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Infrastructure, Health and Education”

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Abstract

This paper summarizes what is known about the impact of public-private partnerships (PPPs) in the three sectors where they have been used intensively: infrastructure (energy, transport, water and sanitation, and telecommunications), education, and health. It lays out the main elements of economic theory relevant to analyzing the trade-off between PPPs and the public provision of complex projects. It places PPPs within a historical perspective. It reviews empirical evaluations of the effectiveness of PPPs and, whenever possible, the implications for social outcomes. Finally, it draws conclusions on cross-cutting issues that influence the efficiency of PPPs, from contract design and regulation to renegotiations and institutional issues. The paper straightens out and qualifies the record of existing evidence and signals some of the main areas and topics for future fruitful research.

JEL Code: L33, H54, I11, I21, D04

Keywords: Public-private partnerships, evaluation, infrastructure, education, health

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1 Introduction

Public-private partnerships (PPPs) are contractual arrangements between a public authority (which can be a local or a central government agency) and a private supplier for the delivery of some services, in which the latter takes responsibility for building or upgrading a piece of infrastructure that supports these services, makes arrangement towards the financing of the investment, and then manages and maintains this facility (Iossa & Martimort (2015)).

Since the 1980s, PPPs have become increasingly popular and are now used widely across the world. The World Bank Private Participation in Infrastructure (PPI) database lists over 6,600 projects in low- and middle-income countries for the 1990-2019 period, representing investments of over US\$1.5 trillion.¹ In Europe, the European Investment Bank (EIB) lists over 1,800 projects, totaling 370 billion euros, in 28 countries since 1990.² The US is some of a latecomer in that space, with only 30 projects in operations, for a total of US\$16.2 billion as of 2019.³ Across the world, governments and international organizations routinely praise PPPs as one of the solutions for bridging the shortage of investment in key infrastructure sectors (World Bank (2017)).

In terms of their contribution to investments in physical and social infrastructure, estimates indicate that PPPs represent approximately 10 percent of the yearly investment in infrastructure by developing countries' governments and approximately 3 percent of global infrastructure spending (Fay et al. (2018); Engel et al. (2020)). In addition, a number of PPPs attract a significant share of public financing, both directly or indirectly, through guarantees (Fay et al. (2017)).

While they are often praised by policy makers, in practice, much anecdotal evidence has led to questioning the performance of PPPs. The large wave of PPPs in the 1990s and 2000s in Latin America was characterized by a very high prevalence of renegotiation and extremely costly government bailouts (Guasch (2004); Guasch et al. (2008))). Moore et al. (2014) document 399

¹See <https://ppi.worldbank.org/en/ppi> (accessed January 27th, 2020).

²See <https://data.eib.org/epec/> (accessed January 27th, 2020).

³See <https://www.infrappworld.com/report/usa-ppp-market-2019> (accessed September 8th, 2021).

renegotiations between 1992-2011 in a panel of 124 transport concessions in Brazil, Chile, Colombia and Peru. [Engel et al. \(2019\)](#) report 535 renegotiations between 1993 and 2010 in a sample of 59 highway PPPs in Colombia, Peru, and Chile. In Mexico, at the end of the 1980s, taxpayers had to cover a US\$8 billion bailout for renegotiated highways. In the UK, which introduced the Private Finance Initiative (PFI) in the early 1990s, the highly publicized failures of London Underground's biggest contractor, Metronet, in 2009 and the construction firm Carillion in 2018, the greatest corporate failure in UK history, led to taxpayer bills totaling hundreds of millions of pounds and to the government deciding to abolish PFI contracts altogether. In other European countries, such as France and Italy, there is an increasing number of accounts of white elephants and excessive costs faced by taxpayers for PPPs, such as stadium, concert halls, or government buildings ([Cours des Comptes \(2017\)](#)).

Despite this high salience in the public debate, there is no systematic review work assessing the actual performance of PPPs. In this paper, we review the empirical research on the impact of PPPs in the three sectors where they have been used on a large scale: infrastructure (energy, transport, water and sanitation, and telecommunications), education, and health. We review evaluations of the effectiveness of PPPs and, whenever possible, the implications for coverage and affordability. Because the choice to resort to PPPs often has important political and social motivations, whenever possible, we do that by putting the experience with PPPs into the relevant historical context.

Finally, we intend to draw conclusions for the design of PPPs. Our objective is to take stock of what has been learned to assess and guide the direction of future research. As such, the objective of this survey is both to straighten out and qualify the record of existing evidence for researchers and policy makers and to signal to applied researchers with an interest in PPPs, which are the main areas and topics for fruitful investment.

Conceptually, PPPs are an example of one of the central topics in economics, namely, the role

of the government in the provision of goods and services. While in the 1970s and 1980s, the debate on the appropriate boundaries between the public and the private sector was mostly framed in the context of the privatization question (Megginson & Netter (2001); Megginson (2005)), since the 1990s, PPPs, in their different forms, have been implemented widely and have become the primary focus of both policy making and research (Engel et al. (2014)).

Involving the private sector through a PPP is different from outright privatization in several important ways. We begin in Section 2 by laying out the theoretical basis of the public vs. private ownership trade-off, focusing on the specificity of PPPs. We also consider how sector-level fundamental characteristics and features of the economic and institutional environment may shift that trade-off. Finally, we dispel some of the myths that are sometimes wrongly invoked to justify the use of PPPs, such as their usefulness in relieving public budgets or saving on financing costs.

Next, in Section 3, we briefly review the use of PPPs throughout three millennia of history. To clearly define the perimeter of this review, we then describe the different existing contractual arrangements prevailing currently, such as build-operate-transfer (BOT), build-operate-own (BOO), concessions, etc., and how these arrangements combine the key characteristics discussed in the previous section.

Section 4 then reviews the literature covering PPPs in each sector, namely, infrastructure, education, and health. Finally, based on both the material from the sections above and additional available evidence, we discuss in Section 5 cross-cutting issues that distinguish successful PPPs from unsuccessful ones. We discuss issues related to the design of contracts and regulation, competition, the institutional and political context, and the pervasive issue of renegotiation. In doing so, we also aim to distinguish general policy lessons that would apply to all types of PPPs from those that may be sector- or context-specific. Last, we flag several uncovered issues that should be high on the agenda of PPP researchers.

2 The Economics of Public-Private Partnerships

2.1 General Elements

The debate in economics on the role of the government vs. the private sector in the provision of goods and services has historically been focused on privatization. Privatization, consisting of the sale of state-owned firms or assets to private agents, implies an outright transfer of ownership.

Starting with [Sappington & Stiglitz \(1987\)](#), [Shapiro & Willig \(1990\)](#), and [Shleifer & Vishny \(1994\)](#), the theoretical literature has established a “neutrality result” or “irrelevance theorem”, which states that under certain assumptions, ownership may be irrelevant to the allocation of resources. These assumptions combine the existence of a complete contracting environment, in which all future contingencies can be anticipated and included in a delegation contract that can be credibly enforced, and the possibility of unlimited side payments. As discussed, for example, in [Martimort \(2006\)](#), this result extends to asymmetric information settings, provided some additional conditions, including risk neutrality and the absence of financial constraints, are met.

Public and private ownership are no longer irrelevant, however, once we move to incomplete contracting environments. Depending on the context and characteristics of the activities and sectors considered, the weight and impact of the different types of incompleteness may make either public or private ownership optimal. At the sector level, and specifically for infrastructure, education, and health, large sunk costs, including relation-specific investments, long-term horizons, the contractibility of quality, and the scope for technological, managerial, and institutional innovations, are some of the most important drivers of this incompleteness.

The magnitude of sunk costs is the first key aspect. Because part of these costs are hard to redeploy and might be relation-specific, and because full cost recovery requires that a sustained stream of quasi-rents is redistributed to the concessionaire, a larger amount of such costs is likely to lead to opportunism by the parties. The impact on the private vs. public ownership trade-off

depends on how the details of the governance structure affect the allocation of ex post bargaining power (Laffont & Tirole (1991); Schmidt (1996)).

Next, the case for private participation relies to a large extent on the superior ability of private partners to deliver cost savings and quality-improving innovations. In this context, whether the quality of both the underlying assets and the service that is ultimately provided is contractible is a second important dimension. Whenever service contractibility is limited, private ownership risks result in quality-shading cost reductions. This can be qualified along several dimensions (Shleifer (1998); Bortolotti et al. (2004)). First, regulation may be tilted towards lower-powered incentives that lead providers to internalize a smaller fraction of such unwanted potential cost reductions. Second, the existence of a downward sloping demand curve, and possibly of competition, may counteract the temptation of providers to lower quality by affording consumers exit or alternative options. Third, in sectors with strong innovation potential, such concerns may be compensated by the gain from the introduction of new designs or technologies. For example, changes in data availability brought about by the ICT revolution may change the degree of information asymmetry and the contractibility of services, thereby altering the optimal allocation of ownership, as shown in a different context by Baker & Hubbard (2004) for the trucking industry.

In addition, features of the economic and legal environment may affect the usefulness of writing a seemingly complete contract with a private partner. This will be the case when agents have a limited ability to commit to a contract, leading to both a potential hold-up problem in the case of non-verifiability and to soft budget constraint issues, and when governments are non-benevolent or corrupt (Martimort (2006)). Note, however, that in some cases, delegation may constitute a commitment device for a government seeking to maintain prices close to cost-recovery levels, in the sense that it may isolate it from political pressures to reduce tariffs, for example ahead of elections.

When focusing on allocative efficiency, the relevant mechanisms that affect the trade-off be-

tween public and private ownership under privatization are similar for PPPs, with one important difference, namely, the multitasking nature of the delegation contract, which includes not only the provision of the service but also potentially the design, building, and financing of the infrastructure and the management of the operating arrangements needed to produce that service (Iossa & Martimort (2015)).

This multitasking characteristic, often in the context of a long-term contract, introduces additional issues when comparing agency costs under alternative ownership structures, which go beyond the simple case for private provision of the service laid out above. For a start, the bundling of construction and operations, together with the level of risk transfer included, generates new agency issues. This renders the case for externalities between the different phases of the contract even more important (Hart (2003); Martimort & Pouyet (2008)). If a higher level of effort during the design and building stages generates cost savings through more efficient or innovative processes when providing the service –the case of positive externalities– then bundling the different phases in a PPP might dominate public provision through traditional procurement combined with provision by a different entity, either public or private. On the other hand, if such externalities are negative, for example, when cost reduction effort leads to lower quality, an enhanced risk of disruption of services or accidents, then such a case is much weaker. This trade-off is also affected by the structure of underlying uncertainty, the contractual nature of risk transfer and of the financing structure (equity vs. debt), which affect the degree of incompleteness, the incentive structure, and the return to the private party (Dewatripont & Legros (2005), Iossa & Martimort (2012)).

One important aspect here is the ability of projects to rely on some form of market test. PPPs with weak market tests because they do not rely on user fees may end up increasing costs, as has been argued, for example, for projects involving the construction of prisons or large-scale education or health facilities (Hart (2003); Bennett & Iossa (2006)). It has been extensively

documented in the case of infrastructure that projects with large capital costs and low levels of fee-based cost recovery are routinely wrongly implemented based on flawed forecasts that combine demand over- and cost underestimation (Pickrell (1992); Altshuler & Luberoff (2004); Flyvbjerg et al. (2003)). PPPs may not be useful in screening out such white elephants unless the projects rely on strong market tests and the public partner has the willingness and ability to resist pressure for renegotiation, which prospect may also weaken the incentive of the private partners to acquire information at the project screening stage (Ganuza & Llobet (2020)).

Finally, another dimension of contractibility, i.e., that regarding assets, also matters for private participation suitability, as contractible assets allow for the periodic reauctioning of the contract. When service and asset quality contractibility is high, a specific case of positive contractual externalities may arise for maintenance. Indeed, a bundled contract may provide stronger incentives while capitalizing on the fact that continuous maintenance generally leads to lower cumulative costs over time when compared with the typical stop-and-go practice of public agencies (Engel et al. (2014); Engel et al. (2020)).

While most of the literature mentioned thus far has focused on efficiency, the consideration of agency costs in both the government and privately owned firms also opens to the analysis of the trade-off between allocative efficiency and rent extraction (Martimort (2006)). The need to leave an information rent to the private partner of a PPP translates directly to the optimal pricing strategy under regulation, with effects on both the intensive and extensive margin on the demand side (Fay et al. (2018)).

This interim efficiency analysis has a direct translation in terms of coverage and affordability of the service for the target population. The way information rents are shared as a result of these ‘double’ agency costs has implications for the prices that users face and in turn for the amount of services they are able to access. The theoretical literature has documented the consequences of

Table 1: **Sector characteristics**

	Sunk costs	Service contractibility	Asset contractibility	Innovation potential	Competition / strength of market test
Transport					
Roads	Large	Good	Good	Average	Average
Railroads	Large	Good	Good	Average	Average
Airports	Medium	Good	Good	Average	Low
Ports	Medium	Good	Good	Average	Low
Water & sanitation	Large	Good	Mediocre	Average	Low
Energy					
Generation	Medium	Good	Good	High	Average
Transmission	Large	Good	Good	Low	Low
Distribution	Medium	Good	Good	Average	High
ICT					
Mobile phones	Medium	Good	Good	High	High
Internet backbone	Large	Good	Good	Average	Low
Education	Medium	Mediocre	Good	High	Average
Health	Medium	Mediocre	Good	High	Average

different types of information incompleteness, be it adverse selection, moral hazard, or long-term uncertainty, on the extent to which prices are distorted away from their potential first-best level –which in most cases is given by a Ramsey pricing rule– even when the trade-off remains favorable to a PPP over traditional public procurement (see, for example, a review in [Iossa & Martimort \(2015\)](#)). The extent to which firm-level organizational features and characteristics of PPPs affect prices and quantities can be seen as building blocks of what [Legros & Newman \(2014\)](#) call an “organizational IO” theory.

2.2 Implications by Sectors

Table 1 summarizes how the main characteristics discussed above vary across the sectors considered in this survey and shape the suitability for PPPs.

Looking first at transport infrastructure, roads and railroads appear to fare well in terms of contractibility of services and assets, as these are fairly easy to specify and verify and are also characterized by the existence of a combination of market tests, as they usually rely significantly

on user fees and competition, at least at the modal level. The main question in this case is related to the very large amount of sunk costs involved in nonredeployable assets. This increases the risk of opportunistic behavior and hence the erosion of efficiency gains. This issue is less stringent for ports and airports, where most of the time, the investment requirements are smaller as they are limited to equipment upgrades (Engel et al. (2020)). In this case, however, the competition potential is also more limited. On balance, transport projects appear to be reasonable candidates for PPP projects, with caveats and design requirements that differ depending on which subsectors are considered. A common factor is their exposure to high demand risk over the life of the projects, a fact that has implications for the optimal risk allocation.

Water and sanitation projects are similar to transport projects in that they entail large sunk costs, which need to be recovered through quasi-rents, and are at risk of opportunistic behavior (Straub (2009)). In addition, the nature of the physical network, which is largely underground, makes asset quality hard to monitor and verify. This aspect complicates the reauctioning of concessions or their transfer to the public sector when contracts expire, making them de facto closer to privatizations. Finally, the competition potential is generally low, demand elasticity is low, and in many cases, nonsubsidized user fees cover only a fraction of the marginal costs; thus, the potential for a market test is limited. As a result, water and sanitation projects are probably a harder case to make for efficient PPPs than their transport counterparts. In addition, the main relevant information incompleteness is likely to be on the cost rather than the demand side.

Regarding energy, we need to distinguish the generation, transmission, and distribution segments, which have in some, although not all, cases been unbundled (Joskow (2008); R. W. Bacon & Besant-Jones (2001)). These segments share a high degree of service and asset contractibility. However, transmission, with its high sunk cost, low innovation potential, and clear natural monopoly characteristics, appears to be less suited for private delegation. Generation and distri-

bution, on the other hand, display both lower sunk costs and higher innovation and competition potential, making them the subsectors of choice for private delegation. Distribution, being the service fee collecting point of the sector and one in which the cost recovery potential is generally high, is generally considered to be the most suited to private delegation. However, policy recommendations have often pushed towards full divestiture rather than some form of PPP, contrary to the transport or water sectors, where the strategic nature of assets usually makes governments reluctant to full privatization. For water, information asymmetry is concentrated on the cost side.

The mobile phone subsector within the ICT sector is perhaps the one for which the characteristics are best aligned to make private delegation successful, with its high contractibility, strong competition and innovation potential, and limited sunk cost requirements. Indeed, unsurprisingly, it is widely characterized by full privatization, putting it to a large extent beyond the scope of this review. The Internet backbone, on the other hand, has more natural monopoly characteristics, with large sunk costs and low competitive potential. As no robust academic studies covering PPPs in the ICT subsector have been identified, as opposed to those covering its outright privatization, this subsector is excluded from this review.

The education and health sectors, in turn, stand out as cases in which quality is hardly verifiable. Regarding education, however, it is argued that schools under a PPP contract face more management flexibility than public schools; they have more autonomy regarding teachers' recruitment, salary scales and work rules. In particular, private schools have more leeway with respect to financial incentives, such as the implementation of performance-based or attendance-based financial bonuses to teachers, which has the potential to increase the quality of the service provided (Banerjee & Duflo (2006)).

However, the case for PPPs in the education sector is more largely tied to the implementation of school choice policies, allowing parents to freely choose their children's school (Friedman (1955)).

The argument then has two layers. First, the fact that private schools typically rely on either tuition fees or on a per-student subsidy, makes them particularly dependent on the beneficiaries' satisfaction, thereby giving them incentives to provide a high-quality service. In turn, as underlined by [Patrinos et al. \(2009\)](#), the presence of affordable private schools might cause public schools to increase the quality of their service as a response to the increased competition. Overall, competition between public schools and schools under a PPP contract has the potential to improve the quality of the entire education system while also stimulating learning methodology innovations.

Of course, this potential rests on several arguments. First, it requires that there exists a market for schools, i.e., that households can freely choose their children's school and that the supply side is diversified enough. Second, for competition to improve the quality of the education system, households must both value schooling quality and be able to easily access information on the latter ([Abdulkadiroğlu et al. \(2020\)](#)). The verifiability of the service quality is thus crucial, but it seems actually limited in practice. Last, in certain contexts, competition at the school level holds the risk of generating perverse effects on public schools, as private schools attract additional resources, inputs, and students away from them.

Finally, the rapid evolution of ICT technologies and big data may unlock important innovations in educational methods. This could provide an additional rationale for PPPs in this sector.

