Economics Letters 256 (2025) 112649

Contents lists available at ScienceDirect

Economics Letters

journal homepage: www.elsevier.com/locate/ecolet

Public–private partnerships, asymmetric information, and incomplete contracts

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ARTICLE INFO

JEL classification:
D23
D86
H41
H57
L33

Keywords:
Public–private partnerships
Traditional procurement
Asymmetric information
Incomplete contracts
Information gathering

ABSTRACT

We develop an incomplete-contracting model in which the government engages a private contractor to provide a public good. Over time, adaptations of the good to changing circumstances may become desirable. The contractor privately learns the costs of implementing these adaptations. We compare two organizational forms. In a public–private partnership, the government actively participates in project management and, by incurring information-gathering costs, may ascertain the contractor's adaptation costs. Under traditional procurement, the government lacks direct involvement in project management, preventing it from ascertaining the adaptation costs. We show that the government's potentially enhanced access to the contractor's information in a public–private partnership can either support or undermine the case for such partnerships.

1. Introduction

When a government engages a private contractor for the provision of a public good, it may choose between two organizational forms: traditional procurement (TP) and a public–private partnership (PPP). A public–private partnership differs from traditional procurement in that it involves a closer and more collaborative relationship between the government and the private contractor. In a public–private partnership, the government is often actively involved in managing and monitoring the project, gaining detailed, ongoing insights into the contractor's costs and operational challenges. In contrast, traditional procurement typically involves a more arm's-length relationship, where the government is less familiar with the contractor's internal cost structure due to its lack of direct involvement in project management.

In this paper, we develop an incomplete contracting model in which only the basic characteristics of the public good can be specified at the outset. When adaptations of the good to changing circumstances become contractible, the contractor privately learns the costs of implementing the adaptations. The sole distinction between the two organizational forms in our model is that, in a public–private partnership, the government may undertake costly information gathering to ascertain the contractor's adaptation costs, whereas in traditional procurement, the government lacks sufficient involvement in the production process to acquire this information.

Our analysis shows that when the government's information gathering costs in a public–private partnership are sufficiently low, the government prefers a public–private partnership. This preference arises because the information asymmetry inherent in traditional procurement can lead to an inefficient adaptation decision. However, if the information gathering costs are higher, yet still low enough to be incurred in a public–private partnership, the government may favor traditional procurement. The reason is that, once adaptations become contractually specifiable, in a public–private partnership the government incurs information-gathering costs to reduce the contractor's information rent. Yet, from an ex ante perspective, the expected surplus may be greater if these costs are avoided, as is the case under traditional procurement. Thus, the government's enhanced access to information about the contractor's costs in a public–private partnership can serve as an argument either for or against such partnerships, depending on the specific circumstances.

The present contribution complements the existing literature on public–private partnerships, which has primarily emphasized the

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[1] I have benefitted from very valuable discussions with Eva Hoppe. Moreover, I would like to thank an anonymous reviewer for making helpful comments. Financial support by Deutsche Forschungsgemeinschaft (DFG, German Research Foundation), Project 433238595, is gratefully acknowledged.

[2] For general introductions to public–private partnerships, see Grimsey and Lewis (2004) and Engel et al. (2014).

https://doi.org/10.1016/j.econlet.2025.112649
Received 28 July 2025; Received in revised form 3 September 2025; Accepted 1 October 2025
Available online 3 October 2025
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bundling of tasks such as design, construction, financing, operation, and maintenance within long-term contracts.[2] In contrast, we focus on the collaborative nature of public–private partnerships, which inherently require closer coordination between public and private partners than traditional procurement methods. This increased interaction may allow the government to gain deeper insights into the contractor's cost structure. While collaboration is a defining feature of all public–private partnerships, its intensity and form vary with project complexity. In particular, technically demanding, high-risk, or innovative projects tend to necessitate more substantial public-sector involvement and closer working relationships than standardized service delivery. Accordingly, our analysis is especially relevant for complex public–private partnerships involving new technologies.

As an illustration, consider the development of a vaccine, where the contractor could be a pharmaceutical firm such as Moderna, working in partnership with government agencies like the NIH.[3] Adaptations might include altering the vaccine formulation to counter emerging virus variants or scaling up manufacturing processes. In a public–private partnership arrangement, the government agency may engage in continuous oversight and monitoring of R&D expenditures by embedding government scientists in the pharmaceutical firm's research team, allowing for a more accurate assessment of the adaptation costs.

