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PRIVATE FINANCE OF PUBLIC INFRASTRUCTURE

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Abstract

Public-private partnerships (PPPs) have emerged as an organizational form to provide public infrastructure. A key characteristic of PPPs is that private investors participate directly in individual infrastructure projects. The advantage of private finance is that it may improve incentives. However, private finance typically neither frees public funds, nor enlarges the pool of viable projects.

Private finance improves risk allocation if exogenous demand risk is assigned to the public, while endogenous risks are assigned to the private parties (PPP and financiers), which provides strong incentives for efficiency. When funding for the project relies on user fees, variable term contracts can allocate risks efficiently, in contrast to fixed term contracts.

A potentially fruitful area for future research, is to explore alternative financial contracts that allocate endogenous risks to private parties, and determine the optimal allocation of these risks among borrowers and lenders. This line of research is probably relevant beyond infrastructure finance.

1. Introduction

In recent decades, public-private partnerships, also known as PPPs, P3s, or concessions, have emerged as an organizational form to provide public infrastructure. Governments now have the alternative of procuring stand-alone infrastructure projects (e.g. highways, tunnels, airports or schools), contracting private firms to design, build, and operate them. Contracts are long term, typically measured in decades.[1]

Two central aspects of any PPP are the issues of funding and financing.[2] Just as traditional publicly procured projects, PPPs are funded by user fees or government transfers or a combination of both. For example, a road in high demand can be funded entirely with user fees, while government transfers are usually the main funding source for schools and hospital PPPs. While the shift from public procurement to PPPs comes usually (though not always) with a shift towards user fees, the nature of project funding is not different with private participation.

The finance of PPPs is a different issue. In public projects, savings are mobilized through public debt and the government budget, with little direct involvement of financiers. PPPs, by contrast, are financed by a combination of debt and equity, with the capital markets and private investors participating directly in the project. A central question for the private finance of public infrastructure is whether the engagement of private investors in public infrastructure improves resource allocation.

A case study illustrates why the answer is not straightforward. In 2002-2003 the London Underground (LU) and two newly formed special purpose vehicles (SPVs), Tube Lines and Metronet, signed a 30-year contract for the maintenance, renewal and upgrading of subway infrastructure. It was estimated that through the improved efficiency of the private sector, the program would save £4 Bn over the life of the contract and add £16 Bn in investments.[3] Nevertheless, by 2007 Metronet went into receivership (bankruptcy) after overspending. According to forensic reports, the reasons for the failure were poor corporate governance and contractual design weaknesses, as most of the risk remained with the public. The terms of the PPP meant that taxpayers were responsible for most of the debt. While Tube Lines was more successful, eventually it was also taken over after delays and cost increases in the upgrades of the Jubilee and Northern line. The Jubilee line upgrade ended costing two and a half times the original estimates. Tube Lines asked for an increase of funding of £5.75 Bn, while the arbiter would only provide £4.4 Bn. Eventually Tubelines was taken over by LU for £310 MM.

More generally, we argue that in the absence of financing constraints on a government, a PPP neither releases public funds nor enlarges the set of infrastructure projects that an economy can undertake. Direct finance of public infrastructure projects matters when it affects incentives, for example, through the allocation of risk. Yet, as the London Underground case illustrates, many things can go wrong when private financiers are directly involved in infrastructure projects. We show that in private finance of infrastructure there is a compelling argument for the government to assume exogenous demand risk through variable term contracts. Concessionaires and financiers should be made to bear endogenous and performance risks.

The rest of the paper proceeds as follows. In section 2 we state and prove irrelevance results in the private finance of public infrastructure. These address two common misconceptions. Section 3 briefly describes how financiers affect incentives in PPPs. Section 4 presents a simple model that

[1]For overviews of PPPs see Grimsey & Lewis (2007), Engel et al. (2014) and Fabre & Straub (2021).

[2]The difference between funding and financing is explained and discussed in depth in Fay et al. (2021).

[3]House of Commons Transport Committee (2010): "Update on the London Underground and the public-private (PPP) partnership agreements", Seventh Report of Session 2009-10, March 26th. Also see: Khoteva & Khoteva (2017) and Sheikh et al. (2015).

rationalizes the contractual separation of risks, because it may help address open questions in the literature on PPPs and finance. Section 5 concludes.

2. Irrelevance results in private finance

Financial intermediaries and the capital markets perform two related but different functions. The first is to mobilize savings, while the second role is to monitor compliance and performance. However, most arguments in favor of the private finance of public infrastructure are based on the assumption that savings mobilization enlarge the choice set of governments—they can "liberate" public funds which can then be used to fund other government policies; or they "expand" the set of available infrastructure projects.

Consider the first argument. Many practitioners and governments claim that, when compared with traditional infrastructure provision, PPP releases public funds; or, put slightly differently, that private finance relaxes the fiscal budget constraint and expands the set of public projects that a government can undertake.

To assess the impact of a PPP on the government budget, Table 1 compares the intertemporal budgetary effect of traditional provision and a PPP when an infrastructure project is funded using government transfers and the government can issue debt to finance the project.[4]

Table 1: Fiscal accounting: Funding from government transfers

	Public provision	PPP
Now:	Issue 100 in debt	"Save" 100 in debt
Now:	Spend 100 on infrastructure	Spend 100 on infrastructure
Future:	Collect 100 in taxes	Collect 100 in taxes
Future:	Pay 100 to bondholders	Pay 100 to concessionaire

As the first line shows, a PPP "saves" 100 in current spending and debt, but in both cases taxpayers pay 100 to fund the project. The only difference is that with traditional provision future governments use taxes to pay bond holders. By contrast, with a PPP they use tax revenues to fund the PPP and pay the concessionaire and its investors.

Table 2 shows that the same reasoning applies for PPPs funded with user fees. Again, the government seemingly "saves" 100 in current spending and debt. Moreover, it does not need to raise any taxes. Nevertheless, relative to traditional provision, it relinquishes 100 in user fee revenue, which the concessionaire uses to pay off the investment. Because in both cases the government pays for the infrastructure with user fee revenue, the fiscal impact is identical.

Table 2: Fiscal accounting: Funding from user fees

	Public provision	PPP
Now:	Issue 100 in debt	"Save" 100 in debt
Now:	Spend 100 on infrastructure	Spend 100 on infrastructure
Future:	Collect 100 in user fees	Give up 100 in user fees
Future:	Pay bondholders 100	Concession collects 100 in user fees

[4]This is based on Engel et al. (2021). Here we have assumed away any incentive effects of private finance, which we examine later.