The rationale for PPPs in health is essentially the same as that in education. Competition between public providers and providers under a PPP contract could increase the quality of the services provided. However, whether competition in health-care leads to quality improvements actually depends on several factors. In particular, [Gaynor et al. \(2015\)](#) underline that tougher competition should incentivize health-care providers to increase their quality to attract and retain patients in systems where prices are regulated. In contrast, there is no consensus in the theoretical literature regarding the impact of competition in models where providers choose both price and

quality. Overall, for competition to improve the quality of health-care services, it seems important for private and public providers to be integrated into a common health-care system, allowing patients to freely choose between them, rather than to serve two distinct segments of the market. Again, it is also crucial that individuals are properly informed over the quality of the services provided. Unfortunately, the verifiability of service quality in health-care seems also limited. In principle, this should be less of a problem when it comes to maintenance and other non-medical services such as food and laundry, and indeed some countries have experienced with hospital concessions limited to these aspects.

As for education, health is a sector in which new ICT technologies and big data hold important promise, particularly through the introduction of remote interactions for consultations and a number of medical procedures. However, the particularities of the health-care sector also raise some challenges in that respect. In particular, introducing competition could have detrimental effects, as this might lead to a medical arms race in which different providers compete by adopting novel medical technologies to attract both patients and physicians ([Dranove & Satterthwaite \(2000\)](#)). This would imply an overconsumption of medical technology in the presence of physician-induced demand, ultimately raising health-care expenditures without necessarily improving patients' health outcomes. In addition, the health-care sector seems subject to substantial uncertainty regarding technological and demographic changes in the long run. Such uncertainties further weaken the ground for PPPs in this sector.

Finally, an open question for all sectors is how these different characteristics interact in a model of PPP suitability. Some of these aspects could be substitutes, while others may display strong complementarities. For example, [Shleifer \(1998\)](#) suggests that both innovation and competition may partly compensate for the lack of service contractibility and quality verifiability. On the other hand, sunk cost and hold-up potential might be more of a complement to the other aspects. A

complete characterization of the nature of these interactions and of the way they may be affected by regulatory choices remains on the agenda.

2.3 The Role of the Environment

It is not only differences across sectors and projects that may affect the trade-off between public and private ownership in the context of a PPP. First, institutional characteristics may play an important role. *Ceteris paribus*, better and faster contract enforcement is likely to enhance the feasibility of long-term PPP contracts. The case regarding bureaucratic efficiency is less obvious. On the one hand, PPP contracts are complex and require more state capability, as argued in [Engel et al. \(2020\)](#). On the other hand, [Fay et al. \(2018\)](#) argue that more efficient bureaucracies may reduce the overall cost of publicly managed projects, thus tilting the trade-off in their favor. The case of corruption is also ambiguous. A corruption-prone environment often begets rigidities as a remedy, because it tilts the rule vs. discretion trade-off in favor of the former, and PPPs may help bypass some of the related costs. However, corruption may also lead to flawed design, side deals, and the biased choice of private partners when implementing PPPs. [Iossa & Martimort \(2016\)](#) indeed show that corruption on the side of the public officials tends to lead to too much incompleteness. This ambiguity is also found empirically. As shown in [Campos et al. \(2021\)](#), in the Odebrecht corruption case in Latin America, no significant difference in the incidence of corruption seemed to exist between PPPs and traditional procurement cases. Another key dimension is the strength of labor regulation and unionization. [Jerch et al. \(2017\)](#) show that in the US, stronger regulations increase the potential efficiency advantage of local bus transportation PPPs and that delegation to the private sector is less likely to occur in this context. This has important implications for the endogeneity of the delegation decision when performing empirical analysis.

Wealth inequality is also likely to affect the trade-off between public and private provision, especially when aspects of coverage and affordability are considered. The impact of private-sector

delegation on prices is generally ambiguous because it is the result of a combination of potential efficiency gains, upward adjustments to obtain prices closer to cost recovery levels, and sometimes higher markups (McKenzie et al. (2003)). When prices end up increasing, the impact is felt more harshly in more unequal environments, as more poor consumers will likely be excluded from the service and middle class consumers will end up dedicating a higher fraction of their income to it (Martimort & Straub (2009)).

Another important aspect for long-term contracts is the need for maintenance or adaptation investments in light of fundamental uncertainties on future states of the world. This is especially relevant in an era of climate change, in which the prospect of future, uncertain productivity shocks, coupled with irreversibility constraints, casts a rather negative light on PPPs in the sectors more exposed to such shocks (Martimort & Straub (2016)).

An additional dimension relates to how PPPs are affected by shocks or changes in the economic and political environment. Indeed, the rigidity of long-term contracts and the associated risk of renegotiations due to a combination of changes in needs, technological evolution, macroeconomic shocks, climate change, institutional weaknesses and political shocks imply additional trade-offs (Guasch et al. (2007); Guasch et al. (2008)) and lead to qualifying the case for PPPs. While some of these issues may already be relevant under simple privatization, the long-term dynamics under PPP contracts may look quite different. Again, regulatory practices may also have a nontrivial impact on these trade-offs (Gagnepain et al. (2013)).

Finally, the theoretical literature makes it possible to dispel or qualify a number of common arguments regarding PPPs. The main one often heard from policy makers is that PPPs can mobilize additional resources, thereby allowing the government to save on scarce and costly public resources. However, as forcefully argued by Engel et al. (2013), through PPPs, the private sector does not fund public projects; it only finances them. The funding, which is understood as who

pays for building and operating the facilities, will ultimately fall on a combination of users and taxpayers. As such, PPPs may only affect the intertemporal allocation of government revenues and expenditures by backloading the payments, but they do not create gains in terms of the fiscal space available in present value terms, per se, which is a form of Ricardian equivalence. Of course, such equivalence may not hold if there are added efficiency gains from private operations. It is thus important to review whether PPPs actually imply efficiency gains in the delivery of key public goods or if they only constitute a political maneuver aimed at relaxing governments' current budget constraint.

It is also often mentioned that a downside of PPPs may stem from relying on private financial arrangements that come at a higher cost than public ones. This must be nuanced on at least two grounds. First, private management and private finance are not perfectly equivalent, although of course, there is some correlation. Indeed, many PPPs rely on significant shares of public financing. Second, private financiers may be better able to monitor projects, resolve key information asymmetries, and hence, ensure that a more efficient financing structure is put in place and more efficient choices are made in the construction phase. To that extent, the simple comparison of the private and public cost of debt may not be the relevant one.

More importantly, simply comparing the cost of private vs. public finance may hide broader social costs. First, PPPs may come at the cost of raising user prices and subsidies and hence, excluding some of the poorest potential consumers of services who often exhibit a rather elastic demand schedule (Fay et al. (2018)). Second, while governments may face lower interest rates, this in part reflects their lower default risk due to the ability to tax or reduce public expenditures when needed, which has an indirect social cost as taxpayers assume contingent liabilities (Kay (1993)). Klein (1997) argues that the advantage conferred upon public projects by this lower cost of capital therefore unduly biases evaluations against PPPs. This also has implications for the discount rate

that should be used to evaluate both PPPs and implicit public comparators. [Grout \(2003\)](#) argues that a lower discount rate should be used to discount public projects, although his model does not rest on distortionary taxation or incomplete markets but rather on the different risk profiles under alternative management structures. In particular, discounting under public provision is applied to a cost cash flow, while under private provision, it is applied to a flow of benefits that is likely to be riskier. Finally, two counterarguments are worth noting. First, the backloaded costs schedule under PPPs means that, everything else equal and from an ex ante evaluation viewpoint, the use of a higher discount rate would actually bias the conclusions in favor of PPPs ([Boardman et al. \(2010\)](#)). Second, as several decades of experience have shown, PPP projects often concern essential services that are not allowed to fail, such that taxpayers also assume large implicit liabilities under PPPs, even in cases where no explicit guarantees are granted by governments.

3 The Variety of PPP Arrangements

3.1 Historical Origin

Some references to private involvement in infrastructure building and maintenance have been found as far back as the early 1st millennium BCE. In ancient Iran, the Persian people developed qanats, i.e., underground irrigation conduits channeling water from aquifers to agricultural areas sometimes several kilometers away ([E. Goldsmith & Hildyard \(1984\)](#)). During the era of Achaemenid supremacy, approximately 500 BCE, evidence exists of these works being managed through long-term public-private contracts granting their builders profits for five generations ([Lightfoot \(2000\)](#)).

A marble stele-carved contract from 318 BCE, probably the oldest known PPP contract, details the arrangements for the drainage of a lake between the Greek city of Eretria and a foreign contractor called Chairephanes ([H. Goldsmith \(2015\)](#)). It stipulates the obligations of the private party, including an upfront payment, a binding work schedule, and penalties in case of noncompletion,

and the benefits in the form of tax exemptions and exclusive rights to the product of the reclaimed land. Wetland drainage was actually a key partenarial activity from the Middle Ages to the 20th century in France. In 1599, Henry IV attributed to Bradley, the Flemish inventor of a windmill used for that purpose, a concession over all French wetlands ([Bezançon \(2004\)](#)).

The Romans perpetuated this practice of engaging the private sector through time-limited contracts. Examples include postal stations located along the network of roads, which were awarded for periods of five years to private parties through competitive bidding ([Bezançon \(2004\)](#)). Similar concessions were used for thermal facilities, such as the Caracalla therms in Rome and ports, among others.

These partnerships then reappeared during the Middle Ages, gaining traction around the 16th century, with the granting of concessions for large pieces of public work such as canals, water supply, or roads. In London, the New River Company, created in 1619, was granted a legal monopoly and mobilized large private financing to build a 60-km canal and distribute water to the city via wooden pipes ([H. Goldsmith \(2015\)](#)). In France, Colbert used concession-like delegation schemes for the building of canals, such as the Canal du Midi built by Pierre-Paul Riquet between 1666 and 1681. Similar schemes were subsequently developed across a variety of undertakings, such as major roads, tobacco commercialization (1679), the Paris firefighting service (1699), mines (1722), or the Paris lightning concession in 1770 ([Bezançon \(2004\)](#)). An interesting feature of the time was that concessions were sought whenever public authorities did not possess the expertise needed for complex projects or were expecting innovative design, the latter being referred to as “innovation concessions” ([Marty \(2014\)](#)).

British turnpikes were another emblematic institutional innovation of the time ([Albert \(1972\)](#)). From the 17th to the 19th century, these not-for-profit trusts levied tolls on road users and used the proceeds to repair and improve the roads. At their peak, at around 1830, there were 1,000

trusts administering approximately 48,000 km of roads in England and Wales, and the concept had been extended across the British Empire as well as the United States.

The explosion of public-private contracts for public works and services occurred in the 19th century, however, with the advent of interurban infrastructure, such as railways and telegraphs, and intraurban infrastructure, such as gas lighting, water supply and trams (H. Goldsmith (2015)). Both municipalities and national governments started routinely contracting with private actors. Railways, representing massive investments for the time, were often privately managed and mobilized a large amount of private financing, but they were supported by large public subsidies in different forms, such as land grants (Eichengreen (1995)). The public-private relationship took many forms across countries, including that of concessions. Bogart & Chaudhary (2012) report that by 1869, the eight major Indian railway companies were private joint stock companies under concession contracts with the secretary of state for India representing the British government. In France, Napoleon III consolidated the prevailing concession model by imposing the merger of railway companies into six concessions and extending the model to many other sectors, such as city development, water and gas provision, trash collection, etc. (Bezançon (2004)).

The development of telephony and electricity led to consolidated regulated monopolies, public or private, depending on the country and time. However, by the 1940s, with the end of the first globalization era and the Great Depression, many private companies had either gone bankrupt or been taken over by government, and public provision was again the dominant mode of provision for most infrastructure services. It was only in the 1980s that a new wave of private participation occurred, leading in particular to the current worldwide expansion of PPP arrangements.

3.2 The Range of Contractual Arrangements

There is a large variety of public-private interactions in the sectors we consider. These interactions range from work and service contracts to full privatization. While the exact scope of what is

considered a PPP varies across authors and institutions, for the purpose of this review, we define PPPs to cover any arrangement going from lease contracts (“*affermage*” in French law) to build-operate-transfer (BOT) contracts (Farquharson et al. (2011); Guasch (2004)).

This definition de facto excludes pure management contracts, which do not contemplate investment requirements from the private party. The inclusion of lease contracts here is contentious, as it is sometimes the case that such arrangements leave investments as the responsibility of the public counterpart. However, this is not always the case, and the denomination has been diversely used. For example, many lease contracts in the French water sector include investment requirements from private firms.

Contractual arrangements hence include a diversity of concessions, in which the private party is responsible for rehabilitating and/or extending existing physical facilities, operating and maintaining them, and ultimately transferring them back to the public sector. In these “brownfield projects”, the public sector is implicitly the owner of the assets all along, although they are under the direct management and care of the private party.

In addition, PPPs include “greenfield projects”, which differ from the former in that they imply the construction of new facilities. Under these headers are found build-operate-transfer (BOT) as well as build-own-operate-transfer (BOOT) schemes.⁴

PPPs also differ depending on the way in which they remunerate their private counterparts. Depending on the sectors, this is achieved through a combination of user fees and public budget-based payments, which is ultimately taxpayer money. This is likely to have important consequences for the incentives faced by the private counterpart at different stages of the life of the contract, from the bidding strategy to the provision of services, and hence for the efficiency of the partnership. PPPs paid purely through the public budget are generally termed “availability contracts”. This is, for example, the case of most private finance initiative (PFI) projects used in the UK for social

⁴Related forms include the build-transfer-operate, (BTO) and design-build-finance-operate (DBFO) schemes commonly used to designate the UK’s PFI projects.

sectors such as education and health.

Finally, while it is important to distinguish between alternative contractual arrangements, such a distinction is not always made in empirical studies, and this de facto forces some flexibility on researchers interested in assessing the impact of PPPs.

4 Empirical Evidence

4.1 Transport

PPPs have been used extensively in the transport sector, including roads, railroads, local bus services, ports and airports. A number of careful studies have documented the impact of delegation to private firms on several dimensions of efficiency.

4.1.1 Roads

Toll road concessions have been around at least since turnpike trusts were introduced in England in the 17th century, and Europe, France and Spain have also implemented such schemes since the 1960s ([Gomez-Ibanez & Meyer \(1994\)](#)). This model was extended throughout the developing world in the 1980s and 1990s ([Estache & De Rus \(2000\)](#)); as of 2019, the PPI database had recorded 1,182 projects and a total of committed investments of nearly US\$350 billion. Such projects still represent a small share of the worldwide road networks, but they usually concentrate on main highway corridors, tunnels, and bridges.

[Bogart \(2005\)](#) carefully assesses whether English turnpikes were the main driver of the 18th-century road transport revolution, which was characterized in particular by a 40% reduction in freight charges and a 60% increase in passenger travel speed. Turnpike development coincided with vast increases in road investments and maintenance and could have been the determinant of large efficiency gains. The issue remains contentious among economic historians, however, because

other key changes also occurred during this period, including improvements in horse breeding and the appearance of larger carriage firms. The adoption of turnpikes may have followed these key technical innovations. In addition, high tolls set at or close to monopoly level may have diverted any technical efficiency gains towards the trustees. Using over 5,000 turnpike observations from 130 city pairs and controlling for time- and route-specific unobservables, [Bogart \(2005\)](#) finds a 43.4% reduction in real land carriage rates between 1750 and 1820, accounting for half of the total reduction over the 18th century. Two additional elements support the conclusion that turnpikes were instrumental in improving transport efficiency. First, there was a large convergence over the second part of the century between the summer and winter rates, a kind of natural experiment; second, no rate decrease was observed in the period immediately preceding the establishment of the first turnpike. Overall, turnpike trusts contributed to a 20% reduction in freight charges and annual social savings of 0.5% of the national income at the beginning of the 19th century.

However, no equivalent analysis is available in recent times regarding how the delegation of road corridors to the private sector contributed to efficiency gains across the transport network. Witness to this, recent literature reviews of the impact of transport investments and costs on economic outcomes such as [Redding & Turner \(2015\)](#) or [Roberts et al. \(2020\)](#) contain no reference whatsoever to concessions and PPPs.

This is partly because defining clear efficiency objectives for transport is very difficult. While electricity or water and sanitation projects can easily be assessed based on a goal of universal access or specific coverage targets at the lowest operating cost, equivalent references do not exist for road transport ([Fay & Rozenberg \(2019\)](#)). The UN Sustainable Development Goals contain calls to “Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all” (SDG9), using as related indicators the “proportion

of the rural population who live within 2 km of an all-season road” and “passenger and freight volumes, by mode of transport,” without, however, setting any explicit targets.

Some evidence exists for construction costs. Regarding cost overruns, most existing data point to PPP road projects having higher overall costs than those built through traditional public procurement. [Blanc-Brude et al. \(2009\)](#) find a 24 percent excess of unit cost per kilometre under PPPs in a sample of 227 road projects, including 65 PPPs, financed by the European Investment Bank between 1990 and 2005 across Europe. They argue that the higher cost is likely explained by the internalization by concessionaires of the construction risk due to overoptimistic ex ante predictions and unforeseen events. [Singh \(2018\)](#) finds a significantly higher ratio of actual to expected construction costs, which is a measure of cost overruns, in a sample of 313 Indian highways, of which a third were PPPs, between 1997 and 2015. He also documents smaller delays for PPPs and better quality, proxied by road roughness collected using a smart-phone-based “accelerometer” app. These higher costs for PPPs leave several open questions. It could be that their related planning process is more realistic or, slightly more cynically, that their bar is set lower to avoid PPPs from looking bad in terms of the highly visible ‘on time and on budget’ criteria. A related question is whether the higher price tag translates into the type of additional investments that leads to lower operating costs in the long term or simply reflects a risk premium and conservative building choices.

The conclusions from these studies should be taken with caution as they imperfectly address the potential endogeneity of contract choice. [Blanc-Brude et al. \(2009\)](#) consider the procurement choices as exogenous, while [Singh \(2018\)](#) uses the time variation related to the enactment in 2005 of a policy systematically favoring delegation to the private sector as an instrument; however, his estimates are still likely to be affected by the changing composition of the pool of potential projects over time if the most cost-effective ones were realized first.

The available descriptive evidence thus seems to point to higher costs under PPPs, but it remains correlational in nature in the absence of a credible identification strategy to address the selection bias that is likely to plague most samples. PPPs are likely to provide incentives for higher quality and more thorough maintenance over the lifetime of the projects, which lowers the unit costs of maintenance effort. [Fay & Rozenberg \(2019\)](#) mention that good maintenance may reduce the total life-cycle cost of transport infrastructure by more than 50 percent. In addition there are likely welfare gains thanks to fewer accidents and less deterioration of vehicles. On the other hand, PPPs also entail an added risk premium for private entrepreneurs possibly bidding up the cost of the capital. Whether the gains outweigh the additional cost involved remains at this stage an open question in the context of road concessions.

