Revenue-Based Auctions and Unbundling Infrastructure Franchises

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Introduction

There is widespread agreement that most developing countries urgently need massive investments in infrastructure. Until relatively recently, the provision of infrastructure services was generally considered the responsability of the public sector. Chronic budgetary problems and widespread disappointment with the performance of state-owned enterprises, however, have led to a wave of privatizations of infrastructur throughtout the world.

Privatization has several advantages. First, the public sector often lacks the financial and human resources necessary to undertake needed projects. Second, private firms are usually better run and more efficient than state-owned firms. Third, private participation helps to screen projects for "white elephants," as firms do not want to lose money. And fourth, cost-based user fees are easier to justify politically when infrastructure providers are private.

Unfortunately, private infrastructure projects are subject to many pitfalls that must be avoided to realize the potential advantages. One of the main difficulties occurs when the privatized infrastructure project is a monopoly, or worse, when the government guarantees monopoly status to the privatized firm in order to raise revenues from the privatization process (this is the case of Peru's long distance telephone market. Exchanging a public for a private monopoly can reduce social welfare, especially if the private investors have lobbying power.

It is well known that there are important limitations to direct government regulation. For example, firms have better information about cost and demand parameters, regulators can observe effort only imperfectly, and there are incentive problems within regulatory organizations that limit their effectiveness. These difficulties are more severe in developing countries, because regulatory agencies lack the necessary human and financial resources to be an effective counterpart to regulated firms.

With this in mind, it is possible to create a social welfare ranking of the alternatives available to a government that plans to privatize the provision of infrastructure services. The overriding premise is that whenever feasible[1] competition should regulate the provision of infrastructure. However when competition cannot work due to the technological characteristics of the infrastructure services (*viz*, tunnels and bridges), regulators should use mechanisms that mimic competition and use direct regulation only as a last resort[2]. This implies that, in principles the temporary franchising of infrastructure should be preferred to the creation of regulated utilities since the former require considerably less regulatory supervision than the latter.

At present, few types of infrastructure projects are auctioned periodically. In some cases the reason is fundamental. For instances, when the quality and maintenance status of the assets cannot be verified (as is the case, for example, with underground pipes in water distribution and sewage), the periodic auctioning of the franchise is not feasible[3]. Under these circumstances, a regulated utility is preferable, since this

[1]For a list of previously regulated infrastructure services that are now provided in competitive markets, see klein and Smith (1994).

[2]Two examples that illustrate the advantages of deregulation over direct regulation are the following. First, the annual benefits from deregulation in the airline, trucking, railroad and telecomm unication sectors in the United States have been estimated to lie in the range of US$35-45 billion (see Winston 1993). Second, in Chile the long distance monopoly operator was assumed to be regulated efficiently. Nevertheless, once competition was introduced in the late 1994, prices of international calls fell by more than 60% and demand more than doubled.

[3]This is Williamson's (1985) argument. French municipal water franchises are an exception, since they are auctioned periodically in order to stimulate efficiency. Yet they rarely change hands (see Klein and Smith 1996).

mechanism provides better incentives for investments and maintenance.

There are other cases where experience with temporary franchises has not been satisfactory. For example, there are many franchise projects that are so risky that private firms refuse to participate without governments guarantees. The guarantees are often implicit: contracts are renegotiated when the franchise holder runs into financial trouble due to higher than anticipated construction costs or lower than expected demand. These renegotiations are usually to the detriment of taxpayers and users. Whether implicit or explicit, guarantees change the incentives facing prospective franchise holders and their financiers. That is, they have fewer incentives to screen projects carefully and to monitor performance and costs. Moreover, a firm that expects to be able to renegotiate will offer its contract artificially low bids "lowballing." If this happens, the advantages of privatization disappear. The result is that taxpayers and users have to pay for white elephants, and inefficient firms may win the franchise because their confidence in their renegotiating skills allows them to underbid their competitors.

Franchise contracts in developing countries tend to lack flexibility. This lack of flexibility is necessary to reduce "creeping" (or even outright) expropriation of the franchise holder and reduce the power of corrupt regulators to favor franchise holders at the expense of the public. Yet, inflexible contracts can be very long run. In addition, renegotiations of contract conditions can be costly in the absence of fair compensation for breach of the original contract. Consider the case in which the project must be expanded or rates must be increased for efficiency reasons. How are the expansion costs to be divided (or, even determined)? How much of the additional income from user fees is to be appropriated by the franchise holder? There are no easy answers to these questions under standard franchise mechanisms.

Since competition and the regulation of monopolies have been extensively covered in the economics literature, this paper concentrates on mechanisms that attempt to reproduce the effects of competition in the case of monopoly franchises of infrastructure services. Demsetz, following Chadwick (1859), has argued that periodic open and competitive auctions for the provision of infrastructure services can reproduce the results that are obtained in competitive markets. Williamson (1985) has criticized this approach, arguing that the franchise holder will skimp on maintenance if the state of conservation of the assets is unobservable, and, that contracts will be renegotiated *ex post facto* to the detriment of the public. This paper analyzes franchises for the provision of infrastructure, with a particular emphasis on the mechanisms by which franchises are auctioned. We argue that many of the problems that plague temporary franchises stem from the standard practice of fixing the length (or term) of the concession. Since the franchise term is independent of actual demand franchise holders bear most of the demand risk. This is inefficient and leads to pressures for guarantees and (eventually) contract renegotiations.

The purpose of this paper is to present a new auction mechanism that solves many of the problems that have hindered the use of franchises. Under least present value of revenue (LPVR) auctions, the regulator fixes user fees (according to some optimizing criterion) and asks for bids on the present value of revenue from user fees that franchise holders will accept in exchange for building, operating and maintaining the infrastructure. The winning bid is the one that asks for the smallest present value of revenues. With this scheme, the franchise ends when the present value of revenue equals the winning bid. Year-to-year revenues are discounted at a rate known to all bidders before the auction. This implies that the term of the concession is not set beforehand. The franchise lasts longer if demand grows slower than expected, and is shorter otherwise.

There are several advantages to this scheme. First, the flexibility of the contract length reduces the importance of making accurate demand forecasts and substantially reduces the risk borne (and the risk premium demanded) by the franchise holder. Second, in LPVR auctions the bid made by a firm reveals the income required to earn a normal profit. We argue that this reduces the scope for post-contract opportunistic renegotiations. It is politically more difficult for the gov-

ernment to exploit the franchise holder by changing the original contract, because the winning bid allows for a clear and observable calculation of the wealth loss borne by the franchise holder. By contrast, under fixed-term franchises it is difficult to estimate how a change in, say, the term of the franchise affects the franchise holder's profitability. Moreover, under LPVR contracts the franchise holder faces larger difficulties in attempting to renegotiate the contract, since any changes in the amounts to be received can be compared with the original winning bid. As a consequence, LPVR auctions discourage lowballing, because it is easier for the regulator to threaten to terminate the franchise and pay the uncollected balance of the original bid in the event that the franchise holder asks for a renegotiation. An easily observable and uncontroversial compensation does not exist in the case of fixed-term contracts.

Third, LPVR franchises are flexible because the planner knows the fair compensation for early termination of the contract. Consider the case where the infrastructure project must be enlarged because demand has grown much faster than anticipated and capacity constraints are binding. The planner can terminate the franchise, pay the uncollected balance and re-auction the larger project, including perhaps the amount paid as compensation, so that no government expenditures are involved. By contrast, when the term of the franchise is fixed, the fair compensation is the expected value of income had the terms of the contract remained unchanged, a number that cannot be inferred from any accounting data. Fourth, under LPVR schemes, changes in user fees have no effect on the revenues of the franchise holder,[4] they only affect the duration of the franchise. Since maintenance costs are related to use but not to the duration of the franchise, the effect of the change in user fees on the present value of costs and on profits is not important. Hence, user fees can be adapted to the changing pattern of demand, in contrast to fixed-term auctions, where modifications of user fees have a direct impact on profits and require pricing rules to be set for the duration of the franchise.

Finally, LPVR auctions provide strong incentives to screen for the quality of the projects. Since bad projects will not recoup costs even if the project lasts indefinitely, an incorrect evaluation of the project saddles the franchise holder with losses. As the need for guarantees is smaller, screening incentives are stronger than with fixed-term auctions where high demand risk has led to generous government guarantees to ensure private interest in participating in the auction.

