **	0.0005 **
	(0.0002)	(0.0002)	(0.0001)	(0.0002)
Contract duration	-0.0793 **	-0.0773 **	-0.0699 **	-0.0806 **
	(0.0311)	(0.0318)	(0.0303)	(0.0342)
Unemployment	0.1031 **	0.1027 **	0.0573	0.1095 **
	(0.0483)	(0.0456)	(0.0394)	(0.0498)
Govt effectiveness	0.3333	0.8342	2.8768 **	
	(1.7082)	(1.9680)	(1.3649)	
Regulatory quality	6.4568 **	3.5310		7.1031 **
	(2.2444)	(2.4543)		(3.0013)
Control of corruption	-0.8357		0.0825	-0.8831
	(0.6091)		(0.5711)	(0.7715)
Constant	-5.6175 ***	-3.3651 *	-0.7376	-6.0955 **
	(1.9660)	(1.9913)	(0.7891)	(2.6609)
Obs.	106	106	106	106
Wald test statistics	29.17	33.39	25.69	22.99
Pseudo R-squared	0.4972	0.4893	0.4764	0.4969

Note: The dependent variable is the binary variable for the multidimensional auction selection. The robust standard errors are shown in parentheses. *, ** and *** indicate the 10%, 5% and 1% significance levels, respectively.

In terms of project characteristics, the total length of tracks is among the significant determinant of the award design decision (in the railway sector). The

governments prefer to adopt the multidimensional set-up as the size of transaction increases. It is reasonable that many other factors than prices—e.g., employment and investment in rural areas—would likely matter in the case of large-scale railway concessions.

With endogeneity controlled for as mentioned above, we find that the selection of multidimensional auctions increases the possibility of renegotiation. Table 11 presents the second stage regression results. It indicates why renegotiation happened or under what circumstances renegotiation tends to take place. The coefficient of the predicted probability of choosing multidimensional auctions is positive and significant. It means that the authorities are motivated to adopt the multidimensional format for certain reasons (as discussed above), but they are likely to fail in benefiting from the potential effects of multidimensional auctions, whence resulting in more renegotiation events. This is consistent with a number of episodes highlighting the real difficulty in managing multidimensionality.

The table also shows that several elements of governance are important to reduce the likelihood of renegotiation. Anti-corruption policies are found particularly powerful. The corruption control index has a significant negative coefficient. A sound regulatory environment may also be useful to mitigate the renegotiation risk. Meanwhile, the probability of renegotiation increases with the size of project in the road sector. Large-scale road concessions are more likely to undergo contractual adjustments in due course.

Table 11. 2SLS Estimation of Renegotiation Equation

	(1)	(2)	(3)	(4)
Road length	0.00050 **	0.00014	0.00067 ***	0.00057 ***
	(0.00021)	(0.00022)	(0.00023)	(0.00018)
Track length	-0.00004	0.00003	-0.00006 *	-0.00004
	(0.00003)	(0.00004)	(0.00003)	(0.00003)
Contract duration	-0.0179 **	-0.0305 ***	-0.0144 *	-0.0174 **
	(0.0079)	(0.0079)	(0.0085)	(0.0082)
Govt effectiveness	0.3303	0.8342 *	-0.1315	
	(0.4485)	(0.4395)	(0.2517)	
Regulatory quality	-0.4738	-1.1963 **		-0.0748
	(0.5839)	(0.5483)		(0.3056)
Control of corruption	-0.5222 ***		-0.5915 ***	-0.5312 ***
	(0.1085)		(0.1078)	(0.1147)
$\overline{D_{MULTI}}$	0.6008 *	-0.3500	0.9569 **	0.6825 **
	(0.3119)	(0.3601)	(0.3711)	(0.2871)
Constant	0.9938 **	1.9252 ***	0.5573 **	0.7228 ***
	(0.4205)	(0.3702)	(0.2401)	(0.2507)
Obs.	106	106	106	106
F statistics	33.80	15.37	37.01	37.52
R-squared	0.3833	0.4412	0.4040	0.4089

Note: The dependent variable is the dummy variable for the incidence of renegotiation. The robust standard errors are shown in parentheses. *, ** and *** indicate the 10%, 5% and 1% significance levels, respectively.

Regardless of potential endogeneity associated with the criteria selection, the simple probit model is performed; the results are shown in Table 12. The main results are broadly unchanged, but the coefficient of the dummy variable for multidimensional auctions is considerably greater that the baseline estimates in Table 11. Because of endogeneity, the simple probit coefficient is considered upward biased. Nonetheless, the basic implication still holds that applying the multidimensional mode would increase a risk of renegotiation and anti-corruption measures could mitigate such a risk.

Table 12. Simple Probit Estimation of Renegotiation Equation

	(1)	(2)	(3)	(4)
Road length	0.0025 ***	0.0018 **	0.0024 ***	0.0024 ***
	(0.0009)	(0.0008)	(0.0009)	(0.0009)
Track length	-0.0009 ***	-0.0002 *	-0.0010 ***	-0.0010 ***
	(0.0003)	(0.0001)	(0.0003)	(0.0004)
Contract duration	-0.0548 *	-0.0201	-0.0507 *	-0.0491 *
	(0.0293)	(0.0199)	(0.0267)	(0.0261)
Govt effectiveness	-1.1320	-0.3597	-0.4268	
	(2.0238)	(1.1329)	(0.6141)	
Regulatory quality	1.0815	-1.6088		-0.4186
	(2.8335)	(1.5981)		(0.8489)
Control of corruption	-4.6711 ***		-4.7495 ***	-4.7673 ***
	(1.1297)		(1.2218)	(1.2704)
D_{MULTI}	6.0272 ***	1.0555 ***	6.2162 ***	6.1290 ***
	(1.6694)	(0.3928)	(1.7825)	(1.9440)
Constant	-0.6219	1.4124	-0.0678	0.1531
	(1.6651)	(1.1071)	(0.7049)	(0.8784)
Obs.	124	124	124	124
Wald test statistics	33.94	27.19	29.96	28.66
Pseudo R-squared	0.4220	0.1706	0.4208	0.4194

Note: The dependent variable is the dummy variable for the incidence of renegotiation. The robust standard errors are shown in parentheses. *, ** and *** indicate the 10%, 5% and 1% significance levels, respectively.