4.1.2 Railroads

The rapid development of railroads in the 19th century was a major driver of welfare improvements, particularly through gains from trade that resulted from lower transport costs ([Fogel \(1964\)](#); [Donaldson & Hornbeck \(2016\)](#); [Donaldson \(2018\)](#)). As mentioned above, the concession model was used extensively in India, the US, the UK, and France, among others.

[Bogart & Chaudhary \(2012, 2015\)](#) exploit a large-scale natural experiment in which Indian railway companies operating in the form of concessions were gradually taken over by the public sector on exogenously defined dates to shed light on the relative efficiency of public and private operators. The private concessions outstanding in the 1860s were bought back thanks to a clause that allowed for the transition on either the twenty-fifth or the fiftieth anniversary of the original contract, at a price based on the mean market value of the company's stock in the preceding three years. As a result, the eight companies transitioned to public ownership between 1879 and 1908. The identification strategy uses this exogenous schedule, combined with railway-specific fixed effects to account for unobserved heterogeneity related to local geography and technical

specifications, year fixed effects to control for common time-varying shocks, and railway-specific trends. After carefully ruling out anticipation effects, cost manipulation, and quality shading, the analysis offers robust evidence of the shift to public ownership leading to a 13% reduction in working expenses (Bogart & Chaudhary (2012)), while productivity and prices did not diverge in the context of increasing capital intensity (Bogart & Chaudhary (2015)). Two institutional characteristics may account for these results. First, the undemocratic nature of the government of the time meant it was mostly focused on fiscal outcomes stemming from reduced expenses on railway operations and unlikely to incur in patronage such as excess employment. In addition, concessions relied importantly on guarantees shielding them from demand risk and were subject to moral hazard. Paradoxically, the move to public ownership in that context likely hardened their soft-budget constraint.

More recently, especially in the 1990s, a number of Latin American countries also experienced the concession model in regard to rehabilitating their ailing railway services, while several European countries introduced competition through the tendering of public service contracts. Most of the available evidence is also descriptive in nature, as it hardly addresses potential confounding factors; however, it nonetheless offers interesting insights regarding the nature of the transition. It also has to be analyzed while considering that around the world, railway networks had attained their maximum length between the two World Wars and, with very few exceptions, had been declining since then as the sector faced increasing intermodal competition (H. Goldsmith (2015)).

In Argentina and Brazil, the shift to private provision occurred in the context of crumbling public-sector firms, with large unionized workforces, obsolete capital stock, declining market shares of passenger and freight transportation, and huge deficits driven among others by large wage bills. For example, as of 1990, Ferrocarriles Argentinos was receiving grants and subsidies equal to 9% of the government's budget and 1% of the Argentine GDP (Ramamurti (1997)). Both countries

maintained the vertical integration of each concession while separating them horizontally between freight and passenger transport and geographically across regions (Estache & De Rus (2000)). The initial outcomes appeared positive for investors, consumers, and taxpayers, as ridership and freight volumes increased, and the fiscal burden significantly decreased. On the other hand, an important number of workers were laid off. Estache & De Rus (2000) report an acceleration in TFP growth under private concession regimes. Difficulties emerge, however, mostly because of the limited commitment ability of the main contracting parties. Private operators do not always fulfill their initial commitments in terms of investments or rehiring workers. On the other hand, the government lacks the ability to effectively regulate services. As a result, in the context of recurring economic and political crises, long-term performance appears disappointing. In Argentina, all the concessions were renationalized following the 2001 economic shock. What would have happened in a counterfactual world of reform under public-sector management remains an open question, but in the context of Latin America in the 1990s, such scenarios were of course politically very improbable.

In the UK, the initial reform package implemented following the 1993 Railways Act combined the horizontal and vertical separation of the different parts of the rail sector with, in particular, a privatized track authority, several rolling stock companies, and 25 train operating companies. The process went through several stages, with significant adjustments being made in particular following the 2000 Hatfield accident, which was blamed on maintenance and staff experience issues. Preston & Robins (2013) perform a welfare assessment based on consumer surplus and total cost changes from a model combining counterfactual demand and cost trend extrapolation. The model concludes that consumers and most private companies gain over the period, while the government is the big loser because of the explosion of costs, potentially related to the loss of the horizontal and vertical economies of scope. Overall, the exercise reveals a significant net welfare loss, although

the magnitude might be quite sensitive to the assumption underlying the trend extrapolation. In terms of the time pattern, the net welfare impact appears neutral in the initial phase until 2000 but appears negative after that, which is consistent with the Hatfield accident leading to a structural break on the requirements for maintenance expenditures in a context where these had been historically neglected. As in the case of Latin America, this second phase is also associated with growing difficulties in the regulatory relationship in a context of increased public scrutiny.

Overall, the review of experiences shows that awarding and regulating railway concessions is a complex undertaking, which involves many related decisions related to the potential separation of different aspects of the service, the regulatory process, in a context in which political constraints are likely to loom large.

A full assessment of the efficiency impact of railway concessions in modern times would require analyzing the numerous transitions between public and private regimes, combining when possible with natural experiments à la [Bogart & Chaudhary \(2012\)](#) with additional suitable controls or with full-fledged structural models with the credible characterization of the evolution of demand. Such an assessment remains on the agenda. It should also be taken into account that the results of such an assessment is likely to be influenced by the stage of maturity of the railway industry at which it is performed.

4.1.3 Bus Services

Local public transportation is one of the areas where the most extensive use of delegation to the private sector has been made. [Levin & Tadelis \(2010\)](#) document the correlates of the contracting-out decision of a range of local services, including public works and transportation, safety, health and human services, parks and recreation, cultural programs and administrative support functions. Across US cities, services for which performance specification and monitoring is easier, as is likely to be the case for bus services, are more likely to be delegated to the private sector, specifically

by smaller cities with more limited administrative resources. The authors also find that this is more likely in places with more experience, spillovers from neighboring localities, and local appointed rather than elected authorities. [Bel & Fageda \(2017\)](#) summarize the previous literature, pointing to a mix of service types, economic considerations, city characteristics, and ideology. They emphasize cost considerations and the fiscal stress of local authorities as the most robust factors across a range of studies, as well as a growing role of right-wing ideology, in particular in studies using data from European countries. Overall, the evidence points to the delegation decision being only partly aligned with potential efficiency gains. The fact that other, more political factors play a role illustrates the importance of considering endogeneity issues when comparing private to public service provision between places but also provides some clue about potential identification strategies.

[Jerch et al. \(2017\)](#) specifically study the impact of the transfer of local bus services to private concessionaires across a sample of US cities. The contracts they analyze are three-year concession contracts, in which private firms are in charge of managing and operating the service, particularly hiring and compensating employees and negotiating with unions if necessary. The delegation decision is obviously not random and illustrates what the authors call a paradox. Cities with stronger unions are characterized both by higher overall costs and hence have more to gain from delegating to the private sector but also a significantly lower probability of doing so. This creates a fundamental endogeneity that biases simple OLS comparisons of efficiency. To address this, [Jerch et al. \(2017\)](#) use a clever instrumental strategy based on a fuzzy regression discontinuity design (RDD) around narrowly won mayoral elections, which are considered quasi-random ([Lee et al. \(2004\)](#); [Lee & Lemieux \(2010\)](#)). They show that a democratic mayor victory reduces the probability of subsequent privatization by between 6 and 10% and that the RDD design satisfies the usual validity tests. When instrumenting the delegation decision, the authors conclude that

the full privatization of public transit leads to a decline in unit labor costs of between 46 and 68%. The effects are stronger in larger cities and those in states with stronger collective bargaining rights. On the other hand, no effect is detected on the frequency of accident or on the level of ridership; thus, the channel does not appear to be related to quality shading but rather to a more efficient allocation of labor. The corresponding welfare losses from foregone cost savings under public management, estimated for Boston and Chicago, amount to 1.7 and 3.7% of public funding, respectively.

4.1.4 Ports and Airports

While the concession model has been widely used for both ports and airports, robust empirical evidence on the efficiency implications is relatively scarce. In fact, most of the specialized literature relies on “benchmarking” techniques, mostly through a stochastic production frontier approach (SFA) or a data envelopment analysis (DEA), sometimes combined with a ‘second stage’ analysis in which the efficiency scores are regressed on a set of variables to assess their determinants. Regarding ports, these studies usually find that some form of private participation leads to higher technical efficiency, as measured by total factor productivity (TFP). This is, for example, the case of [Estache et al. \(2002, 2004\)](#) for Mexico, [Wanke & Barros \(2015\)](#) for Brazil, and [Trujillo et al. \(2013\)](#) for African ports. [Herrera Dappe & Suárez-Alemán \(2016\)](#) provide a detailed overview of the competitiveness of South Asian container ports. The “landlord port” model, which covers lease and concession-like agreements, has been adopted widely in the region and appears to generate superior operational performance, for example, in terms of turnaround time.

For airports, studies include [Oum et al. \(2008\)](#), who apply a stochastic frontier analysis to panel data from 109 of the world’s major airports and rank those with public ownership and management forms as the least efficient, and [Martini et al. \(2013\)](#), who look at Italian airports, extending the analysis to environmental performance such as noise and pollution, and find that public airports

perform better along these dimensions. As correctly pointed out by [Gong et al. \(2012\)](#) in their review of this specific strand of the literature, however, such studies do not address the multiple potential sources of endogeneity issues in their second stage. Among others, explanatory variables may be endogenous because of omitted variables, or these may be correlated with measurement errors due to limited quality data in the first stage.

Instead, a number of studies have relied on cross-country analysis. Again, the main issues include the potential endogeneity of the key explanatory variables, especially the delegation decision, the type of regulation, and the selection bias created by the limited sample coverage, for example, in studies relying only on listed companies. In addition, the dependent variable is not free of problems either, as it is often difficult to disentangle PPPs from real privatization and to come up with a consistent classification of the delegation modalities. [Bilotkach et al. \(2012\)](#) analyze a sample of sixty-one European airports over an eighteen-year period (1990-2007). Exploiting the panel structure of the data, they use a system GMM procedure and instrument for both the lagged dependent variable and the potentially endogenous explanatory variables by using lagged measures of these same variables. Their main estimate concerns aeronautical charges, and the results show that these charges are significantly lower for airports under private management, as well as for airports under “ex post regulation” (basically self-regulation under the threat of regulatory intervention in case of abuse) and those under “single-till regulation” (where the profits from both the aeronautical and the commercial concession services are considered in the determination of the regulated aeronautical charges). These conclusions differ from previous conclusions based on simple cross-sections of airports, where private management appears to correlate with higher charges ([Bel & Fageda \(2010\)](#)), suggesting an endogeneity bias in previous studies, which is consistent with the fact that airports with the largest potential decrease in aeronautical charges are likely to be targeted for delegation as PPPs. The link between these results and efficiency, however, is not

straightforward, as it involves separating the extent to which decreasing charges are the result of reduced costs being passed on to client airlines, from a simple reduction in the extent to which they exercise their market power.

This distinction is further clouded by the fact that different regulatory regimes have diverging implications for pricing. Under single-till regulation, airports have an incentive to internalize externalities between the two types of activities by lowering charges to attract more passengers, who are also potential commercial customers, while such incentives are absent under dual-till regulation (Zhang & Czerny (2012); Malavolti (2016)). The efficiency implication of these lower charges is, however, ambiguous, as they may generate excessive congestion.

4.2 Energy

As discussed in Section 2, the energy sector presents characteristics that distinguish it from other infrastructure sectors. Starting in the 1980s in the UK and 1990s in the US and then across Europe and the developing world, reforms of the traditional vertically integrated public monopoly model have entailed one or more of the four following steps: the unbundling of the generation, transmission, and distribution segments, also often referred to as restructuring; changes in the regulatory process, often from cost of service to higher-powered forms of regulation such as price caps; the introduction of competition; and the introduction of private participation (Borenstein & Bushnell (2015); R. Bacon (2018); Foster & Rana (2019)). Regarding this introduction, distribution, being the part of the chain where fees are collected from customers, was an obvious place to start, followed by generation, while transmission remained in most cases a public monopoly.

These reforms have occurred in places that differ along many dimensions and have different motivations. These include the degree of efficiency of the prevailing public monopolies, as well as the political and ideological context, the motivation of the main market players, and the ability of policy makers to integrate sometimes hard-to-reconcile technical constraints with the recommen-

dations from experts and international organizations (Léautier (2019)). For example, Borenstein & Bushnell (2015) argue that the situation prevailing in the 1990s, with high average costs and low marginal costs resulting from underutilized capacity and low gas prices, explains the strong push for restructuring from large industrial customers in the US. The main driver of the reforms, hence, was less potential productivity gain than rent-shifting from shareholders of utilities with stranded assets to consumers, but this largely happened in the context of a mature power sector. In developing countries, on the other hand, low prices, low connection rates and high transmission and distribution losses meant that power sectors were locked in inefficient equilibria (McRae (2015)). Dertinger & Hirth (2020) find evidence that reforms were more likely in countries where such problems were more severe, and there is also evidence of cream skimming, with higher rates of transition for firms in dense urban areas. This implies that the impact of reforms may differ across settings.

In addition, whenever an increase in private participation occurred, there were large variations in terms of how much PPPs were used in the process (Foster & Rana (2019)). In generation, the creation of independent power producers (IPPs) occurred either through divestitures or through PPP projects. The difference can generally be ascribed to whether there was the concomitant creation of a wholesale electricity market and the deregulation of prices, as in several states in the US, or whether the environment was characterized by contracts including power purchasing agreements (PPAs) between the government and the independent power producers, as in most developing countries. Since the 1990s, a significant number of these PPPs have been developed in the field of renewable energy. In the distribution segment, on the other hand, divestitures dominated the field. Exceptions were sub-Saharan Africa, with a higher prevalence of PPPs in both segments of the market, and Latin America, where most private entry was in the distribution sector through concessions (Foster & Rana (2019)). Political economy and governance issues then

led to the entry of new private actors in the sector drying up in the 2000s and to many concessions reverting to the public sector, especially in the developing world.

The impact of the reforms leading to the increase in the share of PPPs is likely to be heavily dependent on how the package of structural changes mentioned above is implemented. In particular, the ability of private partners to deliver efficiency gains is conditioned by the nature of the regulation they face, by the contractual design defining, among others, risk-sharing conditions, and by the conditions prevailing in each of the segments of the industry in terms of ownership and competition. In addition, these reforms occur in a dramatically changing environment, with rapid technological innovations and increasing gas prices, the consequences of which are often quantitatively more important than potential productivity gains from organizational changes ([Borenstein & Bushnell \(2015\)](#)). This makes energy a very interesting field, as any study is likely to provide insights on the underlying regulatory conditions and market mechanisms that enable efficient PPPs to develop; however, it is also a difficult one, as confounding factors abound, and the huge variability observed in the reforms packages across places suggests clear endogeneity issues. Indeed, in an industry that is characterized by vertical and horizontal interdependent activities more than any other infrastructure sector, distinguishing efficiency gains that stem from pure plant productivity improvement rather than from system-wide reorganization is difficult. These facts probably explain the scarcity of studies specifically assessing efficiency issues in the energy sector, not to mention those focusing on PPPs.

In addition, the assessment is complicated by the need to carefully assess which of the numerous forms of private participation observed can truly be considered PPPs. For example, while most of the literature refers to private participation in energy in the US and UK, including IPPs, as either divestiture or privatization, IPPs are routinely considered PPPs in the development and policy literature. The World Bank Private Participation in Infrastructure provides a glimpse

of the different types of private-sector involvement in low- and middle-income countries for the period 1990 to 2019. It references 4,879 PPP projects in the electricity sector.⁵ Latin America, East Asia and Pacific, and South Asia are the leading regions with 2,108, 1,165, and 754 projects, respectively. However, while 81 and 94 percent of these PPPs were in generation in East and South Asia, respectively, in Latin America it was only 48 percent, with the rest being distribution and transmission projects.

4.2.1 Generation

Regarding electricity generation, a number of studies have analyzed the impact of private participation. However, drawing lessons from this literature for the specific case of PPPs is difficult, as these either fail to control for the potential endogeneity of reforms or they do so using a generic reform index summarizing different dimensions such as unbundling, regulation, and competition (Erdogdu (2011); Dertinger & Hirth (2020)). The generic conclusions from these studies are rather mixed, showing positive impacts on coverage rates but an ambiguous impact on technical aspects such as network losses.

One exception is Sen et al. (2018), who analyze electricity reforms in 17 non-OECD Asian countries using panel data covering the 1990–2013 period. This is an interesting sample, as the region saw the most widespread implementation of generation IPPs and represents over a third of the world’s energy consumption, two-thirds of the world’s poor, and by far the largest potential growth in energy demand over the next few decades. In addition, the countries in the sample represented approximately 30 percent of all firm-year observations related to energy generation in the World Bank PPI database for that period. When instrumenting open or third-party market entry energy reforms, the authors find no impact of IPPs on transmission and distribution losses and a negative impact on both GDP and income inequality; they attribute the outcome to frequent

⁵<https://ppi.worldbank.org/en/ppi>, accessed May 19, 2020.

contractual breakdowns and renegotiations in areas where cost recovery proves difficult and the related cream skimming, as functioning IPPs tend to service low-cost, urban areas rather than extend coverage to poorer and rural areas.

The situation across emerging countries does, however, seem to be heterogeneous. [Gao & Van Biesebroeck \(2014\)](#) look specifically at Chinese fossil fuel-fired electricity generation firms between 1998 and 2007 and find that IPPs experienced reductions in labor and material demand of 7 and 5 percent, respectively. Note, however, that the sample contains both divestiture and PPPs.

These results can be compared to those from papers looking at pure divestiture in a market context, such as [Fabrizio et al. \(2007\)](#) and [Davis & Wolfram \(2012\)](#) for the US and [Trieb & Pollitt \(2019\)](#) for the UK. [Fabrizio et al. \(2007\)](#), whose methodology has inspired most of the other papers, build on the industrial organization literature to address the endogeneity in productivity estimates stemming from the potential simultaneity of input and output choices, using a measure of state-level electricity demand as an instrument for plant output. In addition, they also consider the potential selection of firms in the context of reforms but argue that state-level implementation and the low number of exits from the sample of IPPs reduces these concerns. Indeed, the results from the unbalanced panel of firms look pretty similar to those from the balanced panel. All these papers find substantial efficiency gains. Holding output constant, [Fabrizio et al. \(2007\)](#) find reductions in labor and nonfuel expenses of 3 to 5 percent and 6 to 12 percent relative to other investor-owned utility plants and government- and cooperatively owned plants, respectively. [Davis & Wolfram \(2012\)](#) find a 10 percent increase in the operating efficiency of divested nuclear power reactors. Finally, [Trieb & Pollitt \(2019\)](#) conclude that generation privatization in the UK increased labor productivity but decreased fuel productivity and interpret this outcome as the consequence of a change in plant owners' objectives rather than of a different incentive structure.