An important limitation of LPVR auctions is that they reduce the incentives to take measures that increase demand for the franchise. With a fixed term auction, the franchise holder reaps most of the benefits from investing in demand enhancing activities, since the franchise term remains the same when demand is increased. By contrast, with an LPVR auction the holder of the franchise receives the same revenue in present value regardless of the temporal schedule of demand, so that the incentives to provide good service or to market the project creatively are much diminished. In some types of infrastructure projects this is not a serious disadvantage, since minimum quality and service standards can be set and verified, and once they are met, demand is not highly responsive to the marketing efforts of the franchise holder. Important cases in which this holds, and are thus appropriate for LPVR auctions, are infrastructure projects such as roads, tunnels and bridges.

In cases where demand is sensitive to the actions of the franchise holder or service standards cannot be verified, the scope for applying LPVR auctions can be increased significantly by unbundling the project into two components, one that captures the advantages of LPVR auctions, and another that mitigates the lack of incentives to stimulate demand. Under this scheme, the basic infrastructure is provided under a standard LPVR scheme, which charges a user fee determined by the social planner. In addition, services are provided under a fixed-term (high incentive power) scheme based upon a maximum fee schedule or, alternatively, by competitive operators of the basic in-

[4]So long as the new user fee is high enough to pay the present value of revenue sought by the bidder in finite time.

frastructure. Under such a scheme, the high front load investment in basic infrastructure faces the low risk inherent in LPVR schemes, retaining flexibility and the capacity to screen for white elephants. Operators, who presumably do not face the same high initial investments, would have strong incentives to increase demand. Of course, the disadvantages of fixed term auctions would remain, but the amounts at risk, the amounts to be renegotiated and any compensation would all be smaller, thus reducing their importance.

The rest of the paper is organized as follows. In section 2 we classify infrastructure projects according to their technological characteristics. In order to establish conditions under which franchising is feasible and desirable. In section 3 we discuss several conceptual issues that arise in franchising. Section 4 discusses the shortcomings of fixed-term mechanisms. Section 5 introduces and analyzes LPVR auctions. Section 6 discusses the unbundling of franchises. The authors' conclussions are presented in the final section.

When is Franchising Desirable

Private participation in the provision of infrastructure comes in one of the following three forms. First, technological characteristics may render a competitive market possible, as with electric power generation. Under these circumstances little intervention by the regulator is needed beyond creating and maintaining competitive conditions in the market. Second, firms may compete for a franchise, as has happened with highways in Argentina, Chile, Mexico and other countries. In this case the regulator has a more active role, enforcing agreed tolls and quality standards. Third, the services of the infrastructure project may be provided by a regulated public utility.

In this section we provide a classification of technological and demand conditions that determine which of the three schemes should be used for a particular infrastructure service. Our conclusion, summarized in Figure 1, is the following: When scale economies (relative to the size of the market) are unimportant, competitive conditions can and should be created; no further regulation being required in this case. However, when scale economies matter, two possibilities need to be considered. Franchising is preferred when the quality of assets is observable at a relatively low cost. Otherwise, a regulated public utility is preferable.

Even though the remainder of this section is of independent interest, since we are not aware of a classification along the lines that we present, it can be skipped without loss of continuity. For this reason the reader who trusts the conclusion of the preceding paragraph may go directly to section 3.

Optimal Mechanisms for Infrastructure Provision

We start from the premise that competition should regulate the provision of infrastructure whenever feasible. If competition can work, either because a well-developed market exists or one can be designed (for example, as is the case with electricity generation), private contracts should be left to deal with issues such as renegotiation, flexibility and risk sharing. Regulators should intervene in the design of contracts only when competition cannot work. In that case, they should use mechanisms that mimic competition as far as possible and use direct regulation only as a last resort.

There are sound reasons to avoid direct regulation. It is now common knowledge (see, for example, Laffont and Tirole 1993) that there are limits to regulation. These problems stem from two facts.

First, asymmetries of information imply that regulated firms have better information about relevant cost and demand parameters, and that regulators can observe effort only imperfectly. Second, there are incentive compatibility problems within regulatory organizations that severely limit their effectiveness. These problems lead to the capture of the regulator by the regulated firm, political pressures, and the weakening of the power of incentives that is typical in settings where there are multiple principals (see Dixit 1996).

Standard regulatory problems are exacerbated in developing countries. To avoid corruption or creeping expropriation, regulatory mechanisms should be designed to be inflexible and leave little room for discretion.[5] Nevertheless, inflexibility can be costly if the technology or the behavior of the regulated firm changes. This is quite different from the regulator assumed in the regulation literature (see, for example,

[5] For example, Chile has introduced legislation in electricity and telefocommunications that includes technical formulas that dictate how to compute transmission and distribution costs. An alternative approach stresses simple rules, regulators that are independent from the political authorities, and intense public scrunity of the regulator's actions. Such regulatory governance has seldom been attemped developing countries.

Laffont and Tirole 1993), who can react to new information and wants to find out the true costs of the regulated firm. Such a regulator needs room for discretion, something that can be achieved efficiently only under institutional settings akin to those prevalent in more developed economies, where regulators are independent of political authorities and accountable to the public, and the legal system works properly. Hence, the balance between regulation and competition changes in developing countries. Mechanisms that mimic markets are more valuable when regulation is inefficient or corruptible, the common state of affairs in the developing world.

Scale Economies

An infrastructure project is subject to increasing returns to scale if the average cost is decreasing in the number of users of the service. Many infrastructure projects have increasing returns, which has the unfortunate consequence of leading to natural monopolies; for example: roads, electric transmission, and electric and water distribution. By contrast, electricity generation or long distance and local telephone services (recently) are not subject to significant scale economies and can be provided under competition. When scale economies are relevant in the market, some sort of regulation is unavoidable.

Verifiability of Quality

When economies of scale preclude the development of a competitive market, there still remains the choice between a regulated private utility and a competitively auctioned franchise. The choice depends on the feasibility of verifying the quality of the assets. Thus, contracts specifying maintenance requirements can be written.

Verifiability is the main determinant of the feasibility of limited-time concessions. Infrastructure quality is verifiable if an independent observer can determine the state of conservation of the assets. This is usually the case if there exists a secondary market for the infrastructure. For example, water distribution concessions usually are indefinite, because it is very costly to verify the state of conservation of underground assets. By contrast, road quality can be easily assessed by third parties. Thus, concessions for roads can be extended for a limited time period and competition *ex ante* can be introduced by making firms compete for the franchise.

The verifiability of service quality is also an important consideration in determining the way in which the service should be provided, how it should be regulated, and how much risk should be borne by the concessionaire. If demand depends on the effort of the franchise holder, there is a trade-off between incentives to effort and shielding the concessionaire from risk and hence reducing the risk premium. This trade-off can be relaxed if the regulator is willing to enforce service quality standards, as this option reduces the scope of gains from the franchise holder's efforts. The basic principle is that a smaller influence of the concessionaire on demand should be associated to less demand risk.

Classification

Figure 1 represents the best option available for different kinds of infrastructure provision. In each case the best mechanism is determined by the characteristics of the infrastructure. There are three basic options: competition, creation of a market, and the periodic auction of franchises.

Competition and Creation of a Market

When there are no scale economies with respect to the relevant market, a competitive market can be created. This is applicable, for example, to the case of electricity generation, long distance telephone service, or bulk water supply. [6]

[6]Recent technological advances has made local telephone services a case in which competition can be introduced if interconnection with the former monopoly can be introduced if interconnection with the former monopoly can be enforced. See, for example Smith 1996.

Competition in Chile's Long Distance Telephone Market. An example where there is competitive provision of infrastructure services is the case of long distance telephone calls in Chile, better known as the "multicarrier." Since late in 1994, every local subscriber can access each of several long distance carriers by dialing a three-digit code. The substitution of a competitive market for a regulated monopoly has brought prices down by more than 40 percent and traffic has more than doubled. Previously, the private long distance monopoly had been thought to be regulated efficiently. Not surprisingly, it claimed that scale economies made competition unfeasible.

Competition in Electricity Generation. Electricity generation in Britain, Chile and several other Latin American countries, where private parties bid to supply electricity to the central grid also illustrates how to establish a competitive market. The coordinating mechanism selects the lowest bids to supply the existing demand at each instant (or more practically, each hour or half hour). In Argentina, for example, "...prices for energy are bid rather than related to costs by a formula." Observed performance has been encouraging. The quality of electricity supply has improved and generation costs have fallen. Some problems remain, especially when only a few operators dominate the market and are able to manipulate the mechanism.