The illusion that a PPP frees up government resources stems from the fact that fiscal accounting rules seldom recognize that the financing of a PPP implies an increase in net government borrowing, which the public will pay off in the future.

The second argument claims that private finance of public infrastructure expands the set of private projects that the economy can undertake: i.e., some projects can only be undertaken because there is private finance. To assess this claim it is helpful to use simplified sectoral T accounts.

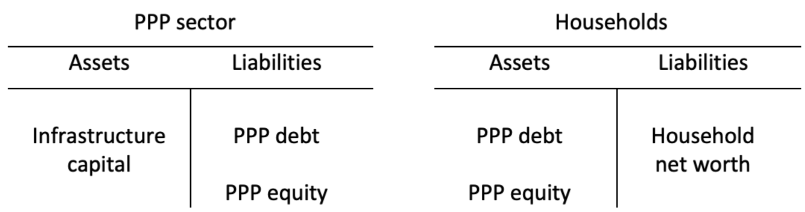

Figure 1: T accounts: PPP sector and Households

Consider an infrastructure facility that is added to an economy—a road, a hospital or a seaport. The first T account in Figure 1 shows that when the project is procured using a PPP, infrastructure capital is added to the asset side of the PPP sector. This asset is financed with private debt and equity (the liability side of the PPPs balance sheet). Now the second T account in Figure 1 shows that the liabilities of the PPP sector are part of the assets of the household sector, which reflects that capital can be accumulated because the household sector saves.[5]

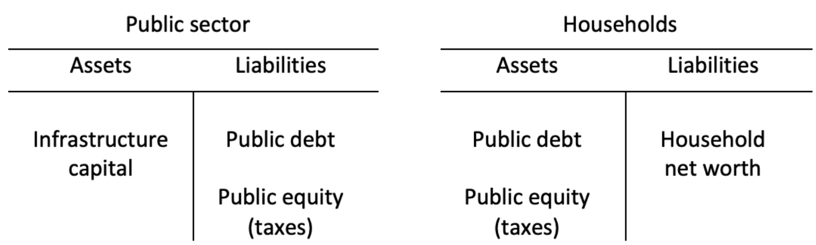

Figure 2: T accounts: Public sector and households

Thus the private finance of infrastructure is supposed to expand the set of projects available to the economy by mobilizing private savings. The argument ignores, however, that savings can also be mobilized through government debt and taxation. In that case infrastructure capital is part of the public sector's assets, as shown in the T accounts in Figure 2. In this case households own public debt and equity claims on the public sector. Moreover, as shown in Figure 3, in either case one can consolidate the balance sheets, with the result that debt and equity disappear in both balance sheets.

Ultimately, infrastructure capital is part of the net worth of households, which reflects the fact that the impact of infrastructure on the real economy stems from its services and not from the particular way in which savings are mobilized to finance the project. This result assumes that the government does not face borrowing constraints. If the country is credit constrained, under certain

[5]In an open economy, household liabilities could include foreign debt.

Assets	Liabilities
Infrastructure capital	Household net worth

Figure 3: Consolidated T account

conditions a foreign PPP may be able to access international capital markets and enlarge the set of feasible projects.

A third irrelevance result is that the risk allocation that is achievable through traditional provision contracts can be also achieved with a PPP implementing the optimal contract, as shown in section 4.3.3. It follows that PPPs do not improve risk allocation for standard contractual forms.

Why, then, should governments prefer private financing of public infrastructure using PPPs? A PPP is preferable to traditional provision only if it is more efficient: the infrastructure costs less if provided as a PPP, or if it delivers better quality of service. Private finance matters if it improves incentives. These irrelevance results typically break down in the presence of market frictions, such as moral hazard. Therefore, in the rest of the paper we concentrate on the issue of agency problems and PPP financing.

3. PPPs and finance in practice

3.1. Finance and the organizational structure of a PPP

PPPs are usually undertaken as project finance, using a structure known as a Special Purpose Vehicle (SPV). These are entities whose sole object is to finance, build, operate and maintain the PPP. The SPV is the counterparty to the Public Authority which commissions the infrastructure project. Financing the project means lending to an entity without assets, except for the PPP's contract and its own equity, as well as its sponsors' reputation and history, in the expectation of future revenue flows. The future flows can be payments and subsidies from the Public Authority for the availability of the project, user fees, or a combination of both.

Infrastructure PPPs bundle several activities into one contract between the SPV and the Public Authority. The contract usually involves the financing, building, operations, and maintenance of a project (sometimes even the design of the project). Under traditional provision of infrastructure, these different activities are managed by the Public Authority with different entities, and sometimes internally. In a PPP, the Public Authority delegates these various activities to the SPV. Iossa & Martimort (2012, 2015) have analyzed the conditions for bundling in infrastructure projects to be optimal, including its financial aspects.

There are two reasons why SPVs may be superior to having a division within a larger company undertake the project (Yescombe 2007). First, it isolates the recipients of funds, which makes the financial analysis of these long-term projects an evaluation of the project by itself, without the complications of being part of a firm with its own financial obligations. Second, disbursements to and from the SPV can be traced clearly. Contract revenues can be put in a trust, and financiers (banks or bond administrators) have step-in rights in case of financial difficulties. If the SPV fails, there still remains a source of residual value in the contract, that can be used to compensate lenders. Step-in rights allow the financiers to take over (or rather delegate) the contract, without having to go through a costly formal bankruptcy procedure and without complex negotiations with the Public Authority. This is an example of an efficient bankruptcy procedure (Hart 2000).

Compared with traditional public provision, the narrow organizational focus of an SPV raises efficiency and aligns incentives. Since PPP projects are large, they require independent management and both scale and scope economies across projects are typically small. Thus, an SPV seems particularly suitable as an organizational form. It is closer to the efficient scale of operations compared to the government entities responsible for public infrastructures in a given country or state. The financial implications of this form of organization for public infrastructure procurement remain largely unexplored, an exception being de Bettignies & Ross (2009).

3.2. The life cycle of PPP finance

During the construction phase of a PPP project, the SPV uses short- and medium-term bank loans, because at this stage it may be necessary to make decisions that require the approval of financial providers (for instance, additional finance to cover cost overruns or project redesign). Banks are more responsive than bond trustees, who require consultation with bondholders before making strategic decisions (EPEC 2010).