Overall, comparing the two sets of results seems to indicate that the structure of incentives faced by private generation firms matters decisively in triggering efficiency gains. These incentives include the nature of the prevailing pricing arrangements, either defined by long-term contract or wholesale market interactions, and the political economy of the process, in particular when contracts include coverage extension agreements to higher-cost customers and areas.

4.2.2 Transmission

Although transmission was not an obvious target of transfer to the private sector, a few countries have implemented concessions in the subsector, in the form of BOT or BOOT. These include Colombia and Peru in Latin America and India and the Philippines in Asia. While no systematic analysis of the performance of these concession schemes exists, they appear to have led to substantial investment and extensions of transmission lines ([Foster & Rana \(2019\)](#)).

4.2.3 Distribution

As pointed out above, PPPs in electricity distribution were mostly concentrated in Latin America, while in other regions, divestiture was the dominant mode of entry for private partners. In the 1990s, almost 500 new concessions were signed in Latin America. The trend changed significantly in the 2000s, however. With “low-hanging fruit” distribution companies in large urban areas having been picked up and a political landscape that was becoming much less favorable to private firms in infrastructure ([Bonnet et al. \(2012\)](#)), the decade was characterized by a much lower number of deals and a growing incidence of project cancellations and renegotiations.

The evaluation of distribution PPPs must be understood in the context of the important inefficiencies of incumbent public distribution firms. In Peru at the beginning of the 1990s, for example, less than half of the households had an electric connection, losses in distribution were 22 percent, and the two main public state distribution companies, Electro Peru and Electro Lima, were ac-

cumulating huge deficits (Pérez-Reyes & Tovar (2010)). In 1993, the main distribution market in and around Lima was transferred to four different concessionaires. The process was less successful for other areas of the country, with concessions being quickly reversed or their implementation defeated from the onset. Considering 14 distribution companies that represented over 99 percent of the national sales, Pérez-Reyes & Tovar (2010) find large efficiency gains among companies transferred to private owners. Of course, although the sample covers the universe of distribution firms in Peru, there are clear selection issues related to the fact that concessions only proved viable in the country's capital city.

In Colombia, the distribution sector faces an equally dire situation. McRae (2015) describes an industry equilibrium in which low prices, payment default, and illegal connections are combined with huge government subsidies to distribution firms. These firms obtain large profits from providing a low-quality service and hence have no incentive to upgrade it, as the capital cost needed would exceed the incremental profit. Colombia divested approximately half of the distribution market between 1996 and 2010, but only one of the deals took the form of a concession. Pombo & Taborda (2006) document efficiency gains among a number of distribution firms using data envelopment analysis (DEA) of a productivity index but find no such effect among the initially most inefficient firms. Again, causality cannot be established, but this result is consistent with McRae's (2015) conclusion that subsidies lock poor areas into low-quality equilibria.

Finally, it is worth mentioning a few studies that have analyzed larger datasets of utilities from across the developing world. Andres (2004), which was then extended by Gassner et al. (2009), relies on 250 utilities, of which 160 are privately managed and 90 are state-owned enterprises (SOEs). Of these, 70 percent of the firms with private participation are in Latin America. However, most of the firms in this treatment group with private participation are full or partial divestiture, leaving only 14 concessions and 3 lease and management contracts. The authors use different specifications,

among which the most robust is the combination of a difference-in-differences with propensity score matching that allows them to control for both constant observable and unobservable differences between the SOEs that shifted to the private sector and those who did not. Overall, a greater degree of private participation is correlated with larger gains in productivity. In particular, it is associated with a 50% increase in electricity sold per worker and a 42% increase in residential connections per worker, both being statistically significant. However, the authors note that results vary by type of contract. Indeed, in the electricity sector, the impact of privatization is largely positive and significant for privatizations only but not for partial divestitures and concession contracts. Overall, if privatization seems to create efficiency gains, the same does not appear to be the case for PPPs in electricity. In addition, the fact that matching results focusing on real PPPs show no significant results calls for caution, although the limited size of the sample might be the reason for this lack of results.

We also have to note that one should be particularly careful when interpreting the results from [Gassner et al. \(2009\)](#). Indeed, the findings from their difference-in-differences combined with propensity score matching are different from those from their simple panel analysis adding utility fixed effects. The latter concludes that partial divestiture did significantly increase efficiency gains, measured by connections per workers and electricity sold per workers. However, this analysis only uses observations for which the type of utility ownership varies over time, from SOEs to the private sector. Such utilities represent a selected sample, and their ex ante performance might have been significantly different from that of other SOEs that did not undergo a change in status. For example, it might be that only poorly performing SOEs were considered for a transfer, which would bias the estimates of the impact upwards.

[Estache & Rossi \(2005\)](#) use a sample of 127 firms in the electricity distribution sector from 14 countries in Latin America during 1994-2001. They first estimate a parametric labor requirement

function in order to evaluate the impact of private participation on firms' efficiency, before checking the robustness of their results through the estimation of a stochastic frontier model and a first-difference model, this last one allowing for the control of unobserved level effects but not time-varying ones. The firms in the sample have different levels of private-sector participation and face different types of regulation (price cap, hybrid schemes, or rate of return). The authors find that private firms are on average significantly more labor efficient than public firms, but this is mostly conditional on the power of the regulatory scheme. However, again, they are not able to differentiate between purely privatized firms and PPPs.

4.2.4 Other Energy-related Sectors

The work of [Mollisi \(2019\)](#) focuses on PPPs in the Italian district heating industry, using the universe of facilities in the country between 2007 and 2014. This industry is one in which the positive externality between construction and operation is large due to the potential for planning and technological innovations. Construction involves a thermal energy generating facility and a network of pipes to distribute heat to surrounding buildings. Careful design may lower the marginal cost at the operation stage by reducing heat losses and reduce the cost of eventual extensions of the network.

The paper follows the industrial organization literature to address the potential simultaneity of input and output choices when estimating productivity. Regarding the selection issue into PPP, however, is only dealt with by performing ancillary estimations to dismiss selection on unobservables on the firm and public authority sides. Decisions to award a PPP are shown to be related to the fiscal situation of the public bodies, and the number of observed bids by similar firms on PPP and non-PPP projects are not significantly different. While it is unclear why this implies the absence of selection on unobservables, we note that this has been a rather standard assumption in most PPP energy studies. Under what amounts to assuming the exogeneity of the choice of

going for a PPP, Mollisi (2019) shows that firms under a PPP perform significantly better; PPPs are associated with a 14 percent increase in output. In addition, as expected in theory, the author finds that “a PPP contract allows a technological externality between the different phases of a project to be internalized, leading to a positive effect on total factor productivity”. In particular, it is estimated that for firms under a PPP, a unit increase in capital quality, defined as the ratio of the total length of the pipeline to the amount of heated volume, raises output by 15%.

4.3 Water

Water is a highly politicized and controversial sector for several reasons. Water does have characteristics of standard goods but is essential for life, and its demand is relatively inelastic.⁶ More importantly, water and sanitation services have large health externalities through the reduction of the transmission of communicable water-related diseases, which kill 3.4 million people every year around the world, most of them children. In addition, it is a sector with low potential competition, a relatively low potential for innovation, large sunk-specific investments, and a high ratio of fixed to variable costs. As a result, the ability of operators to charge cost-recovery level prices is limited, and they are exposed to a high risk of expropriation of their investments.

Water works, including in particular the delivery of water for consumption and irrigation, have involved private partners throughout history, as described in Section 3.1 above regarding the Persian qanats, or closer to our time, the London New River Company in the 17th century and local US water and sanitation systems in the 19th century. During the more recent wave of private participation, which started in the 1980s, water was not always the first sector to attract the interest of private companies; however, a few decades later, privately managed water and sanitation utilities are found in many countries around the world.

The majority of arrangements that prevail in the water and sanitation sector fall under the

⁶Noll et al. (2000) report a price elasticity of demand of between -.25 and -.75 for developing countries.

PPP definition. Concessions are the most commonly found, with variations in terms of the extent of investments stipulated in the contract. While French water concessions (also called affermage) generally only include the need for investments in the rehabilitation or maintenance of an already developed network, those in developing countries, such as the case of Argentina (Buenos Aires, Mendoza), The Philippines (Manila), or Indonesia (Jakarta), often involve agreements to extend the network coverage to previously underserved areas or even build them from scratch. Other countries have used simple management or service contracts, while the UK has gone for full divestiture (Prasad (2006); Porcher & Saussier (2018a)).

The share of the global population currently served by private providers remains low. Straub (2009) reports that according to 2008 UNCTAD figures, 90 percent of all water utilities at the national or local level were public ones and that the typical share of the population served by private suppliers in developing countries was below 5 percent. In the US, the Safe Drinking Information System (SDWIS) database maintained by the Environmental Protection Agency (EPA) reports that close to 90 percent of consumers are served by public utilities, although this was not always the case; in the 19th century, private water firms dominated the market, but this was abruptly reversed around the turn of the 20th century (Masten (2011)). This is especially remarkable, as no other infrastructure sector in the US followed such a trend. In Europe, private firms initially developed water networks, but most countries turned back to public provision. The UK and France stand as exceptions. In France, the three large private firms dominating the market provide water to 65 percent of the municipalities and 67 percent of the population (Chong et al. (2015)). In England and Wales, 50 million consumers receive water and sanitation services from 32 privately owned companies.⁷

The US case is interesting. First, what explains the reversal from the predominantly private ownership of local water systems in the 19th century to public ownership in the 20th century?

⁷See <https://www.ofwat.gov.uk/regulated-companies/ofwat-industry-overview/>, accessed May 28, 2020.

[Masten \(2011\)](#) analyzes a sample of 373 waterworks serving 346 cities with populations over 10,000 in 1890. He uses exogenous characteristics of cities in terms of the distribution and density of the service areas and provides reduced forms as well as instrumental estimates consistent with the view that municipal ownership is more likely when contracting frictions specific to water and sanitation are higher. This appears to be the case in places characterized by densely populated centers, which makes excavation work more disruptive, together with more sparsely populated outlying areas in need of network extension. More uniform communities, on the other hand, are more likely to keep private operators.

Regarding the impact of the growing share of public water provision, [Troesken \(2001\)](#) documents the fact that between 1889 and 1921, public provision sharply decreased the prevalence of waterborne diseases, such as typhoid, among black communities. The results are consistent across a number of tests, including panel city-level data estimations of typhoid death rates against utilities ownership, in which the latter is instrumented using cities' ownership levels of other types of utilities such as gas, electricity, and fire hydrants. A key channel appears to be the extension of the network through additional investments, as shown by evidence from North Carolina cities. Within cities, rates of typhoid among blacks decreased significantly faster when a change to public ownership occurred, and the increase in water mains was higher in predominantly black communities. These results complete those of [Masten \(2011\)](#) by suggesting that local governments with distributional and social concerns might have found it easier to run water services themselves than to enforce specific objectives through contractual arrangements with private operators.

Regarding social outcomes outside of the US, a well-known paper by [Galiani et al. \(2005\)](#) documents the impact of the privatization of water systems in Argentina on child mortality. Between 1991 and 1999, 30 percent of Argentinean municipalities representing 60 percent of the country's population transferred their water systems to private concessionaires, making it one of the largest

experiences with water PPPs in recent decades. The Buenos Aires concession was the first large-scale urban water PPP, and its initial success created a strong momentum for this type of venture, soon leading to a number of similar undertakings in large cities of Latin America, Eastern Europe, Africa, and Asia. From 1991 to 2000, the number of developing countries with water concessions increased from 4 to 38, and the number of people served increased from 6 million to 93 million.⁸ However, the Buenos Aires water concession did not resist the 2001 Argentinean macroeconomic crisis. A period of protracted renegotiation started, and the contract was rescinded in 2006 and taken over by a newly created public entity.

Focusing on the 1990s, [Galiani et al. \(2005\)](#) first document service improvements linked to this shift to private ownership. In Buenos Aires, a private consortium led by the French company Lyonnaise des Eaux won a 35-year concession. Simple before-after comparisons show dramatic improvements in most technical measures, such as water production, share of spilled water, turbidness, etc. Between 1993 and 2000, more than 500,000 households were connected to the network in the greater Buenos Aires, and in the rest of the country, between 1991 and 1997, the share of connected households went from 64 to 71 percent in municipalities with private concessions. The paper uses a difference-in-differences design, carefully documenting pretreatment parallel trends and showing that at the local level, privatization decisions are independent of the outcome of interest. The estimations reveal an 8 percent drop in child mortality in areas with private concessions, mostly as a result of new connections to the network. In addition, the results are shown to hold only for mortality causes strictly related to waterborne diseases, ruling out potential spurious correlations.

[Kosec \(2014\)](#) provides similar results for 39 African countries between 1986 and 2010, 20 of which implemented PPPs in water in at least some subnational regions during the sample period. The paper analyzes the impact of water provision on children's health and school attendance by

⁸See [Marin \(2009, Chp. 2\)](#) for a detailed account of the evolution of water PPPs in developing countries.

matching 99 demographic and health surveys (DHS) to the PPP data. Estimations control for time-invariant, unobserved heterogeneity and address potential time-variant unobserved effects driving both child outcomes and PPP choices through an instrumental variable strategy, where the instrument is the time-variant share of privately run water taps worldwide (but excluding Africa) run by firms from each African country's former colonizer (France, the UK, Belgium, Portugal, Germany, or Italy). The logic is that, in a world in which a few large water firms dominate the market, countries are more likely to award private water concessions contracts to multinational firms from their former colonizer country, even more so at times when these firms are pursuing worldwide market expansion deals. After showing the strong relevance of the instrument and carefully testing for potential violations of the exclusion restriction, the author confirms the results of [Galiani et al. \(2005\)](#). Being in an area covered by a PPP leads to a 16 percent decrease in the prevalence of diarrhea in under-five children and an 11 percent increase in the mean school attendance rate for children 7 to 17 years old. As in the Argentinean case, the main channel appears to be increased access to clean piped water.

Coverage extensions appear to play a key role in these results. In most developing countries, water PPPs have indeed entailed contractual investments to ensure extensions in coverage. [McKenzie et al. \(2003\)](#) find improvements in access of 14 and 7 percent in Bolivia and Mexico, respectively. However, as detailed in [Marin \(2009\)](#), the overall picture is somewhat mixed and includes a number of high-profile cases where concessionaires failed to either live up to their investment commitments or meet their coverage targets. This also implies that different impacts may be expected in countries where universal access has already been attained.

A number of studies have tried to assess the impact of private participation on operational efficiency. Several dimensions are relevant here, including water losses, service quality in terms of reliability and potability, labor productivity, and more encompassing measures of overall technical

efficiency based on benchmarking techniques or cost functions. Water losses, also referred to as nonrevenue water (NRW), correspond to the water that enters the distribution system but is ultimately not billed. This may be due to physical losses, such as spills and leakages, and to commercial losses, such as theft, unbilled consumption, and metering errors. NRW is usually considered to be a good proxy for inefficiency. Depending on the data source, it may or may not be possible to disentangle the physical loss component from the commercial dimension and to identify, for example, the bill collection ratio. Other things being equal, improvements in water service quality can also be considered as proxies for efficiency gains. Quality can be measured in a number of ways, including continuity of the water service, such as daily hours of availability or the frequency of service interruptions; it can also regard the quality of the product itself, including standard measures such as compliance with potability tests or with more general water composition requirements. Finally, in regard to the water and sanitation sector, evaluating efficiency using labor productivity is expected to produce sharp results. Indeed, for water and sanitation utilities, labor generally represents a large fraction of costs and presents very large variations across public and private firms, as the former have often been used as employment handles by politicians.

A couple of large-scale cross-country, cross-industry studies provide evidence on some of these aspects. For water services, [Gassner et al. \(2009\)](#) rely on 836 SOEs and 141 utilities under private operation, most of them in Latin America and the Caribbean, Europe and Central Asia, and East Asia and Pacific. Ninety percent of these private utilities are operating under concessions or lease and management contracts. The authors show that private-sector participation is associated with gains in performance and labor productivity; it leads to a 54 percent estimated increase in connections per worker and an 18 percent increase in water sold per worker (for concessions) relative to SOEs. These results are partly driven by large employment decreases (22 percent) under private management but also by an increase in the average number of connections. Interestingly,

and contrary to the results for electricity, these results appear to hold for all types of private involvement, specifically for PPPs. For example, residential connections per worker increase by 47 percent for concessions and by 78 percent for partial divestitures, while water sold per worker increases by 18 percent for concessions, 40 percent for lease and management contracts, and 62 percent for partial divestitures. Regarding losses and quality, the study is inconclusive, with either null results or results failing to replicate across different methodologies regarding the impact of private participation on the bill-collection rate, water distribution losses, and number of daily hours with water. One limitation of the study is that the results for subcategories of private involvement cannot be robustly established with the matching procedure, as disaggregation leaves insufficient data.

[Andrés et al. \(2013\)](#) follow similar empirical strategies and use unbalanced panel data that include 49 firms and 515 firm-year observations from Argentina, Bolivia, Brazil, Chile, Colombia, Mexico, and Trinidad and Tobago. Again, there is likely a large majority of PPPs in the sample of privately managed firms, although the exact share is not specified. They uncover a significant drop in the employment level of water utilities, both during the transition to private participation and after it. Given the excess employment levels mentioned above, governments often started downsizing the labor force before involving private partners to make the companies more attractive. As a result, labor productivity, measured with water connections per employee, increased 30.7 percent during the transition and another 42.5 percent after the transition. However, once firm-specific trends are controlled for, the increase in productivity growth during the transition appears to be largely reverted post-transition. On the other hand, the authors find a significant decrease in water losses of 3.8 percent during the transition and 14.4 percent in the post-transition period.

[Jiang & Zheng \(2014\)](#) analyze a panel data set of water utilities from 200 Chinese cities between 1998 and 2007. Starting in the 1990s, there was entry of foreign water companies, such as Veolia

and Suez, in particular through build-operate-transfer (BOT) schemes. The authors use a panel model, controlling for firm and time fixed effects, for utility and city-level variables, and for factors explaining the probability of a shift to private participation (such as shift is shown to respond to utilities' profitability and liability level and to cities' road infrastructure in the prior year), and distinguishing between private utilities with a minority versus majority of private shareholding. The authors conclude that private participation in water utilities has led to cost savings through employment downsizing and reduction in managerial expenses, with both effects being significant economically and statistically. In addition, they find positive, although not significant, effects on labor productivity and TFP.