Competition between airport terminals. A very interesting example of the introduction of competition is the partial privatization of the Lester B. Pearson airport in Toronto. Terminals 1 and 2 are owned by a public sector entity. A private consortium holds a concession for the third terminal. The terminals compete with each other to attract airlines, being free to set fees for services.

Periodic Auction of a Franchise

When a competitive market is not feasible some competition can be introduced by periodically auctioning the franchise. This is what Chadwick (1859) called competition *for* the field, which substitutes for competition *in* the field.[7] The reasoning, made popular by Demsetz (1968) is that competition for the franchise will dissipate economic rents (see also Posner 1972; for a critical assessment of Demsetz's work see Williamson 1985). As Klein and Roger (1996) stress, franchise bidding is especially appropriate "[...] whenever investments are not tied to a particular service area" (e.g., bus transport or airplanes). The explanation is that there is less scope for regulatory expropriation when investments are mobile.

When investments are sunk and tied to a particular service area (e.g., a road) periodic auctions can be used only if the quality of the assets can be verified at the end of the franchise. Given the limitations faced by regulation, especially in developing countries, periodic auctions limit the monopoly power and the rents of the concessionaire more effectively than regulated utilities. The problem is that the award of a franchise establishes a long-term relationship between the franchisee and the regulator. Hence, the bidding process must be designed to minimize future problems in the relation and reduce the likelihood of opportunistic renegotiations. Particular attention must be given to the weaknesses of the regulator and to the fears of expropriation of the franchise holder.

Regulated Utility

An indefinite concession is required when the infrastructures services cannot be franchised because the quality of the assets cannot be verified.[8] In this case there must be direct regulation of the firm's monopoly power. If assets are specific, the regulatory contract must be designed to give credible guarantees to the firm that it will not be arbitrarily expropriated.

[7]Chadwick was inspired by the French experience with competitive public works contracts dating back at least to fortress construction under Vaubon in 1605. For more on infrastructure privatization in an historical perspective, see Klein and Roger (1995).

[8]Even in the case of France's water monopolies, which are periodically auctioned, franchises rarely change hands. Apparently, the effect of periodic auctions is to limit the exploitation of monopoly power.

Conceptual Issues in Franchising

This section examines the conceptual issues that determine the appropriate allocation mechanism for a given type of infrastructure franchise. Recall that infrastructure franchises are characterized by long-term relations involving the franchisee, the regulator and the public.

The general rule is that the allocation mechanism should maximize the sum of user and franchise holder surpluses. This implies that the mechanism should maximize the present value of consumer surplus subject to the constraint that the franchise holder makes normal profits.[9] The regulator should prevent the exploitation of any monopoly power, and the most efficient firm should be assigned the franchise in a competitive auction. In addition, the duration of the concession must allow the franchise holder to make a normal return on his investment. There are several open auction mechanisms that, at least in principle, satisfy both requirements, so it is necessary to have some criteria to compare them.

An auction mechanism is a set of rules that specifies how the winner of the auction is chosen. In standard theoretical settings an open and competitive auction guarantees social efficiency. This is not the case for infrastructure franchises, where the award consists of a long-term contract between the State and a private firm (a build, operate and transfer or BOT contract). Uncertainties, risk allocation, incentive problems and the possibility of renegotiations mean that alternative allocation mechanisms may differ substantially in their welfare implications. The franchise contract (i) determines the franchise holder's obligations; (ii) regulates the monopolistic exploitation of the franchise (for example, by fixing a maximum price for the service or by sharing income with the government); and (iii) determines how risks, profits and losses are shared among the franchise holder, road users and taxpayers.

Franchise contracts are often difficult to design because demand forecasts are highly uncertain, sunk investments are large, and it is costly for the State to switch to another supplier after the contract is awarded. Thus, they are subject to what Oliver Williamson (1979, 1985) has termed "the fundamental transformation," that is, before the franchise is awarded, the relation between firms and the State is competitive; after the contract is awarded, it becomes a bilateral monopoly. Because many events that may significantly affect the venture's profitability cannot be specified in a contract, franchise contracts are inherently incomplete, and there is ample room for opportunistic behavior on both sides.

Toll Roads in France: Opportunistic Behavior by a Government: After the oil shock the French government was reluctant to let highway tolls rise because it wanted to control inflation. While the franchise contract stipulated that private concessionaires could set tolls at will, the government ignored it. Concessionaires sued and lost; the court argued that there was a 1945 law which said that the government could fix any price (see Gómez-Ibáñez and Meyer 1993, p.117).

The rest of this section lists several rules that should be taken into account when designing and evaluating an auction mechanism and its associated franchise contract.

[9] When user fees are distortionary, lower revenues from user fees increases welfare. When user fees are not distortionary, additional government revenue (after the franchise is returned to the government or another franchise holder pays for access to the infrastructure), reduces other distortionary taxes.

Information

In order to verify whether the franchise holder complies with the terms of the contract, the regulator needs information. However, given the incentives of the franchise holder to provide misleading data, the ability of the regulator to enforce the contract should not depend on information known only to the franchisee.

The franchise contract is less risky if it restricts the possibilities of opportunistic behavior by the franchise holder or the regulator's use of discretionars power. Hence, the fulfillment of the provisions of the contract should be easily verifiable by third parties, so that disputes are less likely.

Profit Caps and the Verification of Fulfillment of Contract Provisions. The regulator should not attempt to limit the franchise holder's profits. To do so would require knowing the actual cost of building and operating the franchise. It is difficult for a regulator to verify a firm's costs because it is in the franchise holder's interest to report high costs in order to lower accounting profits. Conversely, the above principle is consistent with the specification of quality standards in infrastructure projects when these are easily verifiable. For example, when an airport runway is franchised, quality standards can be objectively set and monitored by third parties with specialized equipment.

Simplicity

A second desirable property is that the auction mechanism be simple. A cursory examination of the mechanisms used to auction franchises in different countries leads to the conclusion that this principle is often ignored. The shortcoming of complex mechanisms is that they depend on many variables, which makes them difficult to analyze and can lead to complaints of evaluator bias. Multifactor point rating systems are commonly used. In order to reduce the scope for evaluator subjectivity, these factors should be quantifiable. However, since the weights assigned to different factors are to some extent arbitrary, they can lead to unanticipated outcomes, thereby increasing uncertainty. Furthermore, complex contracts are not transparent, and this widens the regulator´s discretionary scope and the franchisee's opportunistic behavior. These arguments suggest that the choice of the winner should depend on a single variable.

Regulators are usually tempted by complexity in an effort to satisfy the different interests with stakes in the franchise. For example, planners offering demand guarantees may link them to profit sharing between the state and the franchise holder, thereby seeking compensation for the guarantee if the returns exceed a predetermined limit. This makes it difficult for potential bidders to estimate the value of the project and requires sophisticated monitoring.

Another problem with complex contracts is that supervision is more difficult and there may be a lack of coherence between different provisions of the contract, making renegotiations more likely. As mentioned earlier, the problem with renegotiations is that they replace the ex ante competition of competitive auctions with an ex post bilateral monopoly, in which the government (or worse, the public) usually ends up worse off. Moreover, the results of the renegotiation can easily lead to charges of corruption and discretion, which has perverse effects on the participants in future franchises. Finally, complex contracts hinder the public's ability to understand what has been awarded in the auction.

El Melon Tunnel, Chile: Complex Bidding Arrangements: I 1992, the Chilean government announced a BOT auction for the El Melon tunnel, on the Pan American highway. Projects costs were estimated at US$40 million. Those companies with projects that satisfied minimum technical standards were allowed to bid in the final stage of the auction. The scoring formula for this stage included seven variables with different weights: annual subsidy to or payment by the franchisee, toll level and structure (in itself composed of six different tolls for various classes of vehicles), length of the franchise, minimum income guarantee from the state, degree of construction risk borne by bidders, score on the basis of additional services and, least but not last, the CPI adjustment formula. The outcome of the auction was somewhat unexpected. The first and sec-

ond bids offered the maximum toll and the award was decided on the basis of the payment to the state. The tunnel was built on time but the franchise owner has been pressing for a renegotiation to reduce tolls in exchange for a lower payment to the State. This would lead to an efficiency gain but, at the same time, would establish the precedent that contracts can be renegotiated at the franchise holder's request. So far, the Chilean government has not given in to the pressure.