Once the project is built and the infrastructure is operational and generates steady revenue flows, bond finance can substitute for bank loans. Before the 2008 financial crisis, financial institutions known as monolines provided unconditional and irrevocable guarantees of timely repayment of bond debt in exchange for a fee. This allowed a bond to achieve triple A ratings that allowed institutional investors to buy the bonds (EPEC 2010). Thus, PPPs could be financed at the lower cost of long-term bond rates, relative to the rates on shorter term syndicated bank loans. In some countries, such as the UK and the US, bondholders delegated decisions in the initial stage of the projects to the monoline, which provided a sufficiently agile response (EPEC 2010). Thus lower cost bonds were issued from inception of a project.

Bond financing of infrastructure projects has a long history. An interesting example is the financing of the Golden Gate Bridge.[6] In August 1919, City officials asked the San Francisco City Engineer to explore the possibility of a bridge across the Golden Gate Strait, with an initial public design made public in 1922. In 1923, a special district was created for the purpose of planning, designing, building and financing the bridge, and in 1928 it was incorporated with the cities and counties of San Francisco, Marin, Sonoma, Del Norte, Napa and Mendocino as members. After much opposition, in 1930 (in the middle of the Great Depression) more than 2/3 of voters in the district approved the $35 MM bond issue to build the bridge, which had an estimated cost of $27MM. The bonds were retired in 1971 having paid the full principal and interest from bridge tolls, with (almost) no federal or State funds involved.

Bond financing of PPPs has not always been straightforward. In 2008, the bond market imploded, leading to the end of the monoline business model. Without monolines and their enhancement of investment ratings, institutional investors were unable to lend directly to PPPs. After the crisis, banks took a more important role in the long-term financing of PPPs. Not only did they provide finance during construction, but in many cases bank syndicates and private placements provided long-term finance for the projects, since institutional investors were unable to participate in projects with little history and no credit ratings. More generally, bond finance has been elusive. Ehlers et al. (2014) suggest why:

[6] See: "History and Research, Golden Gate Bridge, Highways and Transportation District", https://www.goldengate.org/bridge/history-research/.

> "Why do potential investors in many countries hold so few infrastructure bonds? [...] there is a lack of a pipeline of properly structured projects that often reflects an inadequate legal and regulatory framework. Infrastructure investments entail complex legal and financial arrangements, requiring a lot of expertise. Building up the necessary expertise is costly, and investors will only be willing to incur these fixed costs if there is a sufficient and predictable pipeline of infrastructure investment opportunities. Otherwise, the costs can easily outweigh the potential benefits of investing into infrastructure over other asset classes such as corporate bonds."

In other words, they argue that intermediaries specialized in these securities have not yet emerged because small deal volumes and a lack of standardization in infrastructure projects.[7] They describe the challenges involved as follows:

> "Creating a pipeline of suitable projects requires a coherent and trusted legal framework for infrastructure projects. The economic viability of infrastructure projects is often dependent on government decisions such as pricing, environmental regulation or transportation and energy policy. In some countries, reliable frameworks do not exist. [...] But even if solid legal frameworks exist, best practices or experience with large infrastructure projects can be lacking on the side of the government."

Ehlers et al. (2014) is an interesting viewpoint because it argues that supply-side factors explain the limited scope of bond finance and the prevalence of banks in infrastructure financing. Note that their argument depends on three premises. First, the legal framework for private involvement in infrastructure is weak and cumbersome, and heterogenous across countries. Second, governments are often unable to provide the conditions to deliver projects as PPPs. Third, banks are better at dealing with these issues. These conjectures may eventually be tested and are a fruitful area for future research.

An implication of the previous analysis is that until these problems are solved and PPP contracts become more standardized, it seems difficult for infrastructure to become a significant asset class.[8]

3.3. Risks

There are few empirical studies measuring the ex post returns of PPPs, let alone their relation to risk factors. Engel et al. (2021) have studied the pure project returns of individual PPP projects in Chile from the start of the PPP program in 1995 to 2019.[9] They show that the variance of project returns is large, suggesting that SPVs bear substantial risk. Apparently, at least in Chile there has been substantial risk transfer to the private sector.

The rules for risk assignment in the case of PPPs have been described by Irwin (2007). The efficient assignment of contractual risks is given by the relative ability of the parties involved to (i) influence the risk or alter project sensitivity to the risk, and (ii) to bear the risk. Thus, most construction, operations and maintenance cost risks should be assigned to the SPV, but sectoral regulatory and policy risk should lie with the Public Authority. Finally, in the case of exogenous demand risk (usually the case for highways, where demand depends mainly on regional economic activity), the

[7]On the issue of bespoke contracts in PPPs, see also Blanc-Brude & Strange (2007).

[8]On this issue see Inderst (2011), Blanc-Brude et al. (2017), Weber & Alfen (2010), Inderst & Stewart (2014a), Inderst & Stewart (2014b), Weisdorf (2007) and Ketterer & Powell (2018).

[9]Sirtaine et al. (2005) is an early example of an evaluation of the profitability of PPPs across various sectors. For an alternative analysis of the profitability of Chilean PPPs, see Vergara-Novoa et al. (2020).

ability to bear risk becomes relevant. Since the users spend a small fraction of their income on tolls while it represents the main or perhaps only source of funds for the private party, this risk should be borne by the public. As Hall (1998) points out, it does not make sense for the SPV to sell insurance to the government or to the public. We develop this argument with a simple model in the next section.