Another example relates to the provision of efficient IT services in public administration, with a software company such as Palantir acting as the contractor. In particular, it is crucial for law enforcement and intelligence agencies to have up-to-date analytical tools. Adaptations might involve upgrading cybersecurity measures as new threats emerge or integrating new modules to address evolving data needs. Under a public–private partnership, the government actively participates in project management and decision-making, which reduces the costs associated with learning about unanticipated adaptation expenses compared to a more distanced traditional procurement contract.

As a further illustration, the government might wish to enhance national emergency communications, ensuring that citizens receive critical alerts and services during disasters. A contractor such as SpaceX could build and operate a network of satellites to serve public communication needs.[4] Once the contract is signed, adaptations such as increasing satellite capacity, repositioning satellites, or modifying ground station infrastructure might become necessary. In the case of traditional procurement, the government does not have continuous involvement in the project and therefore might not be able to learn the contractor's adaptation costs. In contrast, a public–private partnership entails close, ongoing involvement by the government. For instance, the contractor might frequently collaborate with government technical experts in steering committees or joint project offices. Consequently, by incurring some information-gathering expenses, the government might learn the contractor's adaptation costs.

While the examples illustrate that the model's core assumptions are plausible, the aim of our analysis is to explore how the relative performance of public–private partnerships versus traditional procurement in such complex projects depends on the magnitude of the government's information-gathering costs.

Related literature. The contract-theoretic literature on public–private partnerships was initiated by Hart (2003).[5] The present paper complements this literature in two distinct ways. First, the literature typically analyzes incentives to make non-contractible investments. In contrast, we focus on hidden information about adaptation costs, which may lead to ex post inefficiencies.[6] There are no hidden actions or non-verifiable investments in our model. Second, most papers explore the implications of bundling different tasks in public–private partnerships, whereas these tasks remain unbundled in the case of traditional procurement. In contrast, we emphasize that in a public–private partnership, the government is more likely to be able to learn the contractor's private information than in the case of traditional procurement.[7]

Hoppe and Schmitz (2013) and Buso (2019) also investigate the role of asymmetric information in the context of public–private partnerships. However, these papers seek to determine whether or not the two tasks of building and operating an infrastructure should be bundled. In Hoppe and Schmitz (2013), the agent responsible for building the infrastructure can gather information about the costs of improvements required during the operating stage. In Buso (2019), the agent managing the operating stage learns information about an externality parameter linking the building stage with the subsequent operating stage. In contrast, in the present paper we do not study the bundling of tasks and in our setting the government can engage in costly information gathering.

2. The model

Consider a principal (a government agency) who engages an agent (a private contractor) to provide a public good. Both parties are risk-neutral, have reservation utilities normalized to zero, and face no binding wealth constraints. At date 1, the principal can offer an incomplete contract to the agent, specifying the basic features of the good to be provided at date 2 and a transfer payment P_0.[8] Furthermore, the principal chooses one of two organizational forms, $o \in \{TP, PPP\}$. In the case of traditional procurement ($o = TP$), the principal is not involved in the details of the agent's business operations. In contrast, in the case of a public–private partnership ($o = PPP$), the principal and the agent interact closely throughout the duration of the project.[9] Suppose the agent's cost of providing the basic version of the public good is given by $C_0 > 0$, while the principal values it at $V_0 > C_0$.

At date 2, adaptations of the project to the prevailing state of the world become contractible and can increase the principal's valuation by $v > 0$.[10] The costs to the agent of implementing these adaptations

[3] See D'Souza et al. (2025) for a detailed discussion of "Operation Warp Speed," which was successfully launched by President Donald Trump in May 2020 to develop a Covid-19 vaccine, cutting the typical ten-year timeline needed to develop a new vaccine down to ten months.

[4] See Anderson (2013) for a discussion of public–private partnerships in the context of space travel.

[5] For a survey of the contract-theoretic literature on public–private partnerships, see Iossa and Martimort (2015). More recent contributions include, among others, Greco (2015), Martimort and Straub (2016), Buso et al. (2017), Fay et al. (2021), Hoppe and Schmitz (2021), and Buso and Greco (2023).

[6] Hart and Moore (2008, p. 2) point out that in the traditional incomplete contracting literature the "emphasis on noncontractible ex ante investments seems overplayed" and they argue that ex post inefficiencies may play an essential role in explaining organizational forms. Similarly, Moore (2016, p. 12) argues that "Hold-up is important, but looking round the world it seems that ex post inefficiencies are even more important".