Risks and their Allocation

A franchise contract spreads the various risks of a particular infrastructure project among the franchise holder, users and taxpayers. Since the average ex post return and risk premium asked by a franchise holder rises with the risk he or she bears, the chosen mechanism should transfer risks to the party best able to diversify them.[10] Yet, the above principle is subject to a major qualification: a party has fewer incentives to be efficient when he or she does not bear a risk she can control. For example, if the regulator insures against cost overruns, the franchise holder has no incentive to control costs. Thus, controllable risks should be borne by the party that is best able to control them. Any risk which can not be controlled or eliminated ought to be diversified.

Demand Risk

Demand risk arises in contexts where forecasts are notoriously imprecise, as is the case for many types of infrastructure projects. While most economic activities must cope with *the impredictability of market* demand, it is particularly difficult to do so when investments are large (both in absolute terms and relative to the size of the market), indivisible, tied to a particular location, and service at a distance is not feasible. Firms have little flexibility to adapt to low demand scenarios and losses can be substantial. In general, short-term forecasts (three to five years ahead) usually have significant errors; medium- and long-term forecasts are almost useless. The source of forecast errors may be both macro and microeconomic. Macroeconomic risks are related to how the economy is growing on aggregate, while microeconomic risks reflect local demand fluctuations. Finally, if a substantial part of the demand risk cannot be controlled by the franchise holder, it should be diversified.

Toll Roads in Chile: Difficulties in Forecasting Demand: Figure 1 shows the increase in the number of motor vehicles paying tolls during the past decade in three of the main tolled roads in Chile.[11] Macroeconomic risk is reflected, for example, in the fact that vehicle flows grew much faster during 1988 than in

Figure 1

Vehicles Paying Tolls: Growth Rate (%)

	1987	1988	1989	1990	1991	1992	1993	1994	1995
Angosturá:	8.8	15.0	11.7	4.5	8.7	12.4	6.7	7.8	9.4
Zapata:	21.5	14.4	13.1	8.1	7.2	5.2	2.9	3.9	4.9
Lampa:	3.8	13.4	15.9	8.9	6.8	18.0	8.8	16.2	12.5

[10] We are assuming that firms are risk-averse in the sense of decision theory under uncertainty.

[11] The rates correspond to the growth in the flow of vehicles from one year to the next. For example the vehicle flow through the Angosturá tolls in 1987 was 8.8% above that in 1986. These flows are representative, covering the three busiest highways near Santiago.

1990. Microeconomic risk is apparent in most years: the growth of vehicle flow fluctuates considerably around the annual average from one tollbooth to another. It should be stressed that, macroeconomically speaking, the past decade has been Chile's most stable during this century: there have been no recessions and GDP has grown at an average six percent per annum. Despite this, traffic growth rates fluctuate considerably.[12]

Orlival Train, France: Over-Optimistic Demand Estimates: The privately built and run Orlival underground train joins Orly airport with the Paris underground. It was a technical success, because construction costs were as planned and the project was completed on time. However, demand was grossly overestimated, which resulted in big losses (See Tirole. 1977).

Construction and Operation Costs

A different source of risk stems from uncertainty about building and maintenance costs. This risk exists because the costs of building and maintenance generally differ from projections. Actual costs and the diligence of the franchise holder cannot be known directly by the State or by users. As these costs are known and controlled only by the franchise holder, he should assume them.[13]

Policy Risk

Private infrastructure projects face problems of policy induced risk. Actions by different levels of government may have serious effect on the profits of the franchise owner. For example, governments it may build infrastructure that competes with the franchise, it may reduce user fees or it may raise environmental norms. This risk should not be borne by the franchise holder since he cannot control it. However, the government may wish to retain flexibility in the long run, which may require specifying that certain actions are allowable under the contract. The franchise contract should be designed so as to reduce the impact of policy changes that cannot be anticipated.

Expropriation risk should be dealt with through adequate institutional reform. The extent of this risk depends on the type of project. In cases such as electricity generation, a few countries have tried to reduce the government's discretion by incorporating detailed rules into the electric law, rules what would normally be part of discretionary regulations. This has lowered the risk faced by investors at the expense of a loss of flexibility for the regulator. Yet there are cogent reasons for the government to retain flexibility in the case of franchises such as roads. First, is the belief that local authorities should not be bound by the central government. Second, changes in regional conditions might make it desirable to add franchises that capture part of the demand of the original franchise.

If the government does not want to lose flexibility, but the associated level of risk precludes the firms from obtaining finance, there are two options available; namely to provide guarantees that will insure at least a fraction of the returns of the franchise holder, or to design a franchise system that will insulate the firm from these risks.[14] The difference between guarantees and a change in the franchise scheme lies in how they distribute risk.[15] Risk is transferred from the franchise holder to taxpayers in the case of guarantees, and to users of the infrastructure project in the franchise scheme.

[12] Thus similar data for other developing countries are likely to show as much or even more variation.

[13] There could still be cost sharing for adverse selection reasons, although in the case of auctions the case for cost sharing is weaker. See Laffont and Tirole (1993, Chapter 7).

[15] Note that risks are reduced under a utility-type scheme, since the infrastructure does not devolve to the state and the owner can eventually obtain the revenue required to pay a normal return for the project. Whether this is the case will depend on the difference between the firm's discount rate and expected demand growth.

[16] Unless the Arrow-Lind (1970) conditions of independence between the demand shocks to the project and general shocks to the economy holds, see Klein (1996).

The Winner's Curse

A winner's curse occurs when the firm winning the franchise is the one making the most optimistic projection of some uncertain variable, generally demand for the project or construction costs.[17] In preparing their bid for a BOT auction, each bidder projects demand and construction, operation and maintenance costs, which depend on parameters that must be estimated. The bidder that obtains the most optimistic projection will make the best offer, without necessarily being the most efficient bidder. In extreme cases this phenomenon can lead to bankruptcy the franchise holder, or to financial difficulties that lead to contract renegotiation. If prediction errors are smaller, so that there is less risk, the winner's curse becomes less relevant.

Firms that are aware of the curse will scale down their bids according to the uncertainty in their cost and demand projections, and to the number of competitors they expect.[18] Although this makes it less likely that the franchise holder will go bankrupt, the rate of return before correcting for risk will be higher and users will pay more. Any reduction in the prediction risk facing franchise holders lowers not only the usual risk premium but also the premium needed to offset the winner's curse.[19] Experience suggests that bidders in new businesses are more prone to fall victim to the winner's curse.

Marketing and Maintenance

In some cases, the franchise holder can undertake activities that increase the demand for the infrastructure or increase the efficiency of operation of the franchise. A train company may provide good and reliable service, a telephone company may develop and introduce new services (e.g., call waiting) and an airport may invest in a special radar to allow landing with low visibility. The importance of this factor in different projects settings will determine the appropriate auction mechanism. Little can be done to increase the demand for a tunnel, bridge or road, provided that certain minimum quality standards are met.[20] Hence, making the franchise holder assume demand risk serves no purpose in this case. By contrast, in other infrastructure projects such as public transport, telecommunications, water distribution and electric distribution, demand is sensitive to the quality of the service and to marketing efforts by the franchise holder. In the latter case the franchise holder must be given incentives to perform demand enhancing activities, implying the need to assume more risk.

The franchise holder should also be given incentives to maintain the infrastructure project in good condition. As we mentioned before, this is feasible when objective standards can be defined (e.g. indices of ruggedness, in the case of airport runways) which can be monitored with specialized equipment. As discussed in the introduction, the planner should consider other options, such as indefinite concession, when it is not feasible to verify the quality of assets. In addition, the regulator should demand guarantees to safeguard users' interests in case the franchise holder does not meet the required quality standards. Incentive problems are particularly severe toward to the end of the franchise, because the franchise holder has little to gain by spending on maintenance. It may become necessary to have the franchise holder post guarantees that become redeemable at the end of the franchise if the state of the

[17] For good introductions see Thaler (1988) and Milgrom 1989).

[18] A bidder will choose her bid conditional on the fact that her estimates are the most optimistic, because her bid matters only when it wins.