Wallsten & Kosec (2008) use a panel of all community water systems in the US from 1997 to 2003 (over 90,000 as of 2003) to assess the impact of ownership on water quality. The main estimates look at the reported number of violations, controlling for location and time fixed effects, county characteristics, and the type of water sources. The results are hardly conclusive. Private systems appear to generate fewer contaminant violations but more monitoring and reporting violations, an outcome that is reversed for large systems serving more than 100,000 people. The authors find more convincing evidence, though, regarding the impact of indirect or benchmark competition, as proxied by either the HHI index of water providers' share by counties or the number of water providers in counties of more than 100,000 people, which have more stringent disclosure obligations to the public on water quality. Water providers of all types have significantly fewer violations in locations where indirect competition is stronger, especially for more visible violations.

Porcher & Saussier (2018b) provide a useful summary of studies applying DEA and SFA techniques. Their main conclusion is that in developed countries, there is either no gap in efficiency between the privately owned and the public companies or that the latter actually outperforms their private counterparts, while in developing countries, some papers do find an efficiency advantage for

private companies, but this does not seem to be robust. Papers looking at industrialized countries' cross-section samples include, for example, [Bhattacharyya et al. \(1995\)](#), who apply a translog variable cost function to the data of 221 US water utilities in 1992. The authors find public utilities to be more efficient. Regarding developing country samples, [Kirkpatrick \(2006\)](#) use 110 water utilities in African countries, finding a higher relative efficiency for privately owned utilities when applying the DEA method, but no statistically significant difference when using SFA. [Estache et al. \(2002\)](#) apply a stochastic cost frontier model to 50 developing and transition countries' water utilities in the Asia and Pacific region, failing to find significant differences between efficiency under public and private ownership. Caution is in order, however, when interpreting these results. As already argued for port and airport studies in Section 4.1.4 above, in the absence of careful treatment of the potential endogeneity of management forms, these results should be considered correlational in nature.

Finally, a crucial dimension is the impact of water PPPs on tariffs. For developed countries, the evidence is ambiguous at best. [Chong et al. \(2015\)](#) analyze five thousand French municipalities between 1998 and 2008. Their estimate controls for a large range of observables, including technical water sourcing conditions, and addresses the endogeneity of the management choice using municipality fixed effects. The authors find the absence of a price difference between public and private provision for large municipalities above 10,000 inhabitants, but they find an 8 percent higher price for private provision in smaller cities. Looking at franchise renewal patterns, the authors conclude that this difference is likely related to transaction costs, as smaller municipalities have a lower ability to attract significant competition or threaten to take the service in-house when renewing the contracts.

Evidence from developing countries is also mixed and raises different interpretation issues. [Gassner et al. \(2009\)](#) find no significant differences in tariffs between public firms and PPPs. [Marin](#)

(2009) reviews additional case studies with similarly ambiguous results. This must be considered in a context where most public utilities had prices much below cost recovery levels prior to the shift to private operators. While efficiency improvements and labor downsizing reduce costs, the alignment of tariffs to cost recovery levels means that the two effects compensate for each other. Finally, contrary to the developed country environment, the likely impact of tariffs on welfare must be interpreted bearing in mind that in many cases, households lacking access to a water network are sometimes paying much higher prices from street vendors and small-scale private utilities ([Kariuki & Schwartz \(2005\)](#)).

4.4 Education and Health

4.4.1 UK PFIs in Education and Health

The Private Finance Initiative (PFI) developed in the UK was not restricted to the traditional infrastructure sectors. Indeed, this type of contract has also been used on a large scale in the health and education sectors, tying the building of a health or education infrastructure to its operation and maintenance under an availability payment scheme. As of 2018, over 700 PFI projects worth £60 billion were either active or in construction, of which 127 were health and social care projects, for a capital value of initial investment of £13 billion, and 172 were education projects, for a capital value of initial investment of £8.6 billion. Over the last two decades, this total represented approximately 6 percent of the publicly financed government capital investment. A recent report by the UK Comptroller and Auditor General estimated that £200 billion in UK taxpayers money is committed until the 2040s ([National Audit Office \(2018\)](#)). In contrast to most usual PPPs, an important and specific feature of PFI projects is the absence of a direct relationship between the private provider and the actual users of the services. This absence of market tests is a major issue in regard to the potential performance of PFIs.

PFI was introduced by the conservative government of John Major in the UK in 1992 but truly took pace under Tony Blair's New Labour period after 1997.⁹ The scheme was based on the design-build-finance-operate (DBFO) model for large capital investment, for example, hospitals and schools. The PFI scheme had several advantages from a political point of view. First, while the UK government adopted International Financial Reporting Standards (IFRS) in 2009, which de facto put PFI-related debt on the balance sheet, under the European System of Accounts (ESA) used to determine the level of the public-sector net debt (PSND), PFI debt is still scored as off the balance sheet (Hellowell (2010); National Audit Office (2018)). Second, the PFI program was a perfect way to reinforce ties between the public sector and the business community through shared projects and the frequent revolving door movements of advisers and government officials. The main areas in terms of commitment are health and social care, education, defense, and transport.

Most of the available evidence consists of case studies and separate elements on specific project-related costs or quality rather than full-fledged evaluations. There are, however, interesting elements to be noted. First, regarding the cost of finance, there is consistent evidence of an important cost differential. Hellowell (2010) reports conclusions from a PricewaterhouseCoopers study of 64 PFI project comparing the internal rate of return to a WACC benchmark derived from a CAPM model using gas and water utilities betas as reference. The excess cost of private finance is 2.4 percent. More recent data point to excess capital costs of between 2 and 5 percent (National Audit Office, 2018). Going from the lower to the upper bound of that range more than doubles the total interest payments over a 30-year horizon. Colla et al. (2015) compute, for 84 UK PFI contracts signed by NHS organizations across the UK between 1997 and 2010, the net internal rate of return (IRR) equal to the difference between the expected IRR to equity of the projects and the risk-free rate on short-term government bonds. The net IRR is approximately 10 percent and appears very stable across time and projects, responding only to market conditions and lead sponsor size.

⁹See Hellowell (2010) for a detailed account of the UK PFI experience.

Market concentration on the investor side appears to drive the cost of finance up. PFI projects also involve significant transaction costs. Given the complexity of some of the projects involved, ex ante costs related to bid preparation, negotiation at the preferred bidder stage, advisory support from consultants, etc., can amount to as much as 8 percent of the total investment. As with any such costs, at least part of these ultimately falls on the public partner.

In regard to cost and quality, bundling planning, building and operations in a single contract should in theory allow private firms to internalize the positive externalities present between the construction of the dedicated infrastructure and its maintenance, resulting in a higher efficiency. In practice, there is little evidence for this. Early studies mostly fail to find meaningful differences in cost and quality between PFI and no-PFI hospitals (National Audit Office reports, quoted in [Hellowell \(2010\)](#)). This is the case for 16 hospitals assessed in the 2000s in terms of quality of external and internal materials, as well as functions and flexibility for changes. Similar conclusions have been reached for the quality and cost of support services ([National Audit Office \(2018\)](#)). More recently, mixed conclusions include higher costs of cleaning and similar or higher operational costs but also higher maintenance spending in PFI hospitals. This begs the question of whether private operators truly internalize the potential externalities between the different phases of the project by developing innovative designs or whether they opt for a conservative design to be able to cash in as rapidly as possible on public payments in the operation phase. Finally, PFI hospitals appear more likely to be delivered on budget, but construction costs are also higher as they integrate ex ante potential unforeseen contingencies. This is consistent with some of the evidence for road PPPs in Section 4.1.1 and suggests that public authorities may be paying a significant premium to ensure that projects are delivered on time and on budget.

In their review of the literature of PPPs in health, [Roehrich et al. \(2014\)](#) conclude that the “hospital build quality is not unambiguously better for PFIs”. Regarding the education sector

more generally, [Patrinos et al. \(2009\)](#) notes that “there is little actual evidence that private finance initiatives lead to cost savings”. The French Comptroller General office reaches a similar conclusion when evaluating prisons built as PFIs ([Cours des Comptes \(2017\)](#)).

In addition to this lack of robust evidence, the way PFI projects are evaluated is a source of controversy. Indeed, they are traditionally assessed through value for money (VfM) by comparing the expected cost of pure public provision to the expected payments made by the government to the private operator through a PPP. This raises a number of issues. First, VfM as a criterion stops short of integrating all the relevant elements of the welfare gains related to a project. [Boardman et al. \(2010\)](#) advocate for a more encompassing cost-benefit analysis à la [Jones et al. \(1990\)](#), which would at least attempt to evaluate changes in the welfare components of all stakeholders (consumers, producers, employers, and the government) under alternative schemes. [Grout \(2005\)](#), on the other hand, argues that welfare analysis is overly complex and that under a well-organized bidding process, the simple comparison of private alternatives dominates other options. Evidence of strategic underbidding and systematic renegotiation, however, suggests that this may be problematic. In addition, a crucial issue in VfM is the choice of the discount rate used to evaluate the PFI projects. Indeed, as PPPs have significantly backloaded costs, the higher the gap between the chosen discount rate and the government’s borrowing rate is, the more likely a PPP will prove to provide VfM. Using a discount rate closer to the government rate would overturn a large number of VfM evaluations, as shown, for example, for the Sea-to-Sky Highway in BC, Canada, by [Boardman et al. \(2010\)](#).

Overall, it is fair to say that no robust evidence is available to assess the impact of PFI on efficiency, especially in the health and education sectors. The initial model gave way to ‘PF2’ in 2012, with only marginal differences in the nature of the projects. Finally, in October 2018, the British government, which had led the way in PFI experiments, announced it was giving up on

this modality for new infrastructure investments because of their fiscal implications and the lack of evidence about their value for money.¹⁰

4.4.2 Education

Private finance initiatives are only one of the different forms of private involvement in the education sector; voucher and charter schools have become increasingly popular in recent decades. Contrary to PFIs, they directly involve the private sector in the provision of education. Through voucher schemes, households are free to choose their children's school, while private schools that are in agreement with the government - called voucher schools - receive a per-student subsidy. An alternative way to involve the private sector in the provision of education is to outsource the operation of public schools to the private sector, resulting in the so-called charter schools and concession schools.

Given the growing popularity of school choice policies, both voucher and charter schools have been extensively studied recently. [Epple, Romano, & Zimmer \(2015\)](#) and [Epple, Romano, & Urquiola \(2017\)](#) provide comprehensive reviews of this literature, which aims to evaluate the impact of such policies on enrollment, educational outcomes and stratification. Most of the studies covered in these reviews compare the educational outcomes of students in public schools with those of students from voucher or charter schools but do not provide a sense of their cost-effectiveness. In contrast, our goal is to evaluate the relative efficiency of the provision of education by the private sector relative to that of the public sector.¹¹ Note also that the large literature evaluating the impact of the introduction of school choice policies does not fall under the scope of our paper. In what follows, we will thus restrict our analysis to studies tackling cost efficiency considerations when comparing the public and private provision of education.

¹⁰See <https://www.theguardian.com/uk-news/2018/oct/29/hammond-abolishes-pfi-contracts-for-new-infrastructure-projects> (accessed June 4, 2020).

¹¹We also exclude studies exploiting the random allocation of vouchers, even when they include a discussion about the cost-effectiveness of the program, as long as it is not clear that students not receiving a voucher enroll in public schools, as we want to focus on the comparison between schools under a PPP contract and public schools.

Most of the studies reviewed herein focus on PPPs taking place in developing countries. Indeed, their recent success in increasing enrollment rates in primary and secondary education has created a new challenge, as public education systems are often not equipped to absorb this growing demand (World Bank (2018)). Many governments have taken steps to increase school supply, and public-private partnerships are one of the solutions implemented. The key question is then whether private providers can comply with high standards of quality in the provision of education while keeping costs low. Researchers have sometimes teamed up with governments launching PPPs in education, with the aim of studying this question in a clean setting.

Romero et al. (2020) study the decision of the government of Liberia to outsource the provision of education to private providers through the Partnership Schools for Liberia (PSL) program. PSL is a PPP program for school management in which private providers chosen through a competitive bidding process are allocated the responsibility of running public schools and improving learning levels. The providers perform a number of tasks, including training, supervision, monitoring, maintenance, and the supply of inputs, among others. From a pool of 299 public primary and preprimary schools preselected to participate in the experiment, 93 schools were randomly chosen to be managed by one of eight private organizations, allowing a careful evaluation of this program. Those schools were selected out of the 2,619 public schools in the country, based on particular requirements decided ex ante by the government and private providers; therefore, they do not constitute a representative sample. In particular, they have better facilities and infrastructures than the average school in the country. Keeping this caveat in mind, the randomization performed in this sample still ensures that the estimates are internally valid.

Each selected school was assigned to a specific provider based on their declared requirements and location preferences. Schools were then matched in pairs according to their resources and assigned provider, and the treatment was randomized within each pair. While private providers

did not comply perfectly with the treatment assignment by refusing to manage some of the schools allocated to them, the authors kept the original assignment at the school level. In addition, to avoid the contamination of their results by changes in the student composition across schools that may have occurred after the introduction of the program, they sampled students from the pretreatment enrollment records and associated each of them with their original school, regardless of what school they attended once the treatment was introduced. This process allowed [Romero et al. \(2020\)](#) to capture the intention-to-treat impact of the program.

After one academic year, the results show that students in outsourced schools score 0.18 standard deviations higher in both English and mathematics. This result does not seem to be driven by an increase in ‘teaching-to-the-test’ in PSL schools. One of the potential explanations is an increase in attendance, as students in treatment schools are 16 percentage points more likely to be in school during class time. Some important management changes can also partly explain the positive impact on students’ learning, such as the implementation of longer school days in PSL schools, resulting in 3.2 more hours of weekly instructional time. The increased flexibility in the management practice of private providers also appears to have increased teacher accountability, even though teachers in PSL schools are civil servants paid by the Liberian government. Indeed, unannounced spot checks allow the authors to conclude that teachers in PSL schools are 20 percentage points more likely to be in school and 15 percentage points more likely to be engaged in instruction with respect to control schools. In contrast, private providers are not found to engage in student selection, which is usually the main argument against PPPs in education.

The authors conclude that these positive impacts make the PSL program more effective than additional spending for hiring more teachers under business-as-usual situations. However, this conclusion does not take into account that previous estimates are likely to be contaminated by the change in the pool and number of teachers in PSL schools, which took place as the experiment

was going on. Some private providers indeed asked the Ministry of Education to transfer some underperforming teachers from PSL to other public schools, replace them and provide additional teachers. This had several consequences that may lead to qualifying the validity of both the study's estimates and cost-effectiveness analysis. First, the quality of teachers in PSL schools, as well as their number, increased significantly; PSL schools have on average 2.6 more teachers than control schools. Second, these changes imposed additional costs on the public system to run the program. Finally, they also resulted in negative externalities on other public schools due to the transfer of low-performing teachers.

Overall, it is then difficult to conclude whether the study's positive results are driven by the better management of schools by private providers or merely by the additional resources allocated to treated schools and the negative externalities on public schools. In addition to the transfer of lower performing teachers, the PPP contract allowed private providers to cap class sizes, which resulted in the exclusion of some students without ensuring their transfer to another school.¹²

The Promoting Low-Cost Private Schooling in Rural Sindh (PPRS) program, launched by the local government of the province of Pakistan, presents similar features, which contaminate the evaluation of the outsourcing of education to private providers. This intervention, which offers a per-student subsidy to private entrepreneurs for establishing and operating public schools in underserved villages, gives more flexibility to providers in their choice of inputs but is bundled with other initiatives, such as school leadership and teacher training and teaching and learning materials, thereby confounding the pure effect of outsourcing.¹³ However, in contrast to the PSL program, the per-student subsidy in Pakistan is very low, representing less than one-half of the per-student cost in public primary and secondary education in the Sindh Province. This suggests that any positive effect of the program would come from the improved effectiveness of private

¹²Romero et al. (2020) also reported two serious sexual abuse scandals involving staff of two of the private operators.

¹³For example, they were allowed to hire teachers with lower qualifications than those required for government teachers, contrasting with the PSL initiative in which providers could only hire public servants.

providers and not from larger subsidies.

The PPRS program is randomly allocated at the village level, which ensures the existence of a comparable control group and limits migration issues, allowing [Barrera-Osorio et al. \(2017\)](#) to carefully evaluate its impact.¹⁴ The intention-to-treat estimates show that after 1.5 years, the program increased average enrollment by 30 percentage points and test scores by 0.67 standard deviations in treatment villages relative to control villages. However, while being conservative regarding the cost of the program, its cost-effectiveness seems to be quite low compared to similarly estimated values for 14 education interventions reported by [Evans & Popova \(2016\)](#).

Note that the counterfactual against which the program is tested is not “public schools” but rather “no PPRS school in the village”. It is then difficult to know whether the PPRS schools are more effective at increasing enrollment and learning than public schools would have been. In particular, the treatment-on-the-treated impact shows that test scores increased by two standard deviations among children induced by the program to enroll in school. This suggests that test scores are increased by the program merely because there are not enough schools *ex ante* to respond to the existing demand for education. In addition, the treated villages were less likely to have a public or NGO school than control villages at baseline.

In an attempt to evaluate the effectiveness of program schools in raising test scores with respect to that of government schools, [Barrera-Osorio et al. \(2017\)](#) compare the test scores of students enrolled in program schools in the treated villages to those of students enrolled in government schools in control villages. They find that children in program schools score 0.21 standard deviations higher on the total test scores than those in government schools. However, although PPRS schools are randomized at the village level, enrollment is not; student-composition effects are thus likely to bias these estimates, as program schools might attract very specific types of students. For example, high-score students might switch from government to program schools, which would bias

¹⁴In particular, it allows for the elimination of a potential bias coming from the self-selection of private providers in villages with very specific characteristics.

the previous estimates upward. The bias could also go in the opposite direction if, in contrast, previously unenrolled, low-ability students enroll in a program school in treated villages. The authors argue that this latter assumption seems more convincing, as students enrolled in government schools appear to come from households that are less likely to live in poor-quality dwellings and where the head of the household is more educated and is less likely to be a farmer.

Keeping these caveats in mind, one reason behind the potentially higher effectiveness of program schools at raising test scores with respect to government schools is their more efficient use of inputs. [Barrera-Osorio et al. \(2017\)](#) indeed report that program schools hire significantly more teachers, although they are less experienced and do not display less absenteeism. These schools also have significantly better amenities, such as the provision of drinking water and the presence of toilets. The authors assign these changes to the flexibility with which private providers could select their inputs to make them better aligned with demand. They estimate a structural model of the supply and demand of school inputs and conclude, under specific parametric assumptions with respect to the social welfare function, that the input selection of private providers allowed them to reach 90 percent of the surplus that would have been reached by a social planner internalizing all the educational benefits to society.