[7] See also Fouad et al. (2021), who emphasize that a public–private partnership allows the government to identify project costs in a more transparent manner. However, they do not provide a formal analysis.

[8] Thus, following the incomplete contracting approach (cf. Hart, 1995), we rule out complex mechanisms along the lines of d'Aspremont and Gérard-Varet (1979). As has been argued by Hart (2017, p. 1743), such mechanisms are "not seen in practice". Moreover, following Hart (2003), we assume that the government has all bargaining power. It is straightforward to adapt the model to the case in which also the agent has some bargaining power.

[9] For simplicity, in our model the only difference between public–private partnerships and traditional procurement is that the former involves a closer and more collaborative relationship, which may place the government in a better position to learn details about the contractor's operations. For models analyzing other differences between the two organizational forms (e.g., regarding the bundling of sequential project stages), see the literature reviewed by Iossa and Martimort (2015).

[10] The necessity to make adaptations to changing circumstances has also been emphasized by Martimort and Straub (2016). However, their model focuses on moral hazard problems with limited liability (cf. also Hoppe and Schmitz, 2021, and Pi, 2021), which do not play a role in the present framework.

are $c \in [0, \bar{c}]$, where $\bar{c} > 0$. The principal offers an additional payment p to the agent if the agent agrees to carry out the adaptations. We assume that c is a uniformly distributed random variable, and that at date 2, the agent privately learns its realization. In the case of traditional procurement, the principal cannot find out what cost level c has been realized, because he is not closely involved in the production process. In contrast, in the case of a public–private partnership, the principal is more familiar with the details of the project and has better access to the specifics of the production process; so by incurring information gathering costs $k > 0$, the principal can learn the realization of c.

Before analyzing the model, we briefly describe the first-best benchmark. Let $x \in \{0, 1\}$ indicate whether the date-2 adaptations are implemented ($x = 1$) or not ($x = 0$). The first-best solution maximizes the parties' total surplus $V_0 - C_0 + (v - c)x$. Note that it is ex post efficient to implement the adaptations whenever $v - c \geq 0$ holds, so

$$x^{FB}(c) = \begin{cases} 1 & \text{if } c \leq v, \\ 0 & \text{otherwise.} \end{cases}$$

The expected total surplus in the first-best solution is given by $S^{FB} = V_0 - C_0 + E[\max\{v - c, 0\}]$. Observe that $E[\max\{v - c, 0\}] = \int_0^{\min\{v,\bar{c}\}} (v - c)\frac{1}{\bar{c}} dc$, which is equal to $\frac{1}{2\bar{c}} v^2$ if $v \leq \bar{c}$, and equal to $v - \frac{1}{2}\bar{c}$ otherwise. Thus,

$$S^{FB} = \begin{cases} V_0 - C_0 + \frac{1}{2\bar{c}} v^2 & \text{if } v \leq \bar{c}, \\ V_0 - C_0 + v - \frac{1}{2}\bar{c} & \text{otherwise.} \end{cases}$$

The first-best outcome would be achieved under either organizational form if private information were absent. In what follows, we analyze the optimal organizational form given that the agent privately learns his adaptation cost c at date 2 and only incomplete contracts are feasible at date 1.

3. Traditional procurement

First, consider traditional procurement ($o = TP$). At date 2, the principal offers to make a payment p to the agent if the agent agrees to adapt the good to the prevailing circumstances. If the agent accepts the offer, his payoff is given by $P_0 - C_0 + p - c$, while it is $P_0 - C_0$ otherwise. Hence, the agent accepts the offer whenever $c \leq p$.

Anticipating the agent's behavior, the principal sets p to maximize his expected payoff. If $p < \bar{c}$, the agent will accept the offer with probability $\Pr\{c \leq p\} = \frac{1}{\bar{c}} p$. If $p \geq \bar{c}$, the principal's offer will always be accepted by the agent. Therefore, the principal's expected payoff is $V_0 - P_0 + (v - p)\frac{1}{\bar{c}} p$ if $p < \bar{c}$, while it is $V_0 - P_0 + v - p$ if $p \geq \bar{c}$. Thus, it is optimal for the principal to offer $p^{TP}(v) = \frac{1}{2} v$ if $v \leq 2\bar{c}$, and $p^{TP}(v) = \bar{c}$ if $v > 2\bar{c}$.