[19] It is worth mentioning that in sealed bids and first price auctions (which are being used in most countries to award franchises), the premium due to the winner's curse is positive even if bidders are risk neutral; see McAfee and McMillan (1987, p.721).

[20] Penalties for blocked lanes and accidents, standards on waiting times at tolls, etc.

infrastructure does not meet preestablished quality standards.

Renegotiations

As mentioned in the introduction, franchise contracts are often modified when the franchise holder runs into financial trouble, and losses are shifted to taxpayers or users. This is undesirable not only because of the wealth transfers involved, but also because it creates incentives for firms with more lobbying power to underbid more efficient firms in the expectation that terms will be renegotiated in their favor in the future (Williamson 1985). It could be argued that to avoid these undesirable effects it is sufficient for the State to stand firm and allow the franchise holder to go bankrupt. However, this assumes that the State is immune to pressures from interest groups, which is generally not the case, especially in developing countries. Therefore, the auction mechanism should discourage lowballing in the expectation of opportunistic renegotiation of the contract and place constraints on the outcomes of renegotiations that do occur.

Renegotiation and Government Bailouts for Unsuccessful Projects. France awarded four private road concessions in the early 1970s. After the oil shocks three of them went bankrupt and were taken over by the government. Twelve concessions were awarded Spain before 1973. In the case of several of them building costs ended up being 4 to 5 times higher than expected, and traffic one-third of what was originally projected. Three firms went bankrupt, two others were absorbed by stronger franchise holders which were granted toll increases and term extensions. In Mexico, virtually all the highway concessions were renegotiated after cost overruns and low revenues, with a (declared) cost to the government of US$2 billion. This cost does not include the cost to users in term extensions, since in several cases the terms more than doubled. Apparently one of the causes of the cost overruns was that the companies made their profits by inflating construction costs, syphoning funds through the building companies and letting the operating companies go bankrupt.

Flexibility

While it is desirable to prevent opportunistic renegotiations, there are circumstances in which social welfare increases if the terms of the contract can be modified after the franchise is allocated. For example it might be desirable to increase the service capacity of the infrastructure before the end of the franchise period. In other cases user fees may turn out to have been set too high (recall that concessions may last for more than twenty years) or demand may increase and a higher user fee may be required to deal with excess demand. There can be large inefficiencies if the contract specifications cannot be changed.

In such cases, two options are open to the planner. One it to renegotiate the original contract, but this carries with it all the problems of bargaining in a bilateral monopoly situation. The second option is to cancel the concession and pay a fair compensation for the profits foregone by the franchise holder. The problem with the second option is that the fair compensation is the expected present value of future profits had the concession continued on the original terms. Often this figure cannot be deduced from any accounting data and is highly subjective, making endless disputes a likely outcome.

Toll Roads in Argentina: Inadequate Provisions for Renegotiation. An example of a blatantly incomplete contract, should renegotiations take place, are toll road contracts in Argentina. They state that "[...] in case of a substantial and sustainable increase in traffic volume, larger than initially estimated, the concessionaire and the government may conceive a plan to improve the levels of service."

Airport Concessions in Argentina: Compensation Disputes. In Argentina, the government wants to refranchise airports. In order to do this, it must compensate current franchise holders. The former economics minister, Domingo Cavallo, has claimed publicly that some government employees have written a decree that provides for a compensation of US$400 million, while the fair compensation is of the order of US$40 million (El Mercurio 1997).

The only way of preserving flexibility without giving the State room for discretion is by providing a method for determining a fair compensation that is easy to assess, unobjectionable, and close to foregone profits.

White Elephants and Government Guarantees

White elephants are usually built because governments give in to small but well-organized pressure groups. One of the major advantages of the private supply of infrastructure is that the likelihood that these pressures will be effective is smaller since the franchisee stands to lose money if the project turns out to be a white elephant. This filtering ability is reduced if the government provides income or debt guarantees to the franchise owner. Hence, guarantees should be avoided if possible. The only circumstance when guarantees may be justified is when early starters of an activity generate learning externalities that benefit followers.[21]

The Lonquimay Tunnel in Chile: Ineffective Project Screening. In the mid-1940s, Chile and Argentina decided to begin an early process of integration. As part of this process, a railway link was conceived between Concepción and a port in Argentina. The Chileans built the Railway line up to their boundary with Argentina, including the Lonquimay tunnel (which is still the longest tunnel in Latin America), and rail stations along the way. Unfortunately, the Argentinian line was never built, so the project was never put to its intended use. A private firm would not have begun the Chilean part of the project until assured that the Argentine project was underway.

San Jose Lagoon Toll Bridge: Poor Incentives for Project Screening. The San Jose Lagoon Toll Bridge was built to relieve congestion in the San Juan region in Puerto Rico. The government assumed most of the commercial risk by guaranteeing to buy the project back at the concessionaires request if actual traffic fell short of 80 percent of projections in the first three years and of 100 percent of projections after nine years. In that event, the government will pay the concessionaire all project costs plus 13 percent. Under this scheme the firm has no incentives to screen the project for quality. This is an example of a badly designed guarantee scheme.

[21] For a detailed discussion of the role of government guarantees for private infrastructure projects, see Engel, Fisher and Galetovic (EFG) (1997b).

Fixed-Term Auction Mechanisms

Common mechanisms used to award infrastructure franchises are based on a fixed franchise term, which must be long enough to recover investment costs.[22] A common type of fixed-term mechanism is one in which the regulator fixes the term and the franchise is awarded to the firm that offers to charge the lowest user fee.[23] Alternatively, the regulator sets the term and the franchise is adjudicated to the bidder that gets the highest score in a formula that weighs technical and economic aspects.[24]

The main defect of fixed-term mechanisms is that they make the franchise holder assume a large fraction of the demand risk. To see why this is so, note that a franchise may loose money if the term is too short. In the long run, user fees might be enough to pay the investment costs, but the franchise ends before then. Of course, if the auction is competitive, for any given term firms will offer bids such that the duration of the franchise will be just about right to make normal profits on average; bad states where the term is too short will be compensated by good states in which demand is larger than expected so revenues over the duration of the franchise are much larger than the investment. Since returns are uncertain, franchise holders will ask for a risk premium. Thus, on average, profits made in good states more than compensate for losses in bad states. This risk premium is paid by users.

High risk causes several problems which are particularly relevant when initial investments are large. First, potential bidders usually demand debt or minimum income guarantees. Second, they increase the likelihood that the best bid will be made by the firm that is most optimistic in predicting future demand for the infrastructure. This occurs because optimistic estimates lead to aggressive bids when the term of the franchise is fixed. Third, fixed-term mechanisms encourage underbidding by firms that are efficient renegotiators. Fourth, if franchises are allocated to the bidder offering the lowest user charge, the regulator loses the ability to fix user fees based on efficiency criteria so as to correct externalities. This may be of great importance in projects such as highways.

Finally, fixed-term franchises make contracts inflexible when modifications to the original terms are required to increase social welfare. The reason is that it is hard to agree on compensation, which is the expected income foregone by the franchise holder over the remainder of the franchise had the terms of the franchise remained the same. This compensation cannot be determined from any accounting data and must be decided in a bilateral negotiation. On the one hand, there are clear incentives for the franchise holder to exaggerate projections future income. On the other hand, giving considerable power to the regulator to set the compensation opens the door for the use of discretion and the opportunistic taking of the franchise. The same argument applies to modifications of user fees. Even if they prove to be totally inadequate, it is very difficult to determine a fair compensation if income falls, or a sharing scheme if revenues rise.

Fixed-term mechanisms have one important virtue: they give powerful incentives for the franchise holder to in-

[22] Some mechanisms, for example those used in private highways in Mexico, gave the franchise holder the option of extending the franchise for an additional fixed term at the end of the original one. It is easy to show that our comments about fixed term franchises apply to this case as well (see EFG 1997c).

[23] In these cases there are two bids: a first stage technical bid in which participants have to satisfy technical requirements and if they pass, they are allowed to participate in the economic auctions.

[24] In a version used in some highway franchises in Mexico, the toll (user fee) was set by the regulator and the franchise was awarded to the firm asking for the shortest term.

crease demand for the services provided by the infrastructure because most of the returns to those efforts accrue to him. For some types of projects, where demand is responsive to the actions of the operator, this feature may to some extent compensate its disadvantages. However, in projects where revenue is unresponsive to the actions of the operator, the inflexibility and risky nature of fixed-term auctions makes them unattractive.