It should be noted that exogenous demand risk can be large in infrastructure projects. A case in point is the Dulles Greenway PPP in Virginia.[10] The Virginia Legislature allowed the private development of toll roads in 1988. The Dulles Greenway was an unsolicited proposal for a toll-road linking Leesburg, VA to the Dulles International Airport, in response to increased congestion in existing roads. The cost of the project was $350MM, of which $40MM was equity, the rest being privately placed debt. It began operations in 1995 after a 2-year construction period. The expectation was that there would be 35,000 daily vehicles willing to pay $1.75 on average. Unfortunately, only 8,500 daily vehicles used the Dulles Greenway. The number increased, but only to 23,000 when tolls were lowered to $1.00. The project sought refinancing in 1999, after defaulting on its bonds and wiping out one of the early investors. The debt was restructured and the franchise term was extended from 42.5 to 60 years. Eventually, demand for the project increased and it became profitable. This case shows the uncertainty in traffic volume predictions and the levels of demand risk in PPPs.[11]

In principle, the capital market could be used to diversify traffic risk. As we show formally below, an alternative way of dealing with exogenous demand risk while retaining incentives is to use a variable term contract known as Present-Value-of-Revenue (PVR) contract (Engel et al. 2018). Under a PVR contract, the regulator sets the discount rate and the tariff schedule. Firms bid the present value of the user fee revenue they require to finance, build, operate and maintain the infrastructure.[12,13] The firm that bids the lowest PVR gets the concession. The contract ends when the present value of user fees collected by the SPV equals the winning bid. The term of the concession automatically adjusts to demand shocks, resulting in a substantial reduction of demand risk borne by the concessionaire. In this way, demand risk is shifted to the public.

The first example of a PVR contract was the Queen Elizabeth II Bridge. This bridge opened in 1991, crossing the Thames river between Dartford and Thurock.[14] The government assigned the project to a newly formed SPV, the Dartford River Crossing Limited. The SPV would build, operate and maintain the project for the duration of the contract. In return, the SPV would receive the revenue from bridge tolls. According to the contract between the government and the SPV, the maximum term would be 20 years, but it could end sooner if the debt was repaid earlier, thus making it a variable term contract. The shareholders were investment banks and insurance companies. The value of equity of the SPV was set at a nominal amount (less than £2,000, see Fisher & Babbar (1996)). The contribution of each shareholder to equity (Trafalgar Square: 50%, Kleinwort Benson: 16.5%, Prudential: 16.5% and Bank of America: 17%) had the sole purpose of determining the fraction of lending each shareholder

[10]See Engel et al. (2006, 2014) and US DOT, Federal Highway Administration Center for Innovative Support, `https://www.fhwa.dot.gov/ipd/project_profiles/va_dulles_greenway.aspx`: "Project Profile, Dulles Greenway".

[11]For evidence on the lack of accuracy of demand forecasts, see Flyvbjerg et al. (2005), Van Wee (2007) and Trujillo et al. (2000).

[12]One possibility is to set the rate equal to the current weighted average cost of capital for an infrastructure project with standard loading.

[13]In the case of airports, revenues included in the bidding variable should include only aeronautical revenues (passenger and airport fees); Engel et al. (2018a) for details.

[14]See Engel et al. (2014) and Anderson, D. (2020) "The QE2 Bridge and the Private Finance Initiative (PFI) Hangover," Historian's Watch, January 27, https://www.historyworkshop.org.uk/the-qe2-bridge-and-the-private-finance-initiative-pfi-hangover/. Note, though, that this contact was awarded in what is known as a beauty contest, where a jury chooses the best proposal, firms did not bid on the present value of revenues they required.

would provide for the construction of the project. The revenues from tolls were used to repay the debt of the SPV and there were no distributions to shareholders. The sources of finance were subordinated loan stock sold to institutional investors and a syndicated loan with Bank of America as leader. The £120 million debt for the bridge was paid off on 31st of March 2002, after only 11 years of operation. It is noteworthy that the SPV had (almost) no equity, yet received financing.

3.4. Finance and renegotiations

It is well known that PPPs tend to be routinely renegotiated. Many renegotiations occur while projects are under construction or even just after signing. An early influential book by Guasch (2004) studied almost 1,000 PPP projects in Latin America. He showed that more than half (54.4%) of the projects in the transport sector had been renegotiated at least once.

More recently, Engel et al. (2019) examined 59 PPP highways in Chile, Peru and Colombia. There had been 535 contract renegotiations in total, leading to average annual increases over the initially declared investment of 9.5% in Colombia, 3.6% in Peru and 1.3% in Chile.[15] This resulted in accumulated renegotiations of 85.1% of initial investments in Colombia, 13.7% in Peru and 16.5% in Chile. Domingues & Miranda Sarmento (2016) examined the critical triggers of renegotiation in 32 projects in 13 European countries.

Renegotiations lower the risk of failure, which may help attract lenders.[16] On the other hand, the possibility of renegotiating the contract negates many benefits of PPPs. If the SPV knows that not being efficient (in demand forecasts, cost reduction, project design, service quality and so on) does not increase its risk of losses or of project failure, the incentive properties of PPPs are lost. Direct involvement of investors in the project does not help, because contract renegotiations act as an implicit guarantee for debts, and at times even for equity.

A case study illustrates how the expectation of renegotiation weakens the incentives of financiers. In 1989 Mexico awarded 52 toll road concessions covering more than 5.000 km, with investments of around $13 Bn. Half of total financing came from domestic banks, 30 percent were contributions from construction companies through equity and short-term loans, and 20 percent were public sector grants. Projects were auctioned with only preliminary studies, leading to cost overruns. Roads remained empty, because many were white elephants and others were poorly priced; and the PPP program failed spectacularly. The equity losses were estimated at $3 Bn, and the State was forced to take over the non-performing bank debt. Contracts were renegotiated at an estimated fiscal cost of $13 billion (Ortiz et al. 2006). One may wonder why banks did not anticipate that the government was doing a poor job in selecting and designing projects. Indeed, until 1991 they were state owned. At the onset of privatization their capability for financial analysis was weak. Furthermore, it seems that directly involving financiers and investors in project finance worsened resource allocation, because it allowed the government to use an off balance sheet vehicle, and banks had little incentive to lend carefully, as loans were implicitly guaranteed by the state. This case points to a potentially fruitful area for research, namely understanding how effort by financiers in project selection and borrower monitoring can be weakened by implicit guarantees provided by the State.

[15] See also Guasch et al. (2007) and Bitran et al. (2013), who quantify the determinants of government-led renegotiations in Latin America. Guasch et al. (2008) presents an empirical study of renegotiations in the transport and water sectors in Latin America. A recent evaluation of renegotiations in Latin America appears in Guasch et al. (2014).

[16] Menezes & Ryan (2015) show that SPVs may select their financial structure strategically, so that the threat of default can be used to pressure the Public Authority.