As a consequence, in the case of traditional procurement the adaptation decision is

$$x^{TP}(c) = \begin{cases} 1 & \text{if } c \leq \frac{1}{2} v, \\ 0 & \text{otherwise,} \end{cases}$$

and the principal's expected payoff given P_0 reads

$$u_P^{TP}(P_0) = \begin{cases} V_0 - P_0 + \frac{1}{4\bar{c}} v^2 & \text{if } v \leq 2\bar{c}, \\ V_0 - P_0 + v - \bar{c} & \text{otherwise.} \end{cases}$$

Moreover, the agent's expected payoff given P_0 is

$$u_A^{TP}(P_0) = \begin{cases} P_0 - C_0 + \int_0^{\frac{1}{2}v} \left(\frac{1}{2} v - c\right) \frac{1}{\bar{c}} dc = P_0 - C_0 + \frac{1}{8\bar{c}} v^2 & \text{if } v \leq 2\bar{c}, \\ P_0 - C_0 + \int_0^{\bar{c}} (\bar{c} - c)\frac{1}{\bar{c}} dc = P_0 - C_0 + \frac{1}{2}\bar{c} & \text{otherwise.} \end{cases}$$

At date 1, the principal sets the payment P_0 such that $u_A^{TP}(P_0) = 0$, hence

$$P_0^{TP} = \begin{cases} C_0 - \frac{1}{8\bar{c}} v^2 & \text{if } v \leq 2\bar{c}, \\ C_0 - \frac{1}{2}\bar{c} & \text{otherwise.} \end{cases}$$

As a result, the principal extracts the expected total surplus

$$S^{TP} = \begin{cases} V_0 - C_0 + \frac{3}{8\bar{c}} v^2 & \text{if } v \leq 2\bar{c}, \\ V_0 - C_0 + v - \frac{1}{2}\bar{c} & \text{otherwise.} \end{cases}$$

Observe that if $v < 2\bar{c}$, the expected surplus S^{TP} is smaller than the expected first-best surplus S^{FB}. The reason is that, in the case of traditional procurement, the implementation decision is ex post inefficient ($x^{TP}(c) = 0 < x^{FB}(c) = 1$) whenever the realization of the adaptation costs c lies between $\frac{1}{2} v$ and v. This case occurs with positive probability if $v < 2\bar{c}$ holds.

4. Public–private partnership

Next, consider the case of a public–private partnership, where by incurring information-gathering costs k the principal can learn the realization of the agent's adaptation costs c. If the principal does not gather information, at date 2 he makes the price offer $p^{PPP}(v) = p^{TP}(v)$ and his expected payoff given P_0 is the same as in the case of traditional procurement, $u_P^{PPP}(P_0) = u_P^{TP}(P_0)$. If the principal spends k in order to learn the realization of the agent's costs, then the principal asks the agent to adapt the good to the prevailing circumstances for a payment of $p^{PPP}(v) = c$ if and only if $c \leq v$. Hence, the principal's expected payoff given P_0 when he decides to learn the agent's adaptation cost is given by $V_0 - P_0 + E[\max\{v - c, 0\}] - k$.

Taken together, in the case of a public–private partnership the principal's expected payoff given P_0 is

$$u_P^{PPP}(P_0) = \begin{cases} V_0 - P_0 + \frac{1}{2\bar{c}} v^2 - k & \text{if } v \leq \bar{c} \wedge k < \frac{1}{4\bar{c}} v^2, \\ V_0 - P_0 + \frac{1}{4\bar{c}} v^2 & \text{if } v \leq \bar{c} \wedge k \geq \frac{1}{4\bar{c}} v^2 \\ & \quad \text{or } \bar{c} < v \leq 2\bar{c} \wedge k \geq v - \frac{1}{4\bar{c}} v^2 - \frac{1}{2}\bar{c}, \\ V_0 - P_0 + v - \frac{1}{2}\bar{c} - k & \text{if } \bar{c} < v \leq 2\bar{c} \wedge k < v - \frac{1}{4\bar{c}} v^2 - \frac{1}{2}\bar{c} \\ & \quad \text{or } v > 2\bar{c} \wedge k < \frac{1}{2}\bar{c}, \\ V_0 - P_0 + v - \bar{c} & \text{if } v > 2\bar{c} \wedge k \geq \frac{1}{2}\bar{c}. \end{cases}$$