A New Auction Mechanism

This section presents a new mechanism to auction infrastructure franchises with the distinctive feature of having a flexible franchise term that adjusts automatically to demand realizations. The mechanism, in its pure form, is the following:

- The regulator fixes the user fee that the franchise holder can charge
- The franchise is won by the firm that asks for the least preent value of user fee revenue (PVR).
- The franchise ends when the present value of user fee revenue is equal to the franchise holder's bid.[27]

The rate used to discount user fee revenue is part of the franchise contract and is fixed by the regulator before the auction takes place; it should be a good estimate of the rate faced by franchise holders and may vary in a predetermined way (e.g., LIBOR plus a fixed risk premium).

For example, consider an auction in which two firms take part. The first estimates its costs at $100 million, and asks for a PVR equal to $112 million, whereas the second estimates costs at $99 million and asks for $110 million. The second firm wins the franchise and operates it until the present value of user fee revenue is equal to $110 million. As soon as this amount is collected, the franchise ends. The remainder of this section analyzes LPVR auctions and compares them to fixed-term franchises.

Reduction of Demand Risk

By making the length of the franchise responsive to demand, LPVR auctions significantly reduce the demand risk borne by the franchise holder, particularly when compared with the risk faced under fixed-term auctions. To see this, note that when the term is fixed there are states when the franchise is profitable in the long run, but the franchise holder loses money just because the franchise term is "too short." In those cases a term extension would have enabled the franchise holder to make a normal profit. An LPVR auction uses this fact to reduce the risk borne by the franchise holder. The franchise term automatically lengthens when demand grows slower than projected, and shortens when it grows faster. Since franchise owners receive (and users pay) similar amounts in good and bad states with LPVR auctions, the risk premium required by the franchise holder is smaller, and users pay less in expected value over the life of the franchise.

An additional advantage of LPVR auctions is that it is less likely that the firm making the most optimistic demand estimate will be a victim of the winner's curse. The reason is that bids become more cost-oriented than with a fixed-term auction. In addition, uncertainty about revenue decreases, so that the impact of demand forecast errors is smaller. An optimistic demand estimate translates into low user fees or short concession terms. In contrast, with LPVR franchises, firms fix their revenues in present value when they choose their bids; winning the auction by being too optimistic means that the franchise will end earlier than expected, not that the franchise owner will receive less revenue.[26] Hence, bids depend more on the quality of the investment and on estimates of maintenance and operation cost than on demand estimates, so it becomes more

[25] Since the operator may lie, the government needs an independent means of checking the actual use of the infrastructure.

[26] Being more optimistic leads to a somewhat more aggressive bid because estimated operation costs are lower. Yet, when operation costs are small relative to the investment cost, this effect is an order of magnitude smaller than the effect of uncertain demand in the case of fixed-term auctions.

likely that the most efficient firm will win the auction. A smaller winner's curse provides another reason for expecting that bidders will ask for a smaller expected present value equivalent over the life of the franchise.

Benefits of Switching to LPVR Auctions. In EFG (1996) we estimate that in the case of toll roads in Chile, the gain stemming solely from the reduction in risk is, on average, 33 percent of the cost of the project or US$800 million.[28]

LPVR auctions reduce the risk borne by the franchise holder but they do not eliminate it completely. The franchise holder assumes construction risks, as well as fixed maintenance and operating cost risks. Nevertheless, as we have already mentioned earlier, it is efficient to assign to the franchise owner those costs that are unverifiable and under his control. Even if fixed operation and maintenance costs were known with certainty, their present value over the life of the franchise varies with the term. This is desirable, since it creates incentives for the franchise holder to perform activities that raise demand for the services provided by the infrastructure project. Finally, even an indefinite franchise may not be enough to pay for the cost of building the franchise, that is, the project may turn out to be a white elephant. As we have discussed earlier, one of the main reasons for the private provision of infrastructure is the screening of white elephants. There is no social gain in blunting this instrument by insuring against white elephants. In other words, an efficient auction mechanism such as an LPVR should let the franchise holder bear this risk.

Renegotiations, Discretion and Modifications of the Contract

The second advantage of LPVR franchises stems from the fact that the firm's bid reveals the revenues required to make a normal profit.[28] Hence a fair compensation for early termination of the lease is the sum still remaining to be collected.[29] Several consequences follow from this. First, suppose that before the franchise ends the regulator decides that increased demand requires enlarging the infrastructure. Under a fixed-term auction, there is no easy way to assign the costs of the expansion and negotiations take place under conditions of bilateral monopoly, precisely the situation that competitive auctions try to avoid. Alternatively, the lease is terminated, but there is no easy way to determine a fair compensation. Under an LPVR franchise, the regulator pays the unambiguous fair compensation.

Second, the existence of an observable fair compensation makes it more difficult to expropriate the franchise (or even to use regulations to impose a "creeping expropriation"). When the term is fixed, it is difficult to estimate the wealth loss incurred by the franchise holder, so it is easier for the government to argue that the compensation offered implies no loss or that the franchise holder has made "excessive" profits. Under an LPVR auction the franchise holder's bid is a clear and observable benchmark that can be used to challenge any attempt at opportunistic expropriation. Third, in the event that the franchise holder wants to renegotiate, say, because of cost overruns, there is an observable standard against which overly generous compensations can be compared. This helps to stiffen the backbone of the regulator against pressures from the franchise holder. Fourth, for the same reason, LPVR auctions discourage underbidding by opportunistic firms.

Note also that the common forms of renegotiation are ineffective under LPVR. Raising user fees has the effect of shortening the lease, but does not increase the franchise holder's revenues. Lease extensions have

[27] This is an underestimate of the true advantages of the LPVR auctions in this case, because we have omitted the more intangible gains due to the better renegotiation characteristics and those arising from the added flexibility in capacity and toll setting.

[28] This assumes that the auction is competitive.

[29] Of course, this is an upper bound, since the franchise holder saves on operation and maintenance costs if the franchise is terminated ahead of time. A typical franchise contract would specify how this upper bound should be reduced depending on the number of years outstanding.

no meaning in the context of LPVR auctions since, by definition, the term is variable. Thus, any attempt by the franchise holder at renegotiating is likely to take the form of asking for an increase in revenue. The welfare loss of users affected by a renegotiation of this kind is easy to grasp, thus increasing the likelihood that those affected will pressure the regulator to resist the attempts.

Optimality Properties

LPVR franchises enable the regulator to separate the process of setting user fees from the process of allocating the franchise. Hence, LPVR auctions make it much easier to change user fees if they prove to be inadequate. If operation and maintenance costs are small relative to sunk initial investment, user fees can be adjusted optimally to reflect demand conditions, since the effect of changes in user fees are reflected in changes in the length of the franchise and the effects on profits is small.[30]

In fact, it is easy to show that an infrastructure project franchised under LPVR, which is operating at capacity at peak time, can achieve a first best if the user fees are set at the optimal level (EFG 1997c, for a formal proof). For example, suppose there are two possible demand scenarios, each with a peak period with fully utilized capacity (but different demands), and an uncongested period. If user fees are set at marginal cost at off peak times, and at the optimal level at peak time and if the user fees can finance the project in both cases we have a first best.[31]

LPVR Contracts and Government Guarantees

By reducing demand risks, LPVR contracts also considerably reduce the demand for government guarantees. However, as discussed previously, if a project generates important learning externalities that benefit followers, some minimum income guarantee may be warranted.[32] This can be done by guaranteeing a fraction of the present value of revenue asked (say, 80 percent). One advantage is that, in this way, guarantees are chosen by the franchise holder and competed for in the auction.[33]

Variable Term and Financing

It has been suggested (see, e.g., Klein 1997) that one possible disadvantage of LPVR franchises is that variable-term debt contracts are not very common, so that financing could be more expensive. In our judgement this is not so. In what follows we show that variable-term franchises are at least as attractive for debt holders as fixed-term franchises, and considerably more attractive for equity holders.

Consider the case of two identical infrastructure projects that cost $1,500 to build and involve no additional operating costs. Demand may be high (200 units each year) or low (100 units each year); both demand scenarios are equally likely. The regulator fixes user fees at $1 per unit. For simplicity, assume that the discount rate is 0.