4. Optimal contracts

The previous sections have shown several economic and financial issues that arise in infrastructure PPPs. An important insight is that finance affects performance in PPPs through incentives. There is a large literature that models incentives in PPPs, but there are few formal models that study how finance affects incentives in PPPs.[17]

In this section we describe a simple framework to integrate finance and incentives. Models of this type have been used to analyze incentives in PPPs, but have not been applied to the relation between finance and incentives. There are many open questions that can be addressed with this type of model, for example, the interaction between bankruptcy, incentives and performance; the interactions between bankruptcy and renegotiation of financial contracts; financial structuring with variable term contracts; the relation between the capital structure of a PPP project and incentives; and monitoring by financial intermediaries of PPP effort. The following model is a useful building block and we present it to motivate further research.

4.1. Overview of the model

A risk neutral planner hires a risk-averse SPV to finance, build, operate and maintain an infrastructure PPP.[18] We assume demand is mainly exogenous and that quality of service is contractible.[19] This is the case for infrastructure projects such as highways, tunnels and bridges, which represent a large fraction of PPPs by expenditure. The planner designs a contract that assigns exogenous demand risk and endogenous cost risk optimally. Demand risk is assumed exogenous because demand depends mainly on aggregate and regional economic conditions beyond the control of the concessionaire.[20] In contrast, cost risk is assumed endogenous, for example because the SPV can exert non-contractible effort during construction that may result in lower maintenance and operating costs (Hart 2003). By bundling construction and maintenance, a PPP provides incentives for cost-reducing innovations, while no such incentives are present with unbundled public provision (Hart 2003).

Consider first the case without endogenous risk. In that case the optimal contract provides complete insurance to the firm, and competition for the contract ensures the private party receives no rents. Automatic adjustments of the contract term to demand realizations is an essential element of the optimal contract, which can be implemented with a PVR auction.

Consider now the case with endogenous and exogenous risks. Since the firm is risk averse and the planner is risk neutral, standard agency theory suggests that the optimal contract trades off exogenous demand risk against incentives for cost reduction. Somewhat surprisingly, the optimal contract in the model we present below avoids this tradeoff by fully insuring the concessionaire against exogenous demand risk while providing her with strong incentives to reduce costs. The model that follows is based on Engel et al. (2014).

4.2. Model

The planner's problem is to design the optimal infrastructure PPP and to implement it using a competitive auction. We first derive the planner´s optimal contract and next we show that it is implemented with a PVR auction.

[17] Notable exceptions are Iossa & Martimort (2015) and Fay et al. (2021).

[18] As is standard in moral hazard models, the less risk averse agent is modelled as risk neutral for simplicity.

[19] For the case of endogenous demand, see Engel et al. (2013).

[20] Demand risk also depends on service quality (which depends on private party effort). Yet highway services are contractible, so this component can be dealt with by specifying and enforcing service standards.

There are many identical expected utility maximizing firms that can build the project (a highway) at cost I, and have preferences represented by a strictly concave utility function u. We also assume that the design of the highway is given, that there are no maintenance costs, and that there is no depreciation of the asset. Operations costs are constant and for simplicity we include them in the value of I.[21]

Demand for the highway's services are described by a probability density over the present value of user fee revenue that the highway can generate over its entire lifetime, v. This density, denoted by $f(v)$, does not depend on actions of the concessionaire, is defined over $v_{\min} \le v \le v_{\max}$ and satisfies $v_{\min} \ge I$, so that the project is self-financing in all states of demand.[22,23]

We use a standard approach to analyze incentives for effort. Concessionaire effort during construction, e, has a probability $p(e)$ of leading to unobservable life-cycle savings equal to a constant $\theta > 0$ (or 0 otherwise), with $0 \le p(e) \le 1$, $p' > 0$ and $p'' < 0$. The cost of effort is ke, with $k > 0$.

The problem for the planner is to select the optimal remuneration schedule $R(v)$. Since v is exogenous, $v - R(v)$ are the toll revenues received by the government in state v. $R(v)$ does not depend on whether the high or low cost scenario attains because θ cannot be contracted upon because it is unobservable. We make the simplifying assumption that v equals the present value of the private willingness to pay for the project's services. It follows that the present value of consumer surplus in demand state v is equal to $v - R(v)$.

As in Laffont & Tirole (1993, Ch. 1), the planner places no value on the rents of the concessionaire and maximizes expected consumer surplus. Thus the planner solves:[24]

$$\max_{\{R(v),e\}} \int [v - R(v)] f(v) dv$$

$$\text{s.t.} \quad u(0) + ke = p(e) \int u(R(v) - I + \theta) f(v) dv \; + \; (1 - p(e)) \int u(R(v) - I) f(v) dv,$$

$$e = \underset{e' \ge 0}{\operatorname{argmax}} \, \{p(e') \int u(R(v) - I + \theta) f(v) dv \; + \; (1 - p(e')) \int u(R(v) - I) f(v) dv - ke'\},$$

$$0 \le R(v) \le v,$$

$$e \ge 0.$$

We use the convention that integrals without limits run over the range of values of v. The first three constraints are the concessionaire's participation, incentive compatibility, and self-financing constraints, respectively.

In Engel et al. (2014) we use this setting to contrast PPPs with traditional provision. Under traditional provision there is no bundling and the construction firm has no incentives to exert unobservable effort. The optimal contract is one with no risk for the concessionaire: she receives the same remuneration in all states, because adding risk makes her services costlier without any benefit. Since the planner prefers that the concessionaires receive no rents, we have in $R(v) = I$ for all v. This contract can be implemented with a PVR auction.

[21]For simplicity we assume identical costs across firms. If the cost I depends on the firm, a second price auction leads to a rent for the winning firm in the auction but nothing else changes. Finally, the case when either maintenance costs or operations cost depend on effort is treated in Engel et al. (2018).

[22]For simplicity demand is assumed totally inelastic to prices. In Engel et al. (2007) we show that removing this assumption does not alter the main economic results.

[23]See Engel et al. (2013) for the case where the project is not self-financing in some states of demand.

[24]The formulation below assumes the planner and the firm use the same discount rate when calculating v. See Lucas & Jímenez Montesinos (2021) for a review of the long standing debate on whether government should use the market rate and an argument in favor of the assumption we make.