Overall, it remains difficult to determine whether the PPRS program is more efficient at raising test scores and enrollment than what would have been the construction of additional government schools in these villages. Answering this question would require a comparison of the cost-effectiveness of the PPRS program vs. the construction of new public schools.

In an earlier study, [Kim et al. \(1999\)](#) evaluate a similar program, which offers private schools a subsidy per girl enrolled to incentivize them to construct and manage new facilities in low-income urban neighborhoods of Pakistan; the authors reach similar conclusions as those of [Barrera-Osorio et al. \(2017\)](#) by combining randomization at the neighborhood level with a difference-in-differences

analysis. They find that the program increases both girls' and boys' enrollment. Interestingly, they also investigate whether the cost of the program is larger than that of constructing new schools. Even when taking an upper-bound estimate of the start-up cost of the program, funding the program for one school with two classrooms of 50 students each would still cost less than the estimated cost of the construction of a government primary school with two classrooms. [Kim et al. \(1999\)](#) thus conclude that such a program is less costly than establishing a new public school, with the caveat that they did not study whether program schools improve learning outcomes.

It should also be emphasized that the studies reviewed herein do not tackle the question of spillovers and externalities that could arise in an education system where privately and publicly managed schools coexist.¹⁵ If, for example, resources are diverted from public schools to schools under a PPP contract, as was the case in Liberia, then outsourcing some part of the education system to the private sector might be detrimental in the aggregate, even if private providers are more efficient. This would be the case if the loss in test scores for students in public schools caused by these negative externalities more than offsets the gain in test scores of students enrolled in schools under a PPP contract. A different question regarding the implementation of PPPs in education is whether they are successful in effectively leveraging the potentially higher productivity of the private sector. One might, for example, be worried that the existence of a contract between the government and private providers restricting the flexibility and autonomy of the latter will destroy their advantage relative to public schools. Two different studies tackle this issue.

[Barrera-Osorio et al. \(2020\)](#) evaluate a policy taking place in Uganda, where the government has launched a PPP program in which low-cost, registered and certified private schools are eligible to receive a per-student subsidy as part of its strategy to absorb the demand for secondary education. Participating schools are not allowed to charge any additional fees to children from the public system but are allowed to select students. The policy was randomly phased-in, allowing [Barrera-](#)

¹⁵See [Muralidharan & Sundararaman \(2015\)](#) for a nice overview of the aggregate effect of a school choice program in India, implemented by a nonprofit organization in collaboration with the government of Andhra Pradesh and the World Bank.

Osorio et al. (2020) to compare participating private schools to private schools that applied to the program but entered it after a one-year delay. The intention-to-treat estimates indicate that average enrollment is increased by 35% in participating compared to nonparticipating private schools, while students' test scores do not seem significantly different than those in nonparticipating private schools.

Overall, the conclusions derived from this program are unclear. First, it is difficult to know whether the program itself is at the origin of a net increase in enrollment in the population or whether the migration of students across different schools explains this result. In addition, the composition of students in participating vs. nonparticipating private schools appears to be different; for example, students in the former come from households with more educated parents who are investing more in their children's education.

Barrera-Osorio & Raju (2015) evaluate the impact of public subsidies on low-cost private schools in Pakistan, exploiting the fact that, to be eligible, private schools must apply and achieve a minimum student pass-rate in a standardized academic test. The authors are then able to use a regression discontinuity design, comparing outcomes of schools scoring just above the threshold to those scoring just below. They conclude that receiving the subsidy increases the number of students enrolled by 85 students for schools that were just above the threshold, a 37 percent increase compared to the baseline. This result implies that the program is extremely cost-effective at generating enrollment gains. However, the authors do not test whether the program implies some changes in students' learning. This study's results should also be interpreted with caution since it is again possible that the increase in enrollment mainly captures the migration from students across schools rather than net gains in enrollment, especially given that schools participating in the program are not allowed to charge fees to students.

Overall, the question of whether the existence of a contract between the government and private

providers might hamper the potential efficiency advantage of the latter with respect to public schools remains unanswered. [Barrera-Osorio et al. \(2020\)](#) provide some evidence that, at least, contracting with private providers does not seem to have any adverse effects on school governance. However, more studies are needed to obtain robust results on this question.

4.4.3 Health

A variety of health PPPs have been implemented in recent decades, with the aim of improving individuals' health outcomes. Such initiatives seem particularly popular in developing countries, where poor quality of health services and low rates of utilization of health services are common. Governments have attempted to leverage the presence of health facilities managed by nongovernmental organizations and private providers to increase the rates of utilization of health services, as well as to improve their quality.

A number of these initiatives take the form of fee-for-service or performance-based financing mechanisms, in which the government offers payments to contracted private facilities conditional on the volume and/or quality of preselected services they provide.¹⁶ In contrast to fixed payments, such contracts have the potential to incentivize providers to attract more patients and improve the quality of the services they offer.

Overall, the literature covering health PPPs is scarce and of relatively poor quality. We focus on a small number of rigorous studies that clearly focus on programs targeting public and private health providers and present disaggregated results. [Huillery & Seban \(Forthcoming\)](#) evaluate a project through which the Congolese government links payments to health facilities to the number of patients they receive for some predetermined health services.¹⁷ Such a payment scheme should incentivize health facilities to use their knowledge of the local population to better diagnose the

¹⁶The WHO defines performance-based financing schemes as “fee-for-service-conditional-on-quality”. See [Hellowell \(2019\)](#) for a typology of hospital public–private partnerships implemented in Africa, which include different combinations of service and management contracts and facilities' design, building, and maintenance.

¹⁷The targeted services were outpatient first curative visits, prenatal visits, child delivery, obstetric referrals, the full immunization of children, tetanus toxoid immunizations, and family planning visits.

causes of low service utilization and invest in the most relevant strategies available to increase demand.

As part of a research project running from 2010 to 2013 in the Haut-Katanga district, the government randomly assigned the 96 local health areas to either a treatment group - receiving fee-for-service payments - or a control group - receiving a fixed payment of the same amount. This process allows the authors to abstract from resource effects and isolate pure incentive effects. The authors find that, relative to fixed payments, the incentive scheme leads to an overall smaller utilization of health services, which mostly comes from a decrease in curative and prenatal care services. The policy did not increase the use of other targeted (immunization, attended delivery and family planning) or nontargeted services (postnatal services).

These results are surprising to the extent that the program seems to lead treated facilities to implement strategies aimed at attracting more patients. It decreases user fees for some targeted services and has increased health workers' attendance, as well as the number of outreach activities related to targeted services.¹⁸ Some of these actions might have been counterproductive. The decrease in user fees might be interpreted as a signal of low quality, even though there is no evidence of a decrease in service quality in fee-for-service facilities. In addition, it seems that incentive payments backfire by crowding out workers' intrinsic motivation and lowering their job satisfaction. The authors suggest that this might have played a role in the failure of the program to increase health service utilization, explaining why health workers did not invest in awareness campaigns. It also seems that the lack of demand is strongly linked to a misunderstanding of the benefits of specific health services.

Overall, the conclusions from this study suggest that there is room for improvement regarding performance-based financing schemes along two dimensions. First, complementary demand-side interventions such as awareness campaigns might be needed to significantly increase service uti-

¹⁸Note, however, that these estimates are only significant at the 10% level

lization under a performance-based payment scheme. Second, incentives should not only be based on the volume of patients for certain key health interventions but also encompass the quality of the service provided.

Some performance-based financing programs have linked payments made to health facilities not only to the volume of services but also to some quality indicators or health targets. [Soeters et al. \(2011\)](#) study the effectiveness of such a program launched in two districts of the Democratic Republic of Congo, which offer payments for specific health services to independent health facilities while encouraging them to develop subcontracts with private providers.¹⁹ Payments are linked to the quality of the services provided. Every three months, district health authorities review some predefined quality indicators and, based on these evaluations, increase the subsidies to health facilities by up to 15 percent.

Using two rounds of a survey conducted in the treated districts as well as two neighboring districts both before and after the start of the program and controlling for time-invariant confounding factors by implementing a difference-in-differences, the authors find that the change in the share of pregnant women delivering at a health facility (rather than at home) is 21 percentage points higher in control districts. No significant differences are found for the use of other health-care goods and services, such as ITNs, antenatal care, the use of modern family planning methods or visits to a health facility when sick.²⁰ These surprising findings might be explained by the increased investments made by nongovernmental organizations in control districts' health facilities and by lower user fees in control facilities, where they are regulated.

Despite these disappointing findings, the authors report that patient-perceived quality is significantly increased in the Congolese participating districts compared to that in the control districts.

This may indicate that this subjective measure is an imperfect indicator of quality of care, as pa-

¹⁹The health-care services chosen to receive subsidies include “outpatient department consultancies, number of bed days, fully immunizing a child before twelve months of age, construction of a household pit latrine, and use by a woman of oral or injectable contraceptives.”

²⁰The latter outcome appears to be positively impacted by the program, but this is only significant at the 10 percent level.

tients may interpret the increase in user fees in participating health facilities as a signal of quality. A less subjective quality indicator, i.e., the number of qualified staff, has increased by twenty-three percentage points in health facilities located in participating districts compared to only eight percentage points in control districts. Despite the lack of impact on health-care utilization, this increase might have induced improvements in patients' health outcomes. However, the latter are not studied by [Soeters et al. \(2011\)](#), possibly due to data limitations.

A similar performance-based financing program was launched by the government of Cameroon in 2012. Health facilities in selected districts are randomly assigned to one of three treatment groups or to a control group. The first group receives performance-based payments as a function of the volume of services offered. Quality bonuses are also provided and could increase the payments received by facilities by up to 30% compared to the total payment based on health service quantity. Another group receives the same monitoring, supervision and financial resources as the performance-based financing group but without financial incentives linked to performance. Finally, the third group receives only the supervision and monitoring treatment.²¹

Despite the randomization, some baseline characteristics appear to be unbalanced across the different groups. In a study evaluating the program, [De Walque et al. \(2017\)](#) address this issue by combining difference-in-differences and ex ante randomization, exploiting the baseline and follow-up household and health facility surveys. They note that ideally the randomization should have been conducted at the district level, since the proximity between health facilities belonging to different treatment groups implies the possibility of spillovers through different channels. In addition, the household-level analysis suffers from an attenuation bias to the extent that the treatment variable is incorrectly measured; the authors arbitrarily assume that household members use the closest health facility, while data show it is not the case for a substantial share of them.

²¹The performance-based financing package includes payments linked to both the quantity of certain services provided and the quality of care, measured by indicators such as the number of "new cases of STIs diagnosed and correctly treated in the month according to national protocols". The services encompassed by the performance payments include curative care (number of outpatient consultations, number of hospital bed days), preventive care (vaccination, STI treatments, TB treatments) and reproductive health-care. In addition, independent monitoring is performed.

Fortunately, estimates from the household-level specifications are complemented by those from the facility survey, which do not suffer from measurement errors.

Relative to the control group, the experiment suggests that performance-based financing is effective at increasing the utilization of some health-care services, such as child and mother vaccination, the use of modern family planning, and HIV testing. However, it does not have any impact on the use of antenatal care or institutional deliveries. The authors suggest that this might be explained by the level of user fees acting as a barrier on the demand side. They thus suggest that, conditional on the actual use of certain health-care services being low, the government should combine such supply-side policies with demand-side policies, such as voucher schemes.

To understand whether the program translates into quality changes at the facility level, an analysis of health workers' satisfaction and availability of drugs and equipment is performed. [De Walque et al. \(2017\)](#) find that the program significantly improves the satisfaction of health-care workers regarding the overall physical conditions of the facility building and the quantity and quality of the equipment available in the facility, which is confirmed by the analysis of the health facilities' equipment, which has significantly increased over time compared to that of the control facilities. In addition, the number of nurses per facility has also increased significantly over time in participating facilities compared to control facilities. This has led to an increase in overall patient satisfaction, particularly regarding child health consultations. However, these results fail to translate into actual improvements in the quality of care, measured through standardized checklists completed by enumerators while observing antenatal care and children consultations.²² On the other hand, the performance-based financing program fails to significantly impact the quantity and quality of drugs (such as paracetamol, amoxicillin tabs or syrup, ORS, iron tabs, cotrimoxazole, malaria treatment medicines, and vaccines) available in the health facility. This might explain why no changes have been reported by health workers with respect to their perceived ability to provide

²²The checklists comprise information on whether health workers were performing predefined routine activities, such as washing their hands, asking questions about the child's health status, checking HIV status, testing for syphilis, and providing malaria prophylaxis.

high-quality care given the working conditions in the facility.

Overall, the authors conclude that performance-based financing seems to be an effective mechanism in improving the structural quality of care. They also note that monitored facilities in which payments are not linked to performance observe relatively similar improvements than those observed in performance-based financing facilities. What matters most thus seems to be the allocation of additional resources to health facilities, allowing them to upgrade the quality of their equipment and infrastructure.

[Engineer et al. \(2016\)](#) study the effectiveness of a large-scale pay-for-performance program implemented in Afghanistan, randomized across 442 primary care facilities in 11 provinces. Payments were linked to the volume of nine targeted health services and were completed by annual bonuses depending on the equity and quality of service provision. Unfortunately, this program failed to increase the utilization of modern contraception, antenatal care, skilled birth attendance, postnatal care and child vaccination rates.

The authors attribute the failure of the program to inattention to demand-side factors, as well as to management issues. Indeed, it seems that health workers had a limited understanding of the bonus scheme, partly because the communication around bonus payments and performance levels was not clear. More importantly, the authors point to the fact that no demand-side intervention was implemented alongside the pay-for-performance program as 'the most glaring flaw of the approach'. They argue that such an intervention would be key to increasing individuals' awareness and in turn creating demand for health services.

A number of studies have similarly argued that combining performance-based financing with direct demand interventions may be needed to increase the utilization of health services and have looked for conditions to make this effective. One aspect is that demand-side interventions might be more successful in the presence of an already developed private health sector. In 2006, the

government of Gujarat, acknowledging the fact that Indian public facilities often “lack the capacity and reach to serve many rural areas” (Mohanani et al. (2014)), designed a public-private partnership specifically aimed at taking advantage of the large presence of the private sector in the state, the Chiranjeevi Scheme. The latter covers the costs of deliveries in contracted private facilities for women living under the poverty line. In addition, the scheme covers the travel expenses of the beneficiary and of the accompanying person (Bhat et al. (2009)). In exchange, the government pays a fixed amount per delivery at the private facility.

This PPP successfully circumvents the lack of skilled health workers in the public sector, since more than 80% of the private obstetricians present in the districts where it was implemented signed a contract with the government in the two years after the start of the program (Mavalankar et al. (2009)).

As noted by Mohanani et al. (2014), many cross-sectional or before-after studies have concluded that the program is highly effective at increasing the share of institutional deliveries (Bhat et al. (2009)). However, implementing a difference-in-differences, the authors show that these results mostly reflect the bias from the self-selection of pregnant women into the scheme based on specific characteristics or due to a time trend, since the rate of institutional deliveries might have increased even in the absence of the voucher program. They use the timing of the implementation of the scheme across the different districts of Gujarat to identify whether changes in the share of institutional deliveries are linked to the introduction of the voucher program across districts. They conclude that the program is not associated with a significant increase in the probability of institutional delivery or in the use of antenatal and postnatal services. As expected from these results, the probability of delivery with complications did not significantly decrease after the introduction of the program, which is particularly alarming to the extent that 54 percent of the women interviewed suffered from delivery complications.

In addition to the presence of time-varying confounding factors that could bias the results, [Mohan et al. \(2014\)](#) advance two other possible explanations for these disappointing findings. First, the quality of the private facilities participating in the program might be perceived as low, so that women do not want to use their services, even for free. The voucher scheme might also fail to provide the right incentives for health providers to improve this low level of quality.

The second possibility is that institutional deliveries in private hospitals are not actually free of charge, even for women benefiting from a voucher. Indeed, [Mohan et al. \(2014\)](#) find that the program has not been associated with a decrease in out-of-pocket expenditures with respect to institutional deliveries. This suggests that participating private providers still charge fees or increase the cost of side expenditures, which are not covered by the voucher program. For example, it has been reported that institutional deliveries are associated with larger expenditures on medicines for poor women benefiting from the program compared to poor women who do not receive a voucher ([Bhat et al. \(2009\)](#)). In the absence of specific regulations and monitoring, out-of-pocket expenditures charged by private providers might offset the benefits of the voucher.

Overall, the studies reviewed above imply that there exist several conditions for the success of a pay-for-performance scheme. First, budget constraints need to be the primary reason for the lack of use of targeted health-care services ([Arur et al. \(2009\)](#)). Second, the schemes should encompass other potential barriers to access, such as transportation costs. Voucher programs should also be accompanied by an adequate communication campaign ([Obare et al. \(2013\)](#)). Finally, a demand-side intervention can only be effective at harnessing the capacity of private providers if they are willing to participate. In particular, reimbursement rates should be high enough to make programs attractive to private providers.

However, even if these conditions are met, they do not ensure that the program will be successful at increasing health service utilization and health-related outcomes. The Chiranjeevi Scheme shows

that it is crucial to monitor health providers adequately to ensure that they abide by the contract.

The government of Guatemala found a way to improve the health coverage of the rural poor by bringing medical teams directly to them. Realizing that a widespread presence of medical facilities in rural areas might be infeasible due to low population density, poor transportation systems and a lack of skilled health workers, the Ministry of Health decided to contract-out mobile medical teams in charge of providing a package of basic health and preventive services in rural communities that they visit monthly. The government implemented this program, known as the Coverage Extension Program (CEP), by contracting out NGOs to leverage their knowledge of the local communities. NGOs were selected based on predetermined criteria. The final contract delineated the services they should provide and performance targets that they were expected to reach for their contract to be renewed, as well as the fixed payments they would receive. Through this large-scale program, health services were provided to approximately one-third of the country's population between 1997 and 2006.

To evaluate the effectiveness of this program at increasing health services utilization rates, [Cristia et al. \(2015\)](#) exploit the geographical expansion of the program; they implement a difference-in-differences, comparing communities that were covered thanks to the extension of the program to similar communities that were still not covered by 2005.

The results regarding the number of prenatal care sessions indicate that NGOs implemented effective strategies to reach their targets, since the fraction of women receiving three or more prenatal care visits attended by a physician or a nurse increased by 38 percentage points. Similarly, the program was effective at improving the vaccination rate, as the fraction of children vaccinated for different diseases increased between 32 percentage points (BCG vaccination) and 45 percentage points (polio vaccination).