Furthermore, the agent's expected payoff given P_0 reads

$$u_A^{PPP}(P_0) = \begin{cases} P_0 - C_0 + \frac{1}{8\bar{c}} v^2 & \text{if } v \leq \bar{c} \wedge k \geq \frac{1}{4\bar{c}} v^2 \\ & \quad \text{or } \bar{c} < v \leq 2\bar{c} \wedge k \geq v - \frac{1}{4\bar{c}} v^2 - \frac{1}{2}\bar{c}, \\ P_0 - C_0 + \frac{1}{2}\bar{c} & \text{if } v > 2\bar{c} \wedge k \geq \frac{1}{2}\bar{c}, \\ P_0 - C_0 & \text{otherwise.} \end{cases}$$

At date 1, the principal sets the payment P_0 such that $u_A^{PPP}(P_0) = 0$, so

$$P_0^{PPP} = \begin{cases} C_0 - \frac{1}{8\bar{c}} v^2 & \text{if } v \leq \bar{c} \wedge k \geq \frac{1}{4\bar{c}} v^2 \\ & \quad \text{or } \bar{c} < v \leq 2\bar{c} \wedge k \geq v - \frac{1}{4\bar{c}} v^2 - \frac{1}{2}\bar{c}, \\ C_0 - \frac{1}{2}\bar{c} & \text{if } v > 2\bar{c} \wedge k \geq \frac{1}{2}\bar{c}, \\ C_0 & \text{otherwise.} \end{cases}$$

As a consequence, the principal extracts the expected total surplus

$$S^{PPP} = \begin{cases} V_0 - C_0 + \frac{1}{2\bar{c}} v^2 - k & \text{if } v \leq \bar{c} \wedge k < \frac{1}{4\bar{c}} v^2, \\ V_0 - C_0 + \frac{3}{8\bar{c}} v^2 & \text{if } v \leq \bar{c} \wedge k \geq \frac{1}{4\bar{c}} v^2 \\ & \quad \text{or } \bar{c} < v \leq 2\bar{c} \wedge k \geq v - \frac{1}{4\bar{c}} v^2 - \frac{1}{2}\bar{c}, \\ V_0 - C_0 + v - \frac{1}{2}\bar{c} - k & \text{if } \bar{c} < v \leq 2\bar{c} \wedge k < v - \frac{1}{4\bar{c}} v^2 - \frac{1}{2}\bar{c} \\ & \quad \text{or } v > 2\bar{c} \wedge k < \frac{1}{2}\bar{c}, \\ V_0 - C_0 + v - \frac{1}{2}\bar{c} & \text{if } v > 2\bar{c} \wedge k \geq \frac{1}{2}\bar{c}. \end{cases}$$

Note that if the principal gathers information, the adaptation decision is ex post efficient, $x^{PPP}(c) = x^{FB}(c)$. However, in this case, the expected surplus S^{PPP} is always smaller than the expected first-best surplus S^{FB}, due to the information gathering costs k. If the principal does not gather information, the adaptation decision is the same as in the case of traditional procurement, $x^{PPP}(c) = x^{TP}(c)$, and the expected surplus does not depend on the organizational form, $S^{PPP} = S^{TP}$.

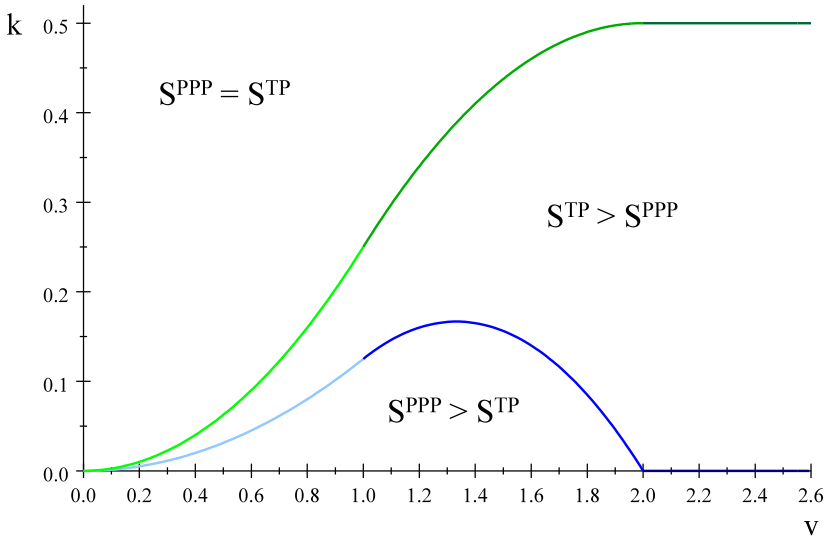

Fig. 1. The figure illustrates the optimal organizational form, depending on the principal's information gathering costs k and the value v that he derives from implementation of the adaptations. The principal prefers a public–private partnership in the region below the blue curve. In the region between the blue curve and the green curve, the principal prefers traditional procurement.