Next, assume that $p'(0)[u(\theta) - u(0)] > k$. Then, as shown in Engel et al. (2014), there exist PPP contracts where the concessionaire provides effort and faces costly risk that provides more welfare than the optimal contract under public provision. The optimal such contract satisfies $R(v) = R^*$ for all v, where $I - \theta < R^* < I$ solves

$$p(e(R^*))u(R^* - I + \theta) \; + \; (1 - p(e(R^*)))u(R^* - I) = ke(R^*) + u(0)$$

with $e = e(R)$ a decreasing function defined implicitly by the first-order condition derived from the SPV's incentive compatibility constraint:

$$p'(e(R))[u'(R - I + \theta) - u'(R - I)] = k.$$

By providing incentives for the SPV to exert optimal effort $e^* = e(R^*)$, users save on average $I - R^*$.Observe that concessionaire receives $R^* < I$ for certain, plus a lottery with probability $p(e)$ that its costs will be lower by θ.

4.3. Some implications

4.3.1. PPPs do not free up public funds. Assume there is no moral hazard ($p(e) \equiv 0$) and users are charged their willingness to pay for the project, v. In this case the optimal contract sets $r(v) = I$ for all v. Then the impact of the highway project on the government budget in demand state v will be $v - I$, both under a PPP and under traditional provision. As discussed in section 2, in the absence of efficiency gains, PPPs do not free up government resources. Alternatively, only if a PPP leads to efficiency gains does it free public resources, on average $I - R^*$ in the model.

4.3.2. Separation of exogenous and endogenous risk. One of the most important results from this simple model is that the revenues received by the SPV are equal to R^* independent of the demand state v. That is, under the optimal contract, the SPV is fully insured against exogenous demand risk, while bearing all endogenous risk. This creates incentives for the SPV to efficiently manage risks under its control. Since the revenues received by the concessionaire are equal in all states of demand, the contract can be allocated by using a least present value of revenue auction. Under this contract, the concession lasts until the SPV collects the present value of user fee revenue bid in the auction.

The intuition underlying this result can be described in two intuitive steps. First, any contract which guarantees a level of effort is less costly if it offers full insurance across states of demand v. This follows from the concavity of u: any variation in exogenous SPV revenues across demand states acts like a coin toss that adds risk but does not provide incentives. Second, in the optimal contract the government wants to minimize the (present value of) the transfer to the SPV. Hence, a PVR contract implements the optimum if awarded by auction.

The separation of endogenous and exogenous risk is a key characteristic of the private finance of public infrastructure. It allows the Public Authority to exploit the additional degree of freedom provided by varying the term of the contract, which can be used to insure the SPV against exogenous demand shocks.

Engel et al. (2018) explores one aspect of this issue, describing the contracts that have been used in Chile to finance airport PPPs. In the model when effort is successful, gains are linear in exogenous demand, in contrast to the above model where they were constant. More generally, the separation of endogenous and exogenous risks could also be used in private contracts, whenever a party to a contract has better diversification opportunities than the other. A potential area of research is to explore the contracts between financiers and the SPV that build on this separation.

Table 3: Exogenous risk and contractual form

	Contractual form		
	Traditional provision	PPP	
Funding source	(1)	(2)	(3)
User fees		PVR contract	Fixed term contract
Users	$CS_0^\infty(v) - R_0^\infty(v)$	$CS_0^\infty(v) - R_0^\infty(v)$	$CS_0^\infty(v) - R_0^\infty(v)$
Taxpayers	$R_0^\infty(v) - I$	$R_0^\infty(v) - I$	$R_T^\infty(v)$
Firm	$I - I$	$I - I$	$R_0^T(v) - I$
Taxes		Availability payments	Fixed term shadow tolls
Users	$CS_0^\infty(v)$	$CS_0^\infty(v)$	$CS_0^\infty(v)$
Tapayers	$-I$	$-I$	$-R_0^T(v)$
Firm	$I - I$	$I - I$	$R_0^T(v) - I$

Notation. v: state of demand; CS: consumer surplus; R: user fees or shadow toll revenue; I: upfront investment; X_s^t: present discounted value of X between times s and t, as of time 0; T: length of fixed-term contract. Source: Engel et al. (2014).

4.3.3. Diversification of exogenous risk through the budget.

The optimal contract takes advantage of the fact that the government may be less risk averse than the SPV, a shortcut that captures that the government has diversification opportunities that cannot be accessed by the SPV.[25] Of course, with perfect capital markets, the diversification of exogenous risk that can be achieved by public provision can also be achieved through the capital market. In practice, however, there are transaction costs that preclude the existence of complete markets and limit diversification through the capital market.

Exploring whether and how PPPs could spread exogenous risk through the capital market is a promising area for research. In the meantime, we present a complementary result, namely that any risk allocation that is achievable through traditional provision can be also achieved with a PPP implementing the optimal contract (Engel et al. 2014).

To see this, consider the following scenario, which is the special case of the model of section 4.2 without endogenous risk, i.e., $p(e) = 0$ (Engel et al. 2001, 2013). Demand for the infrastructure is uncertain, so that consumer surplus at time t, CS_t, and user fee revenues, R_t, are random variables determined by the state of demand, v. Upfront investment, I, is the same in all demand states and operating and maintenance costs are zero. Finally, the SPV is selected in a competitive auction that dissipates rents.

Table 3 shows the distribution of the present value of cash flows and surpluses in one demand state, v, for alternative funding sources and procurement mechanisms. Rows distinguish between the funding sources (user fees versus taxes). Columns distinguish between governance structures (traditional provision versus PPPs). Within PPPs, alternative contractual forms are possible, depending on the source of revenues: PVR contracts, fixed-term concessions, availability contracts and shadow tolls.[26]

Note that with user fee funding, traditional provision (column 1) and PVR (column 2) are identical. Similarly, public funding under traditional provision and availability payments are also identical.

[25] In some cases, local governments may have less opportunity to diversify risk than companies with access to international capital markets.

[26] Shadow tolls is a mechanism in which the Public Authority pays a fee in lieu of users for a fixed number of years, T.

This is our main claim: independent of the source of funds, there exist PPP contracts that replicate in all demand states the surplus and cash flow distribution of traditional provision and have the same impact on the intertemporal public budget.

To see this, let X_s^t denote the present value of X between times s and t, as of time 0, and consider first the case in which funding comes from user fees. Under public provision, the project is built at cost I, and the builder is paid I before the infrastructure becomes operational (we assume competitive tendering at the construction stage, so no rents). Hence, taxpayers pay I upfront, collect $\mathrm{R}_0^\infty(v)$ in state v and receive $\mathrm{R}_0^\infty(v) - I$ in present value. Users, on the other hand, receive a net surplus equal to $\mathrm{CS}_0^\infty(v) - \mathrm{R}_0^\infty(v)$.