In the first project the term of the franchise is fixed and independent of demand realizations; the franchise is allocated to the firm asking the shortest term. If firms are risk neutral, the winner would offer a term of 10 years.[34] Yet, since firms are risk averse, they will ask for a longer term, say 12 years. In that case, if demand is high, the franchise holder makes a profit of $900. By contrast, if demand is low he loses $300.

[30] Note, however, that user fees should not be fixed so low that the franchise never achieves the LPVR revenue.

[31] In EFG (1997c) we show that LPVR auctions are optimal subject to the self-financing constraint.

[32] Even with an LPVR concession, the franchise holder may lose money if demand is so low that a very long term is not enough to recoup the initial investment and cover operating costs.

[33] Since there may be collusion among auction participants, the government should set an upper bound to the guarantee.

[34] The reason is that ($200*10)/2+($100*10)/2 = $1,500.

The second project is auctioned by LPVR. Regardless of risk aversion, the winner will ask for $1,500, because this sum covers costs in both cases of nature. No matter what demand is, with an LPVR auction economic profits are zero.

Let us now look at matters from the perspective of lenders. For the sake of simplicity, assume that they are willing to lend only if the probability of default is zero. Under a fixed-term franchise revenues will be at least $1,200. Thus, debt-holders will lend more than $1,200 only if a guarantee is given. By contrast, under an LPVR auction financiers would be willing to lend up to the full amount needed to construct the project, that is, $1,500.

As long as debt finances less than $1,200, lenders can be sure that they will receive at least $100 per year under both mechanisms. In both cases, the possibility of prepayment can be considered if the optimistic demand scenario occurs. Thus, how safe a loan is does not depend on the mechanism chosen. The reason is quite general. Lenders are first in line among claim holders, so they receive all cash flows in cases where demand is low. And these flows do not depend on the auction mechanism that is used.

Assume now that debt finances more than $1,200. Under fixed-term franchises this will be feasible only if the government provides a guarantee. By contrast, with an LPVR scheme a guarantee would be needed to ensure a given timing of payments but not the total amount, which is certain. Even if guarantees are equally attractive under both mechanisms, the advantages of LPVR auction from the social point of view are evident.

Note, moreover, that this example also serves to show that shareholders assume much less risk under an LPVR auction. For example, if 80 percent of the project is financed with debt, and 20percent with equity, and, if the government guarantees the debt, equity holders lose all their investment when demand is low. By contrast, they do not lose anything under an LPVR auction. Admittedly, equity holders do not know when they are going to recoup their investment, but this risk is minor compared with the possibility of losing the investment.

The above reasoning is not only theoretical, as the following examples show.

The Queen Elisabeth II Bridge: A Variable-Term Franchise. In 1987, the British government awarded a concession for the construction and operation of the Queen Elisabeth II Bridge that crosses the Thames near Dartford in Essex county. The winning consortium of Kleinwort Benson, Trafalgar House, Bank of America and Prudential Assurance was chosen in part because of its innovative financing package (which would also be suitable to finance a project awarded with an LPVR auction). While the demand for bridge crossings was uncertain, there was little doubt that the project was financially sound provided that the franchise term was long enough. Thus, the concession will end after 20 years or as soon as toll income is enough to repay principal and interest, whichever happens first. The project relied entirely on debt financing. The four members of the cosortium formed the Dartford River Ltd., with nominal capital of £1,000, which was lent £190 million. Dartford River Ltd. pays no dividends and all its net cash flow is used to pay back debt and interest. The bridge was inaugurated in October 1991 and it is estimated that it will return to the government in 1999, after only eight years.

The Second Severn Crossing: "Bankability" of Variable-Term Franchises. In 1992, construction work started on the Second Severn Crossing, the second bridge on the Severn estuary at the English Stones site. The amount of revenue that the franchise holder is allowed to collect is fixed for the entire period of 30 years, so that the concession ends as soon as the sum is collected. According to Jones et al. (1996): "If the contingent concession length had not been allowed, extra risk would have been transferred to the project's cost of capital, and banks may have been less prepared to take on financing risks." This £300 million project was finished under budget in June of 1996, and is now operating successfully.

There are several lessons to be learned from the previous reasoning and examples. First, guarantees are less important when the franchise is allocated with an LPVR auction. Second, even if the government pledges the same guarantee under both mechanisms, its actual outlays will be smaller with an LPVR auction because guarantees will be exercised less often. This point is important because it is highly likely that the guarantees provided by the State will come into effect in recessionary periods, thereby accentuating the fiscal problems that characterize economic downturns. Third, fixed-term and LPVR auctions are identical in terms of the flows they generate for paying off the contract debt; it is not true that the variable term of the LPVR auction means that loan repayments will be less certain. Finally, equity holders assume much less risk with an LPVR auction, and this translates into a lower risk premium, less frequent undesirable renegotiations and lower payments by users.

Does Term Extension Help?

A second limitation that has been suggested for LPVR auctions (see, e.g., Klein 1997), is that since infrastructure projects in developing countries are discounted at rates between 10 percent and 15 percent, the additional income obtained by the franchise holder when the term of the franchise is extended is of little use.[35]

There are two reasons why the above argument is not valid. First, discount rates depend on risk, the more risk the higher the discount rate. High "typical" discount rates are observed in projects where the term is fixed, thus risk is also high. For this reason, under an LPVR auction "typical" discount rates should be lower. Second, in most infrastructure projects demand grows over time at a rate similar to that of GDP, and risk free rates tend to be similar to GDP growth rates. That being the case, an extension of the term should increase the present discounted value of a project by approximately the same percentage.

Flexible Term and Maintenance Costs

It is clear that LPVR reduces demand uncertainty, but could it increases maintenance cost uncertainty which, in turn, might revert our previous results? First, note that average maintenance costs per vehicle must be lower than tolls, or the road would not have been built by private firms. Hence, uncertainty about maintenance costs will in general be less important than uncertainty about demand for the road. A complete answer to the question of whether the existence of uncertainty about maintenance costs will reduce the advantages of LPVR depends on the type of maintenance costs.

If costs are proportional to the number of cars that use the road, then bidders care only about net revenue per car (toll - maintenance cost per car) and it can be easily shown that all our propositions comparing the advantages of LVPR over fixed-term franchises continue to hold.

Suppose that maintenance costs are a fixed amount per period, depending on weathering effects, for instance. Under a fixed-term, maintenance costs are known beforehand, while there is uncertainty about the magnitude of these costs under LPVR. However, we have shown in previous work that the effect is of second order, and that this effect favors LVPR in the sense of raising social welfare as compared to a fixed-term franchise (EFG 1995). The intuition is simple: with the same toll, the lower demand risk faced by the franchise holder leads to a shorter concession term on average, and, thus, to lower expected maintenance costs. Since the franchise ends sooner on average, tolls fall earlier to a level which is enough to cover maintenance costs under an LPVR auction and have higher welfare than under a fixed-term franchise.

The last possibility is that the quality of construction is endogenous and that maintenance costs depend on construction quality. There are two effects that make the comparison more difficult than in the previous situations. Uncertainty about the duration of the concession under LVPR and hence uncertainty about maintenance costs will lead to a risk averse design that

[35] Remember that infrastructure franchises typically last between 10 and 30 years.

tends to have lower maintenance costs. However, a fixed-term concession will have on average a longer term, so the franchise holder will build for a longer term. These two effects go in opposite directions, so that is not clear whether maintenance cost uncertainty reduces the benefits of LVPR.

Incentives for Efficient Marketing

A real limitation of LPVR franchises is that incentives to market efficiently are smaller than when the term is fixed (EGF 1997c for a formal proof). The reason is that with LPVR mechanisms, any marketing effort which translates into higher demand shortens the term of the franchise, so that profits increase less than in the case where the term of the franchise is fixed. This implies that under LPVR auctions franchise holders have fewer incentives to invest in demand-increasing features. For this reason, an LPVR auction needs to be complemented with institutions that determine and enforce minimum quality standards to be met by franchise holders (see Tirole 1997). On this basis we do not recommend a pure LPVR auction for infrastructure projects in which demand is highly responsive to the activities of this franchise owners and where minimum standards are not sufficient to enforce adequate service.

There are additional means to enhancing marketing efforts. First, as suggested in Tirole (1997), a monetary reward that is larger the sooner the franchise ends may provide additional incentives for efficient management. Second, in some cases unbundling may be used to separate those parts of the business where there is little use for performance incentives from those parts in which they are important. This is the topic of the next section.[36]

[36] Another way of increasing the marketing effort is by lowering the discount rate, which makes shorter franchises more attractive, yet might create other distortions.