5. Optimal organizational form

We can now state our main result. At date 1, the principal chooses the organizational form that maximizes the expected total surplus.

Proposition 1. *(i) The principal prefers a public–private partnership ($S^{PPP} > S^{TP}$) if one of the following conditions holds:*

- $v \leq \bar{c}$ *and* $k < \frac{1}{8\bar{c}}v^2$
- $\bar{c} < v \leq 2\bar{c}$ *and* $k < v - \frac{3}{8\bar{c}}v^2 - \frac{1}{2}\bar{c}$

(ii) The principal prefers traditional procurement ($S^{TP} > S^{PPP}$) if one of the following conditions holds:

- $v \leq \bar{c}$ *and* $\frac{1}{8\bar{c}}v^2 < k < \frac{1}{4\bar{c}}v^2$
- $\bar{c} < v \leq 2\bar{c}$ *and* $v - \frac{3}{8\bar{c}}v^2 - \frac{1}{2}\bar{c} < k < v - \frac{1}{4\bar{c}}v^2 - \frac{1}{2}\bar{c}$
- $v > 2\bar{c}$ *and* $k < \frac{1}{2}\bar{c}$

(iii) Otherwise, the principal is indifferent between the two organizational forms.

The proposition is illustrated in Fig. 1.[11] If the principal's information-gathering costs k are sufficiently low, the principal may opt for a public–private partnership at date 1. In this scenario, at date 2, in a public–private partnership the principal will choose to gather information about the agent's adaptation costs, enabling an ex post efficient adaptation decision. As a result, the expected total surplus exceeds that of traditional procurement, where adaptation decisions may be ex post inefficient (provided that v is not so large that the first-best solution would be attained under traditional procurement).

For intermediate values of the information gathering costs k, in a public–private partnership the principal will still gather information to reduce the agent's rent at date 2. Although this results in an ex post efficient adaptation decision, the relatively high costs of information gathering reduce the expected total surplus below that of traditional procurement. In other words, in a public–private partnership the principal would incur information gathering costs at date 2 to increase his share of the pie, while reducing its overall size. Yet, the principal can extract the expected total surplus at date 1. Thus, at date 1, the principal prefers traditional procurement.

Finally, if information-gathering costs are prohibitively high, the principal will not incur them and is indifferent between the two organizational forms.

[11] The figure depicts the case $\bar{c} = 1$.

6. Concluding remarks

Complementing the existing literature on public–private partnerships, in the present contribution we have focused on the fact that in public–private partnerships the government and the private contractor collaborate more closely than in the case of traditional procurement, putting the government in a better position to learn information about the private contractor's costs. In particular, we have examined a very simple framework in which both the costs and benefits of a public–private partnership arise solely from the government's potentially superior ability to learn the contractor's adaptation costs.[12]

As noted in the Introduction, most contract-theoretic studies on public–private partnerships following Hart (2003) focus on investment incentives and the bundling of tasks such as construction and operation of infrastructure. Future research could fruitfully integrate the informational asymmetries explored in the present study with these more conventional research themes. Moreover, like most contributions in the literature on public–private partnerships, this paper assumes that the public good is provided by a private contractor. However, in some instances, a state-owned enterprise may instead provide the public good. Hoppe and Schmitz (2010) have examined public–private partnerships alongside optimal ownership structures, but they focus solely on symmetric information. Exploring the implications of asymmetric information in such a hybrid model may represent a promising direction for future research.[13]

Data availability

No data was used for the research described in the article.

[12] Thus, in its simplicity the model aligns with a key requirement emphasized by Moore (2016, p. 11) : "As a general rule of research, it's a pity to write down a model in which benefits and costs are distant cousins. Such a model can seem too kitchen sink. An ideal theory has a single force working in two ways, so that the costs and benefits are two sides of the same coin".

[13] See also Schmitz (2006, 2008) for an analysis of optimal ownership structures under asymmetric information in the incomplete contracting setup introduced by Grossman and Hart (1986), and see Schmitz (2023) for the implications of introducing asymmetric information into the privatization framework of Hart et al. (1997). However, these papers do not explore the role of public–private partnerships.

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