Under a PVR contract, taxpayers save I upfront, but they relinquish user fee revenue during the length of the concession, which is equal to I in present value (given that the competitive assumption means that the winning bid will ask for I in present value of revenues). Because the state collects user fees after the concession ends, taxpayers receive $\mathrm{R}_0^\infty(v) - I$. Users' net surplus in state v is $\mathrm{CS}_0^\infty(v) - \mathrm{R}_0^\infty(v)$, as with traditional provision. This confirms that when there are user fees, any risk diversification advantage for the government can be realized with a PPP under a PVR contract.

Now consider a fixed-term PPP that lasts T years (column 3). The SPV collects $\mathrm{R}_0^T(v)$ with a surplus of $\mathrm{R}_0^T(v) - I$, which is a random variable. In contrast, it faces no risk under a PVR contract. Taxpayers receive $\mathrm{R}_T^\infty(v)$ and, in general, their risk falls.[27] A fixed-term contract thus shifts risk from taxpayers to the SPV because it faces uncertainty about demand for the project during the fixed term T.

Next consider projects that are fully funded from the budget. Again, with traditional provision the project is built at cost I, which the firm receives before the infrastructure becomes operational — taxpayers pay I upfront. When a PPP is financed with availability payments, the timing of disbursements differs, but the present value of payments is still I. Hence, neither taxpayers nor the SPV bear risk, and the impact of the project on the intertemporal public budget is the same in both cases.

PPPs funded via taxes have sometimes resorted to shadow tolls, as in the case of Portugal (Miranda Sarmento & Renneboog 2015). This type of contract shifts risk to the SPV, creating a risk premium (lower right corner of Table 3). Thus, a shadow toll contract adds a zero-sum lottery to an availability contract without providing a compensating benefit.

Summing up, in the absence of moral hazard, the optimal risk allocation can be achieved both under traditional provision and PPPs, see columns (1) and (2) in Table 3. Alternative PPP contracts are not efficient (see column (3)).

4.3.4. The PPP interest rate premium. We return to the case with endogenous risk. A recurrent criticism of PPPs is that they cost more per dollar of financing than public debt — the so-called PPP premium. The numbers that have been quoted for this cost difference vary widely. According to Yescombe (2007, p. 18), the cost of capital for a PPP used to be 200-300 basis points higher than the cost of public funds. Yescombe also shows that the spread over the lender's cost of funds lies in the range of 75-150 basis points, with highway projects being at the upper limit Yescombe (2007, p. 150).

There are various reasons why the measured PPP premium should not be used as an argument against PPPs. First, Lucas & Jímenez Montesinos (2021) note that the PPP premium may be the result of mis-measurement, since taxpayers act as risk-absorbing debt and equity holders in public investment projects. When the cost of that risk is factored in, the difference in financing costs is

[27]For any process with independent increments, as well as any stationary non-deterministic process, it is easy to show that the standard deviation of R_T^∞ is decreasing in T. It follows that with public provision or a PVR contract, the standard deviation of taxpayers' discounted revenue will be higher than under a fixed-term PPP.

reduced.

Second, the PPP premium reflects incentives for efficiency and innovation not present under public provision. To see this, we define the PPP premium as the risk premium paid by the planner to compensate the risk averse private party. Under traditional provision the optimal contract has no PPP premium. In contrast, under a PPP, there is a premium which is larger when the response to effort is more important.

Despite paying a premium, the planner prefers a PPP over traditional provision The reason is that even though the implicit interest rate of every dollar transferred by the planner to the SPV is higher under a PPP, the total expected cost to society is lower: R^* instead of I. The flip side of the PPP premium is that effort exerted by the concessionaire results in innovations that increase consumer surplus from $v - I$ to $v - R^*$.

More generally, one of the main points of a PPP is to shift endogenous risk to the SPV, to prevent moral hazard and strengthen incentives to cut costs and provide adequate service quality. Unless the SPV is risk neutral, it will charge for bearing that risk. Moreover, these risks are not diversifiable in the capital market, for if they could be diversified, there would be no incentive to improve performance in the first place. There is no reason to believe prima facie that achieving equivalent incentives with traditional provision would be cheaper. As Klein (1997) pointed out, the cost of funds cannot be considered independently from the incentive systems.

5. Conclusion

We began this review by stating that the central question of private finance of public infrastructure is whether the direct involvement of the capital markets and investors-financiers in the project improves resource allocation. We have seen that private finance does not save public funds or enlarge the set of infrastructure projects worth undertaking, unless the contract creates incentives for effort. Thus, the impact of private finance on resource allocation is associated to improved incentives. Well-designed contracts improve efficiency by prompting financiers to lend carefully and monitor the SPV. Badly designed contracts that ensure that financiers face no risk of losses regardless of performance will lead to poor performance.

The insight of the paper is that if financial contracts affect performance in PPPs, they act through improved incentives. Therefore we argue that a promising area of research is to study how financial structures affect incentives in PPPs. Examples are the impact of bankruptcy provisions on incentives, the bankability of projects under different contractual forms, and the provision of monitoring incentives for the financial provider. The model described in the previous section can serve as a starting point.

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LITERATURE CITED

Bitran E, Nieto-Parra S, Robledo JS. 2013. Opening the black box of contract renegotiations: An analysis of road concessions in Chile, Colombia and Peru. Working Paper 317, OCDE

Blanc-Brude F, Strange R. 2007. How banks price loans to Public-private partnerships? evidence from the European markets. *Journal of Applied Corporate Finance* 19(4):29–41

Blanc-Brude F, Whittaker T, Wilde S. 2017. Searching for a listed infrastructure asset class: Mean-variance spanning tests of 22 listed infrastructure proxies. *Financial Markets and Portfolio Management* 31:137–179

de Bettignies JE, Ross TW. 2009. Public–private partnerships and the privatization of financing: An incomplete contracts approach. *International Journal of Industrial Organization* 27:358–368

Domingues S, Miranda Sarmento J. 2016. Critical renegotiation triggers of european transport concessions. *Transport Policy* 48:82–91

Ehlers T, Packer F, Remolona E. 2014. Infrastructure and corporate bond markets in Asia, In *RBA Annual Conference on Financial Flows and Infrastructure Financing*