Mobile medical teams are not a universal solution; their effectiveness at increasing health ser-

vices utilization seems limited to services already considered important and effective. Indeed, the program was not successful at increasing the knowledge or use of contraceptives among the population, despite low baseline levels. The authors report that mobile medical teams were unable to get around the strong cultural barriers regarding family planning methods. This, again, underlines how health service utilization is strongly tied to the way the services are perceived by the population. Decreasing the travel costs and out-of-pocket expenditures associated with the utilization of targeted health services is only part of the determinants of this demand; health PPPs should also encompass information campaigns to make individuals aware and willing to use them.

Overall, the various forms of interventions reviewed in this paper help draw general lessons regarding the potential for PPPs in health to improve service utilization and health-related outcomes. First, it seems important that incentive payments are linked not only to the volume of services offered but also to their quality. Second, a strong consensus also emerges regarding the necessity of combining demand- and supply-side policies to effectively increase both health-care utilization and health-related outcomes.

Addressing demand-side constraints appears to be a necessary condition for the success of health PPPs. It is crucial that a proper diagnosis of the situation is made *ex ante* to understand the reasons for service underutilization and, as concluded by [Engineer et al. \(2016\)](#), to “identify where the most important bottlenecks to service use are”. Is the issue a lack of demand for health services? If yes, is the lack generated by the costs of the services, their poor quality, the distance between individuals and health centers, or by a lack of awareness of the benefits of health-care? The answers to these questions will help choose the adequate type of PPP to implement.

5 Summary and Cross-cutting Issues

This section starts by proposing a typology of the different successful empirical strategies that have been implemented, highlighting the main areas open for progress. It then summarizes some of the main lessons learned through the lens of the more important cross-cutting issues that emerged in the process. These include aspects related to the implementation of PPPs, such as competition for and in the market, contract design and regulation, and renegotiations. It also includes aspects related more specifically to the broader political, economic and institutional context. In doing so, the review also points to significantly understudied issues that represent important gaps in our knowledge.

5.1 Successful Empirical Strategies

A majority of existing studies have adopted a reduced form approach. Among these, there are a few interesting sources of causal evidence on the impact of PPPs drawn from natural experiments, often in a historical context. [Bogart \(2005\)](#) leverages the comparison between summer and winter turnpike rates to attribute causality in rate decline to their large-scale adoption. [Bogart & Chaudhary \(2012\)](#) take advantage of the exogenous schedule governing Indian railway concession take-over by the public sector to study their impact on the cost of service provision. [Masten \(2011\)](#) uses exogenous characteristics of the urban space—distribution and the density of the population—to analyze the likelihood of private vs. public provision of water in early 20th-century US cities.

Closer to us, a few studies rely on the claim that the choice to implement a PPP can be considered exogenous relative to some outcomes of interest and apply simple difference-in-differences techniques. [Galiani et al. \(2005\)](#) analyze water PPPs in Argentina in the 1990s and show that the choices of municipalities to delegate the service to the private sector are independent of their

outcome of interest, namely, child mortality. In federal contexts, the state-level implementation of reforms of the type observed in the US for electricity generation allows, under certain conditions, firm-level modality choices to be considered exogenous. Some papers have combined simple difference-in-differences with controls for time-invariant unobserved heterogeneity through fixed effects and specific trends at the level of the observations of interest. Finally, further refinements include some form of propensity matching. One open option is the implementation of synthetic control methods, as done by [McGraw \(2020\)](#) to estimate the impact of airport construction on city-level employment growth. Broadly speaking, the reduced form approach is generally more convincing when analyzing social rather than economic outcomes, as the latter appear more likely to be in some way related to the management choice in the first place.

Unsurprisingly, we found no example of randomized control trials in the context of infrastructure PPP studies. In recent years, RCTs have been implemented, however, in the context of education and health PPPs, in keeping with what is now a standard approach in studying these sectors. Researchers have been able to partner with governments to roll out PPPs randomly, either at the school or village level (e.g., [Romero et al. \(2020\)](#); [Barrera-Osorio et al. \(2017\)](#)). Health pay-for-performance programs are similarly randomized across health areas or facilities (e.g., [Huillery & Seban \(Forthcoming\)](#); [Engineer et al. \(2016\)](#)). While there is still a limited number of studies available, they have provided important insights into the proper design of PPPs in these sectors. The nature of these sectors has, however, also posed specific challenges to the design of RCTs. Among these, there are limitations in the extent of feasible randomization due to government-imposed constraints. There are also potential spillovers and externalities due to the movements of students or patients and of inputs and resources such as teachers or health workers across categories of schools and health facilities.

In most cases, however, the exogeneity of the implementation of PPPs is not a reasonable

assumption, and dimensions of time-variant heterogeneity need to be addressed. Either the universe of service providers in a sector and the region of choice are organized under a specific modality or the selection rule across places and firms is meaningfully related to the outcomes of interest. As is the case in regard to public policies in general and infrastructure in particular, PPPs are often targeted to either more or less efficient areas or providers. Many of the reasons why PPPs may have an impact on efficiency, e.g., by changing the incentive structure of managers and workers, limiting capture and political pressures, or hardening soft-budget constraints, also point to potential selection effects related to the decision to implement PPPs based on utilities' observables and unobservables and on specific shocks. Indeed, several studies have documented such selection at the delegation stage, based on sector- or firm-level profitability, as well as the quality of national or local governments' governance or political orientation (Auriol & Straub (2011)). Researchers have used a number of clever instrumental strategies to address this issue.

Instruments are generally grounded in the underlying narrative of the cases under study. The first important category of reasons driving the implementation of PPPs is politics. In most contexts, delegation to the private sector is more likely under the rule of right-wing politicians. Of course, this simple fact is not sufficient to derive a valid instrumental strategy, as the mechanisms leading to some politicians holding power are also likely to affect policy choices such as PPP implementation through other channels. One exception appears to be the use of close election regression discontinuity design, an option used by Jerch et al. (2017) to assess bus service private delegation contracts in the US. Surprisingly, this empirical strategy has not been used in other settings where it would be applicable, such as the case of water delegation in France.

Alternatively, instrumental strategies can be borrowed from the industrial organization literature. The first lesson from IO contributions is that outcomes such as productivity are potentially endogenous when they are estimated, which is an issue that can readily be addressed following

the field's best practices but is unfortunately often ignored by the PPP literature. The second issue relates to selection into PPPs and, when this happens, to the endogeneity of the contractual forms and clauses chosen. Suitable instruments can be constructed to exploit the cross-sectional (generally cross-country) correlations at specific points in time between the market structures of large firms intervening in the PPP world or the correlations between dominant policy measures. An example of the former is in [Kosec \(2014\)](#) where the author exploits, in a sample of African countries implementing water PPPs, the fact that a few large international players dominate the market for private water provision and the ties between these countries and the firms from their former colonizer country at times when these are pursuing new deals. The logic is that given the prevailing ties, a more than random share of the deals should happen in connected countries.

An example of the latter strategy can be found in [Guasch et al. \(2007\)](#), who instrument prevailing water and transport concession clauses or regulatory arrangements using the average prevalence, at the time each contract is signed, of similar clauses or regulations for projects in different countries. Such instruments are valid because the choice of specific clauses or regulations will only be correlated across different countries and sectors through channels independent of the specific unobserved effects driving endogeneity. These unobserved dimensions include country-specific political and institutional effects, as well as operator-specific effects, while the instruments extract correlations related to global sectorial, technological, and policy trends implying common shifts across countries, for example, recommendations from international institutions and consulting firms.

Finally, let us sketch a few routes for future contributions. First, the field clearly has an excess of poorly identified cross-sectional studies paying relatively scant attention to identification challenges and presenting correlations as causal relationships. These could usefully be traded off for more good-quality case studies providing detailed institutional information on the specifics of PPP implementation and performance in different contexts. A few examples of good-practice

studies include [Ramamurti \(1997\)](#) on Argentinean railways and [Reis & Sarmiento \(2019\)](#) on the renegotiation of the Portuguese highway PPP program in 2011 (see discussion below).

Second, very few papers so far have taken the structural route. Some structural modeling has been used to address the potential endogeneity of total factor productivity when used as an outcome. On the other hand, a full-fledged structural modeling of the evolution of prices, demand, and supply under alternative market providers, public vs. PPPs, is clearly one of the main open areas for innovative contributions.

5.2 Lessons Learned

Overall, private participation has had different impacts on outcomes of interest in each of the sectors analyzed, depending on the period, the political and institutional context, the specifics of the contracts and the regulatory arrangements in place.

In transport, the evidence is inconclusive or contradictory. While Indian railroads became more efficient when they moved back to public management, the analysis of Latin American and British, as well as US bus services, reached opposite conclusions. For roads, 18th-century turnpikes appear to have boosted efficiency through better maintenance and higher investments, but the evidence on modern PPPs is still ambiguous. Similarly, energy generation or distribution PPPs seem to produce quite different results depending on whether they happen in a mature context with universal coverage and wholesale market arrangements or under bilateral contracts and with obligations of coverage extensions. Water PPPs have been effective in extending coverage in some developing countries and in reducing child mortality. On the other hand, their efficiency and pricing implications are more mixed. Education PPPs seem to increase the efficiency in the use of inputs and ultimately provide cost-effective improvements in learning outcomes, but their general equilibrium impact is understudied. Health PPPs, on the other hand, mostly display disappointing results, pointing to the importance of a number of enabling conditions that include

a lack of incentives for providers to improve quality of services, as well as the absence of a proper diagnosis of the main barriers to demand.

In all sectors, the existence and allocation of efficiency gains thus appears to often depend on the specific design of the contracts and on the nature of regulatory arrangements. Finally, in many cases, adverse outcomes have been the result of contentious renegotiations.

Establishing more systematically how these aspects play out in determining the impact of PPPs across outcomes is therefore useful because it may help identify existing research gaps and inform policy choices.

5.2.1 Renegotiation

In many instances, the mixed outcomes of PPPs are linked to the high rate of renegotiation occurring at early stages of the contracts. High profile renegotiations have taken place, for example, in the case of the Buenos Aires water concession, leading to the concessionaire ultimately leaving the country without any agreed settlement after years of conflict, or in the two water concessions in Manila, Philippines. Similarly, renegotiations have been documented in all sectors and continents, often occurring very early in the life of the contracts. [Guasch et al. \(2008\)](#) document that 53 percent of the concessions in the transport sector and 76 percent in the water sector in LAC were renegotiated, on average only 3.1 and 1.6 years after the contract was initiated. Factoring in the fact that a PPP can be renegotiated several times over the life of the contract, [Moore et al. \(2014\)](#) document 399 renegotiations between 1992-2011 in a panel of 124 transport concessions in Brazil, Chile, Colombia and Peru. [Engel et al. \(2019\)](#) report 535 renegotiations between 1993 and 2010 in a sample of 59 highway PPPs in Colombia, Peru, and Chile. Almost half of these events occurred during the construction phase of the projects. In Mexico, at the end of the 1980s, taxpayers had to cover a US\$8 billion bailout for renegotiated highways. In Asia, [Sen et al. \(2018\)](#) link the adverse effect of energy IPPs to frequent renegotiations in the least profitable geographical areas.

What is renegotiation? Most of the time, renegotiations touch on the tariffs, investment commitments, or the duration of the PPP. Who renegotiates? A broad typology of cases shows two main patterns. The first case corresponds to firm-led renegotiations (Guasch et al. (2008)). The trigger can be unforeseen events or shocks or simply a combination of overestimated demand forecasts and underestimated costs (Flyvbjerg et al. (2003)), leading firms to struggle to make profits. Alternatively, private operators may behave opportunistically. For example, they may choose to not maximize efficiency investments in the short run to benefit from more favorable regulation later on, an occurrence known as the ratchet effect in the literature (Laffont & Tirole (1993)), or they may strategically underbid at the award phase, securing the contract with a view to renegotiate and modify the terms later on.

The second case corresponds to government-led renegotiations (Guasch et al. (2007)). This may be the case when opportunistic governments renege on previously agreed contracts, for example, at the time of elections, for ideological or populist reasons, as happened, for example, in Latin America in the 1990s and 2000s, when a number of countries shifted to the left politically and popular discontent with privatization policies ran high (Bonnet et al. (2012)). Finally, there are many ambiguous cases, where, although one of the parties initiated the renegotiation process, there is an underlying agreement. Engel et al. (2019) report that a number of renegotiations ended up trading higher tariffs against additional work not included in the original agreements. In this way, public authorities manage to increase current investments while shifting the cost directly through availability payments or indirectly through foregone revenues to future governments.

Another case in which renegotiations can be considered to serve the mutual interest of the firm, public authorities, and users is depicted in Reis & Sarmiento (2019). The paper describes the renegotiation of highway concessions in Portugal in 2011, forced upon the country by the European Union, the European Central Bank, and the International Monetary Fund (“the Troika”)

in exchange for financial support. The process involved a reduction in the level of service, a transfer of some of the operations to the public sector, a reduction in private profitability, and a shift in risk allocation. As a result, in a context in which public payments for the highway program amounted to a major burden on public finances, the renegotiation lowered the future government payments by at least 18 percent while reducing the shareholders' and private operators' returns, leaving toll prices unchanged, and maintaining European safety and quality rules. Hence, bankruptcy and default by the Portuguese government was avoided, in what appears to have been an extraordinary example of mutually beneficial renegotiation.

Who benefits? Typically, firms, as they agree to increase investments in exchange for direct payment, increases in tariffs or extensions of the contract. However, the discussion above shows that these tangible benefits are sometimes accompanied by more intangible benefits on the government side, such as increased chances of reelection. The difficult question is of course the extent to which the public using the services benefits or loses from such arrangements. While a case can be made that preventing major disruptions when PPPs face the risk of bankruptcy is ultimately to the public's benefit, it is also possible that users end up paying excessive costs through higher fees or taxes.

Overall, making sense of the abundant and sometimes contradictory anecdotal evidence requires some theoretical framework. Three main strands of modeling appear relevant. The first one is based on the principal-agent framework. In this context, imperfect commitment, together with adverse selection and the revelation of information over time, leads to potential renegotiations. The core trade-off here is that renegotiations may improve contracts ex post but have perverse effects on ex ante incentives. In theory, these can be anticipated in the contract, which becomes renegotiation-proof. [Gagnepain et al. \(2013\)](#) develop a model in which implicit "re-negotiations" happen through the periodic reawarding of a concession contract to the same operators, yielding a succession of

renegotiation-proof short-term contracts, which can then be compared to a hypothetical long-term full commitment alternative.

Additionally, in the context of a principal-agent model with adverse selection, [Guasch et al. \(2008\)](#) develop a model in which actual renegotiation occurs because of an imperfect and costly enforcement technology, in the spirit of the Chicago School law enforcement model. The PPP contract is characterized by a fundamental information asymmetry (the firm knows its costs better) and a commitment problem on the government side if the concessionaire, when losing money ex post, wishes to renegotiate. In this context, renegotiations triggered by firms are more likely when institutional quality, characterized by bureaucratic efficiency, rule of law, or corruption, is low, the cost of public funds is high, and the economy faces important shocks or high volatility. Regarding the specific design issues related to PPP implementation, the model predicts that renegotiation will happen at a higher rate when a specialized regulator is absent or inexperienced, and regulation is high-powered, for example, in the case of pure price cap schemes, which may leave firms with losses in the case of adverse circumstances.

[Guasch et al. \(2007\)](#) extend this framework to several periods to account for renegotiations triggered by the public authority in the context of a political cycle, where the incumbent government is reelected with some probability. The model allows for Pareto improving ex post agreements to alter the initial contract without the ratchet effect, as well as for opportunistic, rent-shifting renegotiations, for example, for electoral or fiscal considerations. The main differences between government- and concessionaires-led renegotiations concern investment, financing sources, and corruption variables. Using 307 water and transport concessions in 5 countries (Argentina, Brazil, Chile, Colombia and Mexico) between 1989 and 2000, the two papers find evidence that is consistent with this theoretical framework.

An alternative approach is found in [Bajari & Tadelis \(2001\)](#), who build on [Williamson's \(1985\)](#)

transaction cost approach and propose a framework centered on a different trade-off, arising from the tension between the ex ante provision of incentives and the ex post cost of renegotiations. In their model, simple projects are very “complete” and regulated by high-powered incentives such as fixed prices, while more complex projects, in which renegotiation costs would be higher ex post, are more “incomplete” and regulated by low-powered mechanisms such as cost plus. The analysis suggests that in the case of complex projects of the type often found in PPP contracts, the risk of ex post costly renegotiations may warrant granting public authorities more ex ante flexibility to negotiate with potential private parties and move away from rigid award rules through competitive bidding and high-powered contracts. [Bajari et al. \(2009\)](#) find that these prescriptions are consistent with observations from private-sector building contracts awarded in Northern California during the 1995-2000 period.

A third ingredient was put forward by Moszoro and Spiller ([2014](#), [2019](#)). They observe that private contracts are generally of the relational type; in case of unforeseen circumstances, partners adjust their behavior without the need to renegotiate. Public contracts, on the other hand, are more formal and rigid because the public sector is subject to a “responsibility risk”. When implementing complex projects such as PPPs, public agents opt for high levels of contract specificity and rigidity to limit hazards from opportunistic third parties such as political opponents, competitors, and interest groups, de facto externalizing the associated adaptation costs to the public at large. In the context of concession contracts, this translates into extremely long and complex contracts covering extensively contingencies and items such as the main regulatory terms, prices, quality, renewal, penalties, etc. The Buenos Aires water concession contract, for example, famously included hundreds of pages and several volumes. These considerations lead to more rigidity and to the need to renegotiate ex post when shocks happen.

The bottom line from these theoretical exercises seems to be that renegotiations may only

partially be a symptom of governance failure. Indeed, some basic incidence is expected and may be unavoidable due to the “fundamentals” of PPPs and the sectors where they take place, i.e., the nature of public contracts, irreducible complexity and deep uncertainty, long-term contracts, etc. In parallel, some incidence is related to the absence of market tests and to regulatory failures and could be reduced with suitable designs. Depending on the context, a part of observed renegotiations is thus likely to be the symptom of limitations of the institutional and contractual environment and to be welfare reducing. How important this part is then depends on the specific institutional and economic environment.

[Gagnepain et al. \(2013\)](#) quantify the cost of renegotiation in a developed country context using a structural contract model applied to the case of French local transportation concession contracts. In a counterfactual experiment where full commitment is assumed, they find sizable welfare gains, indeed supporting the idea that renegotiations are costly. Overall, full commitment would increase welfare by 4 percent. However, they also show that the potential gains from reducing renegotiations would accrue to operators, who see their benefits increase by 11 percent, at the detriment of consumers and taxpayers.