One remaining empirical concern may be that the unemployment proxy could not capture the socio-economic and political conditions related to the auction design decision in infrastructure concession contracts. One might think that heterogeneity among countries would be underestimated in our model and that unobservable country-specific characteristics could overwhelm the effect of unemployment. Table 13 shows the estimated first stage selection model with different socio-economic proxies, which are country-specific in our data. The unemployment rate is only the statistically significant determinant; the Gini coefficient and poverty headcount ratio (US$1 per day) have been found insignificant.

Moreover, the unemployment rate still remains significant and positive, even when country heterogeneity is controlled for at the more general level. The last two column models employ the country dummy variables, instead of country-specific observables; Chile is used as a baseline. The results indicate that country-specific unobservables have a considerable explanatory power for the multidimensionality choice. The estimated coefficient is significantly different from the baseline country, Chile. Colombia is the least likely to use multidimensional auctions, followed by Uruguay and Brazil. If the probit model is applied, the number of valid observations significantly drops.[9] However, the positive coefficient still remains significant, and Chile is most likely to employ the multi-criteria rule in road and railway concessions.

The estimated country dummy coefficients in Table 13 are broadly consistent with our unemployment measurement (Figure 6) and some of the governance indices (Figure 7), although they do not perfectly correspond to one another. It means that the unemployment rate may misrepresent the whole picture of socio-economic conditions in the individual economies, but it is still a valid proxy to a certain extent.

The policy implication is straightforward; auctioneers tend to make use of multiple award criteria when PPP infrastructure transactions are sizable and their administrative and regulatory capability is sufficient. At the same time, however, the adoption of multidimensional auctions is inspired by the need for social considerations, particularly from the employment point of view. If such political intervention erodes auction efficiency and transparency, the risks of the failure in infrastructure concessions will be enormous. The past data suggest that the multidimensional format increases the incidence of renegotiation. In other words, it seems much difficult to implement efficient multidimensional auctions.

This is consistent with some tentative propositions of the existing auction theory. Auction theory indicates that it is always controversial how to evaluate many dimensions included. Probably, the two-stage approach with a few criteria is optimally implementable under certain circumstances. The strong pre-commitment to the evaluation

[9] For technical reasons, the probit model is estimated with data from only three countries (i.e., Argentina, Chile and Peru). In our sample, five countries have no variation in the dependent variable, D_{MULTI}; for these countries, the probability of adopting the multidimensional auction format is perfectly predictable.

method is required prior to the auction. Consistently, our estimation results show that good governance is a key to help mitigate the renegotiation risk.

Table 13. Alternative First-Stage Regressions

	Linear	Linear	Probit
Unemployment	0.0199 *	0.0373 **	0.1194 *
	(0.0107)	(0.0178)	(0.0623)
Poverty headcount ratio	0.0517		
	(0.0390)		
Gini coefficient	-0.0464		
	(0.0319)		
Govt effectiveness	1.3080 *		
	(0.6822)		
Regulatory quality	-1.6701		
	(1.2286)		
Control of corruption	0.5724 *		
	(0.3159)		
Argentina		-0.4486 ***	-1.2678 ***
		(0.1709)	(0.4999)
Bolivia		-0.6310 ***	
		(0.1264)	
Brazil		-0.7479 ***	
		(0.1407)	
Colombia		-1.0623 ***	
		(0.2564)	
Mexico		-0.5517 ***	
		(0.1302)	
Peru		-0.4940 *	-1.3621 *
		(0.2569)	(0.7687)
Uruguay		-0.7953 ***	
		(0.1522)	
Constant	3.2345	0.4369 ***	-0.3060
	(2.2658)	(0.1531)	(0.4606)
Obs.	123	123	54
F statistics	8.25	...	
R-squared	0.3790	0.4079	
Wald test statistics			7.32
Pseudo R-squared			0.1152

Note: The dependent variable is the binary variable for the multidimensional auction selection. The robust standard errors are shown in parentheses. *, ** and *** indicate the 10%, 5% and 1% significance levels, respectively.

7. CONCLUSIONS

Multidimensional auctions are a natural and practical solution when auctioneers pursue more than one objective in their PPP-related transactions. Both in theory and practice, however, it seems difficult to achieve auction efficiency with multiple award criteria.

With auction data on road and railway concessions in Latin America, the paper aimed to estimate the impact of adopting the multidimensional format by a two-stage least squares technique with a binary selection in the first-stage regression. One of the

important empirical features is that the government decision of award criteria is endogenous.

We find that that auctioneers tend to rely on the multiple criteria format when there is greater need for social considerations, such as alleviation of unemployment. It can be interpreted as a potential risk that such political considerations could reduce auction efficiency and transparency. In fact, we also show that the risk of renegotiation of infrastructure concession contracts increases when the multidimensional evaluation format is adopted.

Despite the general difficulty to implement multidimensional auctions in an efficient manner, good governance has an important role to play in reducing the likelihood of renegotiation. In particular, we find that anti-corruption policies are a powerful instrument for avoiding renegotiation. To put it the other way around, a corrupt economy would have more frequent renegotiation incidence even if the concession contracts are concluded through multidimensional auctions.

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