Unbundling: Designing Appropriate Incentives

It was argued in the previous section that LPVR auctions solve many of the problems created by fixed-term franchises. However, they do not provide strong incentives to invest in activities that increase demand by enhancing the quality of service. This is not a serious limitation in projects where demand depends little on the concessionaire's efforts (e.g., roads, tunnels or bridges) and where verifying minimum quality standards is easy. But in other types of franchises like ports, airports, water reservoirs or underground parking places, demand is sensitive to quality, and standards of service are difficult to design and enforce. Moreover, there may be many different types of services and new ones may be offered to increase demand. In those cases LPVR schemes may be inappropriate. In this section we argue that the scope of LPVR, auctions can be considerably widened if projects are unbundled into two components: a construction concession, auctioned under LPVR and an operating franchise adjudicated by a mechanism that provides high incentives to raise demand for the services of the project (either a fixed-term franchise or, whenever possible, competitive operators). Throughout this section we assume that the quality and state of conservation of assets can be easily verified.

Unbundling an Airport: Before an airport can operate, large investments are needed in runways, terminals, storage areas, and so on. Investments in runways are sunk and objective quality standards can be set and verified with specialized equipment. An LPVR auction is appropriate for the right to build runways because demand for the runway is independent of the effort of the franchise holder (provided that appropriate security standards are met). The revenues of the LPVR operator would come from landing fees. However, demand for airport services is sensitive to their quality since it depends on the availability of gates, efficiency in the handling of baggage and cargo, etc. If traffic is sufficiently large, more than one terminal will be necessary. The regulator can then sell the land to build terminals, and let different terminals compete and set prices for their services. No further regulation is needed. If traffic is small, so that only one terminal is needed, the right to build and operate it can be allocated in a fixed-term franchise. The runway can still be allocated with an LPVR auction.

Unbundling: Principles

When a project consists of several distinct businesses, it is better to manage each division as an independent profit center, unless economies of scope are important. Unbundling makes it possible to give each division appropriate incentives. In many infrastructure projects (e.g., airports, reservoirs, ports or underground parking lots) demand-enhancing activities are useful only in some segments. For example, seaport activity depends on the speed and diligence with which ships are unloaded. Thus, the franchise holder, who has partial control over demand, should face some demand risk. By contrast, provided that jetties, protection from waves or quays meet adequate construction standards, demand for port services depends little on actions taken by the franchise holder. There is nothing to be gained by making the franchise holder assume the risk that income will not be enough to cover investment outlays because the concession has a fixed duration; risk will only increase the required risk premium and the cost of the infrastructure.

The preceding discussion suggests that infrastructure projects can be franchised according to the following principles:

- Segments where the franchise holder's effort has little or no effect on demand and initial investments are large should be franchised using an LPVR auction.

- Segments where demand-increasing activities are important should be competitive if feasible, otherwise franchised with a fixed-term auction.

Thus unbundling enables the regulator to combine the flexibility and better risk distribution of an LPVR auction with the incentives resulting from competition or fixed-term franchises. In those segments that are franchised with an LPVR auction firms minimize costs because cost overruns are not covered by the regulator. But the franchise holder faces a lower demand risk since he will eventually receive the desired revenue income (in present value). Moreover, the scheme still retains the property of screening for white elephants since that risk is not covered by the regulator and the flexibility that characterized LPVR auctions survive.

Consider now the operation of those segments where the franchise holder's effort affects demand. Whenever competition can be established among operators, indefinite leases are appropriate. User fees and quality will be determined by competition without the need for regulatory intervention. When there is only one possible operator for the project, it is convenient to offer fixed-term operating franchises. Prospective franchise holders bid the user fee they would be willing to accept in order to operate the infrastructure project. The lowest bid wins the franchise. The total cost to a user is the sum of the fixed amount going to the segment franchised with an LPVR scheme and the user fee asked by the fixed-term franchise holder. Fixed-term leases provide the high power incentives for actions that increase demand for the infrastructure project, since at the margin, the operator is willing to spend a dollar in costs that increase demand by more than a dollar in present value during the remainder of the franchise. For example, the operator may invest in more efficient electronic tolling systems or better luggage transport systems at an airport.

Fixed-term leases retain their disadvantages, but since the sunk investment that the operator must incur is smaller when the project is unbundled, risk premiums fall and the various problems of fixed-term leases are also smaller. The desire to renegotiate the original contract exists, but the amounts at stake and the political power of the operator are substantially diminished. The contract is still inflexible but the consequences of inflexibility are less serious, because even though a fair compensation cannot be easily calculated, the amounts being considered are also smaller. If user fees are set too high, the regulator can lower the part of the total user fee received by the builder, without harming him (at least if the user fee assigned to the builder does not fall so much that the builder is never repaid) while increasing the demand faced by the operator, who still receives the same user fee. If the user fees are set too low, the builder will also be indifferent, but the operator will oppose a measure that reduces the demand it faces. Nevertheless, since the amounts at stake are lower, it should be easier to make an arrangement that compensates the operator, even though the renegotiation process may be biased towards the operator.

Implementation

We propose the following guidelines for the implementation of an unbundled privatization scheme:

- Determine the segments where competition is feasible. In those establish equal access to all firms that are interested.

- Determine minimum verifiable quality standards.

- Auction those segments where investment costs are large and demand is unresponsive to the franchise holder's effort using an LPVR scheme with a base "infrastructure fee" set by the regulator based on welfare considerations.

- In those segments where demand is responsive to the franchise holder's effort, if possible, establish competition in operations. Alternatively, auction a fixed-term maximum "service fee" franchise.[37]

[37] As long as the franchise can be auctioned on the basis of one variable. Otherwise, the planner must design a scoring function that weights the prices of the different services.

• If the LPVR construction franchise ends before the operations contract, the total infrastructure fee is set to zero and users continue paying the service fee.[38]

If the operation franchise ends before the LPVR franchise, the operation infrastructure project is reauctioned under a second fixed-term operating franchise.[39]

[38] This assumes that no major repair or improvement of the basic infrastructure is needed.

[39] This second stage operation franchise should include payment for the residual value of any investments made by the first operator, to ensure that remains interest in their maintenance close to the end of the franchise.

Conclusion

The experience with private infrastructure franchises has been mixed. In some cases, such as the provision of new roads in Mexico, the results have been disappointing. Moreover, regulators in developing countries faces various handicaps that imply that methods that are easily applicable in developed countries cannot be applied there. For example, the ability of the regulator to defend the interest of the public against the pressures of lobbies representing private infrastructure franchises, can be extremely poor. Hence franchise contracts must be carefully designed to retain flexibility under the changing conditions in developing countries while leaving no space for discretion on the part of the regulator. In this paper, we have presented a mechanism to auction infrastructure franchises which, we believe, represents a significant improvement over previous systems when the projects have high initial sunk costs and demand is unresponsive to effort by the franchise holder.

LPVR auctions suffer from a trade-off between demand risk and incentives. This scheme eliminates much of the undesirable demand risk borne by the franchise holder. At the same time, however it generates insufficient incentives to provide services of good quality and to invest in socially valuable marketing efforts. As Tirole (1997) has stressed, this suggests that LPVR franchises should be complemented with other regulatory innovations, such as independent third parties whose job is to verify both the quality of the infrastructure and service, and of commensurate fines for noncompliance. Since fixed-term and LPVR auctions represent the opposite extremes in terms of incentives, risk and flexibility, it seems that a method that combines the best features of each may be appropriate in cases where LPVR auctions are unattractive because demand is highly responsive to the actions of the operator. In these cases we propose unbundling financing and construction from the operation of the project. Under the unbundled scheme, building of the basic infrastructure proceeds along LPVR lines, with the builder receiving predetermined user fees ("infrastructure fees") for the different services of the project until the present value of the sum asked by the construction firm is reached. Operations are franchised to a different firm under a fixed-term franchise, where firms compete on the basis of the lowest user fee for service ("service fees"). Normally the operation franchise is also responsible for the maintenance of the project. Under this scheme, the building firm faces low risk and the contract is flexible. The operating contract is inflexible, but as the investment of the operating firm is much smaller and can be incurred over time, uncertainty matters less. Moreover, the operating company has powerful incentives to increase demand for the infrastructure project.

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