Engel E, Ferrari M, Fischer R, Galetovic A. 2021. Managing the fiscal risks wrought by PPPs: A simple framework and some lessons from Chile. Unpublished

Engel E, Fischer R, Galetovic A. 2001. Least-present-value-of revenue auctions and highway franchising. *Journal of Political Economy* 109(5):993–1020

Engel E, Fischer R, Galetovic A. 2006. Privatizing highways in the united states. *Review of Industrial Organization* 29:27–53

Engel E, Fischer R, Galetovic A. 2007. The basic public finance of public-private partnerships. Working paper 13284, NBER

Engel E, Fischer R, Galetovic A. 2013. The basic public finance of public-private partnerships. *Journal of the European Economic Association* 11(1):83–111

Engel E, Fischer R, Galetovic A. 2014. Public-private partnerships: A basic guide. Cambridge University Press

Engel E, Fischer R, Galetovic A. 2018. The joy of flying: Efficient airport ppp contracts. *Transportation Research Part B:Methodological* 114:131–146

Engel E, Fischer R, Galetovic A. 2019. Soft budgets and renegotiation in public-private partnerships. *Economics of Transportation* 17:40–50

EPEC. 2010. Capital markets in PPP financing: Where we were and where are we going? Tech. rep., European Investment Bank

Fabre A, Straub S. 2021. The impact of public-private (ppps) in infrastructure, health and education, forthcoming. *Journal of Economic Literature*

Fay M, Martimort D, Straub S. 2021. Funding and financing infrastructure: The joint-use of public and private finance. *Journal of Development Economics* 150:102629

Fisher G, Babbar S. 1996. Private financing of toll roads. RMC Discussion Paper Series 117, World Bank

Flyvbjerg B, Holm MKS, Buhl SL. 2005. How (in)accurate are demand forecasts in public works projects? *Journal of the American Planning Association* 71(2)

Grimsey D, Lewis MK. 2007. Public private partnerships and public procurement. *Agenda* 14(2)

Guasch JL. 2004. Granting and renegotiating infrastructure concessions: Doing it right. Washington: The World Bank

Guasch JL, Benitez D, Portables I, Flor L. 2014. The renegotiation of ppp contracts: An overview of its recent evolution in latin america pdf. Discussion Paper 18, International Transport Forum

Guasch JL, Laffont JJ, Straub S. 2007. Concessions of infrastructure in Latin America: Government-led renegotiations. *Journal of Applied Econometrics* 22(Jo):1267–1294

Guasch JL, Laffont JJ, Straub S. 2008. Renegotiation of concession contracts in Latin America. *International Journal of Industrial Organization* 26:421–442

Hall J. 1998. Private opportunity, public benefit? *Fiscal Studies* 19(2):121–140

Hart O. 2000. Different approaches to bankruptcy. Tech. Rep. 7921, NBER

Hart O. 2003. Incomplete contracts and public ownership: Remarks and an application to public-private partnerships. *Economic Journal* 113:C69–C76

Inderst G. 2011. Infrastructure as an asset class. *EIB Papers* 15(1):70–105

Inderst G, Stewart F. 2014a. Institutional investment in infrastructure in developing countries. introduction to potential models. Policy Research Working paper 6780, The World Bank

Inderst G, Stewart F. 2014b. Institutional investment in infrastructure in emerging markets and developing economies

Iossa E, Martimort D. 2012. Risk allocation and the costs and benefits of public-private partnerships. *RAND Journal*

of Economics 43(3):442–474
Iossa E, Martimort D. 2015. The simple microeconomics of public-private partnerships. *Journal of Public Economic Theory* 17(1):4–48
Irwin T. 2007. Government guarantees: Allocating and valuing risk in privately financed infrastructure projects. The World Bank
Ketterer J, Powell A. 2018. Financing infrastructure: on the quest for an asset class. Discussion paper 622, Inter-american Development Bank
Khoteva M, Khoteva D. 2017. Public-private Partnerships: A solution for infrastructure development in the UK? Case Study of the London Underground Public-private Partnership Project. *International Review of Management and Marketing* 7(1):300–308
Klein M. 1997. The risk premium for evaluating public projects. *Oxford Review of Economic Policy* 13(4):29–42
Laffont JJ, Tirole J. 1993. A theory of incentives in procurement and regulation. Cambridge, MA: The MIT Press
Lucas D, Jímenez Montesinos J. 2021. A fair value approach to valuing public infrastructure projects and the risk transfer in Public-Private-Partnerships. In *Economics of Infrastructure Investment*, ed. E Gleaser. The University of Chicago Press, 369–408
Menezes F, Ryan M. 2015. Default and renegotiation in public-private partnership auctions. *Journal of Public Economic Theory* 17:49–77
Miranda Sarmento J, Renneboog L. 2015. Portugal's experience with public-privatepartnerships. In *Public Private Partnerships: A Global Review*, eds. A Akintoye, M Beck, M Kumaraswamy. Routledge, UK.
Ortiz F, Bain R, Carniado S. 2006. A credit review of Mexico's toll road sector: Stable and strong. Infrastructure Finance, Standard & Poor's.
Sheikh S, Asher MG, Ramakrishnan V. 2015. A case study of Metronet PPP in the UK: Implications for India? Research Paper 15-26, Lee Kuan Yew School of Public Policy
Sirtaine S, Pinglo ME, Guasch JL, Foster V. 2005. How profitable areinfrastructure concessionsin latin america? empirical evidence and regulatory implications. Trends and Policy Options 2, PPIAF
Trujillo L, Quinet E, Estache A. 2000. Forecasting the demand for privatized transport: what economic regulators should know and why, vol. 2446. World Bank Publications
Van Wee B. 2007. Large infrastructure projects: a review of the quality of demand forecasts and cost estimations. *Environment and Planning B: Planning and Design* 34(4):611–625
Vergara-Novoa C, Sepúlveda-Rojas JP, Alfaro MD, Soto P, Benitez-Fuentes PA. 2020. Analysis of revenues, costs and average costs of highway concessions in Chile. *Transport Policy* 95:114–123
Weber B, Alfen H. 2010. Infrastructure as an asset class: Investment strategies, project finance and ppps. John Wiley and Sons
Weisdorf M. 2007. Infrastructure: A growing real return asset class 24:17–27
Yescombe ER. 2007. Public-private partnerships: Principles of policy and finance. Butterworth-Heinemaan

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