This cost is likely to be even larger in weak governance environments, although no similar exercise has been conducted thus far. In a policy note analyzing the past Lebanese experience with PPPs and the feasibility of future deals, [Straub \(2019\)](#) adopts a more normative viewpoint. Lebanon is highly fragile in macroeconomic and financial terms, and it is beset by very weak governance, with rent-seeking partisan politics and corruption running high. Strikingly, the country offers both highly successful experiences with PPPs, such as the case of the postal service PPP LibanPost, and others that went terribly wrong, for example, in the telecom or waste management sectors. In this context, not all governance failures can realistically be fixed in the short term; thus, any future deal will need to strike a number of compromises to reduce the potential costs

of disruptive renegotiations. This involves, among others, finding the right level of incompleteness in the layout of the deals and tailoring the institutional process to avoid the most obvious risk of capture and ex ante distortions. While in that context, the benefits from full commitment might well be much larger than in the French example above, a more pragmatic approach involves aiming at more flexible arrangements that may survive in the Lebanese context.

In a stronger governance environment, Chile enacted a reform in 2010, which stipulated the obligation to organize tenders for any additional works agreed in a renegotiation, also excluding the concessionaire and related parties from the process. [Engel et al. \(2020\)](#) indicate that this led to a 90 percent reduction in renegotiation of transport concessions during construction, which is the stage where they are more likely to respond to opportunistic motives.

5.2.2 Competition

Based on theoretical considerations (see Section 2), the potential for competition for or in the market has been an important motivation for public authorities to introduce PPPs in the sectors under study. At the ex ante award stage, the organization of competitive tenders is generally imposed by national legislations regarding public-sector contracting and has long been considered a key aspect in making sure that the most efficient private partner would be selected and that efficiency gains deriving from its expertise and the specific incentive structure in place would at least partially accrue to the public partner.

As this review shows, the return from experience indicates that this view has to be qualified on several grounds. In many cases bidding processes have shown to be fragile or not able to deliver on their promises. Two issues stand out. First, competitive tenders are not immune to corruption and collusion. This has been documented broadly in the context of infrastructure tenders and privatization ([Rose-Ackerman & Palifka \(2016\)](#); [Auriol & Straub \(2011\)](#); [Lambert-Mogiliansky \(2011\)](#)). In the specific case of PPPs, [Guasch & Straub \(2009\)](#) show that more

corrupt environments lead to a higher frequency of renegotiations of concessions at the initiative of firms but to a lower frequency initiated by governments. They show that governments renegotiate significantly less when concessions have been granted based on “flexible” criteria that can be adjusted ex post and interpret this as evidence that more corrupt public authorities chose award criteria that enable them to strike favorable ex ante deals. Second, PPP auctions are subject to strategic underbidding, also called lowballing, by firms competing for ex post rents available through contract adjustments or renegotiations (Engel et al. (2019); Menezes & Ryan (2015)). Such behavior may spur innovation in corruption technology, allowing firms with such specific skills to grab disproportionately more rents (Campos et al. (2021)).

The second issue has to do with transaction costs. The Bajari & Tadelis (2001) argument exposed above implies that in the context of complex projects, there might be a case for choosing a less competitive procedure, or at least including in the award phase a more thorough ex ante negotiation phase. This might be even more warranted in cases where the public party has limited administrative capacity and might be at a significant disadvantage in cases of renegotiation or when the time comes to renew the contract. Chong et al. (2015) show that local French authorities in small municipalities lack the ability to discipline providers by generating sufficient competition, particularly at the franchise renewal stage, leading to significantly higher prices of water under the PPP modality. Iossa & Waterson (2019) also find that tender performance in the market for local bus services in London seem to deteriorate over time, with the number of firms declining and the average price increasing, despite the fact that the public party in charge of choosing operators takes care in designing tenders to minimize these effects, focusing on small, high frequency contracts, and a high degree of transparency.

When award mechanisms rely on bilateral negotiations, this may result in repeated relationships and lock-in effects, with key players benefiting from entrenched positions that weaken competition.

As shown in the case of water, this can be problematic in the long run, especially in industries characterized by significant supply-side concentration.

At the ex post service provision stage, we have argued that contractibility is key to ensuring that efficiency gains are not diffused by quality downgrading and that some form of competition might play a similar role by affording consumers alternative options. Some of the evidence presented in this review supports this view. In the energy sector, the most successful instances of private delegation clearly appear to have materialized in contexts where there was some form of competition. Generation IPPs have overall been much more successful in competitive contexts (such as the UK or US, where local markets appear reasonably competitive, see [Bushnell et al. \(2017\)](#)) than in places where wholesale markets do not exist or, more generally, an ordered restructuring process has not happened. In Peru, the electricity distribution company of the department of Lima was divided into four lots, arguably creating both more ex ante competition and the potential for ex post benchmark competition. These concessions were the only ones to finally prove viable ([Pérez-Reyes & Tovar \(2010\)](#)). In the US, [Wallsten & Kosec \(2008\)](#) show that community water systems have fewer quality norm violations in places where they face more indirect or benchmark competition.

Regarding education and health, we have argued that competition is also a key component of the rationale for PPPs. In this context, there are a number of conditions for competition to be effective, namely, that customers face an integrated market where they can choose their provider, that the quality of the services is easily verifiable and that individuals have the correct information. However, most of the studies reviewed seem to be primarily driven by the willingness of government to provide a cheap and quick answer to the growth in demand for those services. In this context, competition risks becoming a drag on these programs, as it may generate the migration of students across schools or the reallocation of quality staff and other inputs across types of providers ([Romero et al. \(2020\)](#)). This is particularly true in low- and middle-income

countries and in most cases leads to a disregard for the specific design issues that would ensure both the proper incentive mechanisms for providers and the identification of the constraints facing potential users.

5.2.3 Regulation and Contract Design

Also important in generating benefits from the introduction of PPPs is the influence of contract-related factors that change along with ownership shifts, such as the regulatory environment or specific clauses.

The available evidence shows that regulation is particularly crucial in the electricity sector. [Estache & Rossi \(2005\)](#) analyze electricity distribution firms in 14 Latin American countries and conclude that higher-powered regulation, including price-cap and hybrid schemes, induces higher labor efficiency than rate-of-return regulation. In many cases, the introduction of PPPs has been accompanied by a move away from pure rate-of-return and towards incentive regulation. This move is likely to have been a source of efficiency gains in an industry where we expect the main information asymmetry to relate to producers' costs. The case for high-powered regulation should, however, not be overdone, as shown by the link between price cap schemes and potentially disruptive renegotiations mentioned above.

In the transport sector, for example, highway PPPs, costs are generally easily observable, and the information gap concerns mostly demand. Regulation and contractual design then appear to condition the efficiency impact of PPPs by affecting demand realizations and the exposure of private firms to demand risk. The inclusion of specific revenue guarantees in the contracts has often been a way to ensure the ability of concessionaires to recover their investment in case of negative demand shocks. However, they weaken the power of incentives, they bid up the risk premium needed for firms to engage in the contracts and, as [Guasch et al. \(2008\)](#) have shown, they increase the risk of subsequent renegotiations and failures.

An alternative that has gained traction is the least present value of revenue (LPVR) auction first proposed by [Engel et al. \(2001\)](#), in which the contract is awarded to the firm bidding the lowest present value of tariff revenue for a given discount rate and tariff schedule, and the duration adapts endogenously, with the contract ending when the stipulated amount of revenue has been collected. [Engel et al. \(2020\)](#) provide anecdotal evidence and stylized facts of their potential benefits, as such schemes have been implemented, for example, in the UK, Chile, Colombia and Portugal. However, systematic empirical evidence on the efficiency effect of this specific form of PPP contracts is still needed.

The role of regulation is also salient in the case of airports. In this sector, the ambiguous results found with respect to airport PPPs point to a complex interaction between airport ownership, management and regulation. Single-till vs. dual-till regulation changes the way airports decide on aeronautic charges independently of other efficiency effects. Under the former, all revenues, including charges to airlines and commercial revenues are regulated jointly, while they are separated under the latter. In the first case, they then internalize the externality between air traffic and commercial activities, which creates an incentive to lower charges to attract more passengers, who are also potential commercial customers. Isolating efficiency gains then implies identifying the components behind decreasing charges on client airlines. These include reduced costs, reductions in the exercise of market power, and the pricing decisions induced by the regulatory schemes. In general, sectors such as energy or air transport, in which regulation affects the way decisions are made in different tiers or segments of the activity and how they interact in shaping firms' ability to exert market power and their profits, are likely to be characterized by complex effects in terms of efficiency. In these cases, it is difficult to disentangle pure efficiency effects from other channels.

We note that robust and nuanced evidence on the impact of regulation on the performance of PPPs in the different sectors is still rather scarce, probably because addressing the potential

endogeneity of regulatory choices might be challenging. As stressed above, this is likely to be an area in which structural modeling will help.

5.2.4 Institutional and Political Context

Further to the specific design of PPPs and the related regulations, their ultimate performance also appears to depend heavily on the nature of the institutional and political settings in which the delegation decision, or its reversal, occurs. This is, for example, clear in the case of railroads. As seen in Section 4.1.2, public railroads were found to outperform their PPP counterparts in later 19th-century India, while they were dramatically inefficient in 20th-century Latin America. One of the main differences seems to be that Indian railroad concessions were subject to important moral hazards, leading to a recurrent soft-budget constraint because of a combination of revenue guarantees and lower-powered rate-of-return regulations. Public managers were able to solve these problems thanks to the undemocratic nature of the government of the time, which did not have to cater to labor union demands and did not depend on pleasing political backers to ensure electoral support. Meanwhile, in Argentina, Brazil, and the UK, a combination of strong unions, the lack of maintenance and new investment, and the inability of politicians to resist subsidizing inefficient services led to a deteriorating public service. The transfer to the private sector was then a way to solve that problem. Similarly, public US bus companies were not able to curb labor costs in the context of unions' strong bargaining power until they transferred operations to the private sector. Note also that Indian railway PPPs were set in a time where railways were the dominant technology for land transport, while in the late 20th century, it was a mode long displaced by road and air transport, facing ever-increasing modal competition both on the passenger and freight segments.

The common aspect was that in all cases, the change to or away from a PPP was a form of commitment device to force more efficient cost management and reduce public liabilities or increase

tax revenues. For railways and probably also highway concessions, these play out in a context, identified in Section 2, of services with large sunk costs and the risk of quasi-rents expropriation leading to large deficits and the degradation of the quality of services, with important fiscal and social externalities. The change in ownership was at least a temporary solution in a context where the quality of service was mostly verifiable, but in the longer term, failures of commitment to properly invest and maintain the networks became apparent.

In water, one of the robust effects found regarding PPPs being instrumental in generating positive health externalities appears to rely crucially on the fact that these projects were subject to universal coverage obligations; thus, the reduction in child mortality and other related benefits were directly the consequence of new connections to the network and the improvement in the quality of the water consumed. In developing countries where access to the network was low to start with, this has shaped the initial perception of the performance of the wave of water PPPs that happened in the 1990s and 2000s. However, the extension of the network has entailed large investments, different forms of subsidies or cross-subsidies between categories of users, and mechanisms to provide robustness in the face of strong economic volatility. The complexity of the task has led not only to subsequent conflicts between the public and private partners but also to the population being unhappy facing increasing water charges, to concessionaires failing to live up to their investment commitments, and ultimately to a nonnegligible share of PPPs being returned to public ownership. Ultimately, enforcing wide-ranging distributional and social objectives that are not always aligned with productivity-enhancing and profit-maximizing choices through long-term contracts with private partners, often foreign multinationals, has proved difficult and probably explains the fact that many local governments still prefer to keep water services in-house.

A similar situation, where the objective of the introduction of PPPs was somewhat detached from strict productivity-improving motives, can be found in the electricity sector. A combination

of ideological motivations and pressure from specific market players or international organizations in the case of developing countries was in most cases behind the introduction of reform packages, including the delegation of specific segments to private operators. This misalignment is evident in the fact that the way the package of reforms, including restructuring, regulation, competition, and private participation, was introduced across countries was quite unpredictable both in its composition and sequencing due to the local political process (Foster & Rana (2019)). This goes a long way towards explaining the mixed results exposed above. Understanding the determinants of the way reforms were introduced and how this shaped subsequent outcomes is also an important pending item on the research agenda.

An additional element explaining mixed PPP outcomes has been the limited administrative capacity of public authorities, both in general terms and specifically with regard to the management of the PPP design and management process. It is somewhat of a paradox that public authorities with limited capacity, poorer governance, and lower resources often appear more likely to delegate services through PPP arrangements (Levin & Tadelis (2010); Banerjee & Duflo (2006)). This is likely to be the result of a combination of lower public-sector project management capacity leading to favor outsourcing of some sort and of lower ability to design, negotiate, and sustain successful PPPs. Most of the evidence is, however, cross-sectional and correlational in nature. A better understanding of not only the characteristics of the public entities that engage in PPP contracting but also how these should affect the optimal design of the contracts in a world in which conflicts and volatility are pervasive is also high on the agenda.

5.2.5 Climate Change

Finally, one crucial issue that the literature evaluating PPP performance has barely touched upon is climate change. It is now widely understood that infrastructure investments, because of their very long-lived nature and their relevance for almost all productive sectors in the economy, lock-in

specific types of economic behavior over several decades (Lecocq & Shalizi (2014)). This implies, on the one hand, that the contemporary choices of projects and technologies have very important consequences for future carbon emissions and, on the other hand, that projects currently inaugurated are likely to need to adapt to profound changes in the natural environment over the following decades. Regarding the latter, Martimort & Straub (2016) theoretically show that in a context of deep uncertainty on future climate shocks and irreversibility due to the bundling of contract stages, long-term PPP contracts face strong limitations. The paper argues that such contracts are then plagued with added agency costs and that the parties may be better off if drafting shorter-term agreements and waiting until uncertainty on climate conditions is resolved to renew them. It identifies water and energy production as sectors with high demand for flexibility in this context.

What these two dimensions might imply for the PPPs in this review should be high on the research agenda. Of interest would be the way PPP contracts evolve in a context where climate change risks become more prevalent and are anticipated by investors and governments, as well as the impact of these choices on the performance of PPP arrangements. Technological choices by PPP investors are of particular interest in this context. Indeed, technologies or added investments to mitigate the impact of climate change are generally cost-increasing, and they may imply complex complementarities with contractual choices.

5.2.6 Some Open Issues

Finally, a few issues stand out as promising and yet untouched research areas from the PPP perspective. First, this review has left out the ICT sector, where no studies specifically analyzing PPPs stand out. While most private-sector involvement in ICT has taken the form of pure privatization, the development of the Internet backbone is a case in which significant investments might be taking place through PPPs and the modalities and implications have yet to be studied. The Internet backbone, for example, through the connection to fibre optic submarine cables, is key to

enhancing local high-speed Internet and telecommunication services. It is characterized by high sunk costs, giving it a natural monopoly nature, but involves significant potential for technological innovation and has been considered suitable for PPP schemes. This is, for example, the case of the partnership between the government of São Tomé & Príncipe and a subsidiary of Portugal Telecom to invest in access to the Africa Coast to Europe (ACE) submarine fibre optic cable and a submarine cable landing station.²³ While the economic impact of improving backbone connections has recently been analyzed (Hjort and Poulsen, 2019), no similar study exists regarding the specific implementation through PPPs.

Second, an exciting open issue is that of digital infrastructure. As infrastructure networks, and in particular energy and transportation, become increasingly digitalized, we expect important changes in terms of cost structures and competition, as well as quality and service delivery monitoring. How will big data and connected objects, from cars to electricity and water meters, potentially affect the way the different industries work and the interactions between public and private partners? As indicated in Section 2, real-time flows of data along networks may dramatically reduce the degree of information asymmetry between public and private players and change both the way services are regulated and the optimal allocation of ownership. Future work will tell to which extent big data have the potential to change the way contracts are written, as well as the ability of researchers to evaluate the performance of projects. While this is a more general topic, it may also have important implications for PPPs.

Finally, little is known about the importance of human capital in PPPs. What does the selection of workers on both sides of the partnerships look like? How does this affect the nature and design of the deals and the subsequent impact of PPPs? Can part of the (expected) impact of PPPs be traced back to the quality of workers? Some evidence exists that the performance of individuals and organizations accounts for part of the variations observed in procurement prices (Best et al.

²³See <http://a4ai.org/wp-content/uploads/2015/11/PPPs-in-Sao-Tome-and-Principe.pdf> (accessed July 23rd, 2020).

(2017)). Whether similar results hold for PPPs is not known.

On the private side, the PPP industry is very active, where large consulting firms, infrastructure funds, and international organizations employ a large quantity of specialized staff. Governments also increasingly set up specialized units. It appears that revolving doors are open between these different professional environments, as was, for example, the case in the UK when the PFI program was implemented (Hellowell, 2010), and this largely contributes to shaping the type of deals that are considered and implemented. Studies of this PPP labor market would be extremely useful in understanding the broader political economy of the sector and many related positive and normative questions.

6 Conclusion

While PPPs still represent a relatively small share of the overall worldwide investments in physical and social infrastructure, they enjoy a high popularity in policy and government circles and are currently widespread across places and sectors. A large amount has been written on the subject, trying to assess the effect of PPPs on outcomes ranging from efficiency and pricing to social indicators. This review has identified a fair number of methodologically sound contributions that rely on a variety of techniques and data, as well as some promising methodological avenues for future work.

Overall, the existing evidence paints a rather mixed picture. The jury is still very much out regarding the efficiency gains provided by PPPs, and more good-quality studies with convincing identification strategies are needed. What is abundantly clear, however, is that whether PPPs succeed or fail in addressing service shortages across the sectors we have reviewed is closely linked to the institutional context in which they are implemented, to the historical and political landscape in which they take place and to the specific contracts and regulatory designs.

Some of these issues are by now better understood. For example, there is a relatively consistent body of knowledge on how to adjust the design of contracts to address the risks of renegotiations that have for decades proved to be a major drag on PPPs. Others are still on the agenda. This is the case for optimal regulatory arrangements in weak governance contexts, which are still poorly understood. We also lack a better understanding of the best way PPPs could be introduced as part of larger sectoral reforms, as was the case for electricity in recent decades. Similarly, despite the widespread use of bureaucratic quality indices in cross-country research, we still lack a detailed understanding of how to structure the public part of PPPs and how to design the particulars of the public-private relationship, especially in high-risk and weak governance contexts. Finally, we know very little about the optimal design of long-term PPPs or about their suitability in a world facing climate change-related uncertainties.

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