INSTITUTIONAL ECONOMICS AND THE COST OF CAPITAL

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ABSTRACT

In the United States and around the world, communities are turning to private institutions to finance and build public infrastructure. In response, a robust debate has arisen both in the academic literature and in public policy discussions about the relative cost of capital of public and private equity providers for infrastructure projects. Much of that academic debate flows from an influential 1970 article in which Kenneth Arrow and Robert Lind concluded that the social cost of public-sector provided capital is lower than that of private capital because project risk is more efficiently spread across numerous taxpayers than across relatively concentrated private investors. In parallel, scholars influenced by Michael Jensen and William Meckling have studied the agency costs that arise as a consequence of increased separation between equity holders and managers, and practitioners have developed various mechanisms to control these agency costs. We believe that these two countervailing forces –risk spreading and agency costs—are critical in determining a party's cost of capital, and that the existing literature on public-private partnerships has focused heavily on risk spreading while discounting the role of agency costs and the various mechanisms that have arisen to control them. In this paper, we analyze various differences in the nature of residual claims in the public and private sectors, and study their potential effects on the relative social cost of capital. Our analysis suggests that Arrow and Lind's conclusions may not be as instructive in determining the public sector's cost of capital as is currently thought.

Keywords: Cost of Capital, Public-Private Partnerships, Infrastructure, Arrow-Lind Theorem, Agency Problems, Risk Sharing, Risk Spreading, Corporate Governance.

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Key Questions for Discussion:

- Did the economics profession arrive at a firm conclusion about the relative public versus private cost of capital after the 1960s/1970s debate? If so, why has that conclusion not permeated the policy debate on the issue since the intervening decades?
- From what precise economic concepts do those conclusions stem?
- How applicable are those conclusions today, given the massive changes in global financial markets (and their attendant ability to spread risk) since that time?
- How can we use modern economics methods, such as experimental economics, to get an empirical handle on the size of the differential in the cost of capital?
- If there is a meaningful difference in the relative cost of capital, how can economists' work help to inform the policy debate?

Introduction

Is the social cost of bearing a given amount of risk greater when borne by private investors or by taxpayers? Scholars have grappled with this question since at least the 1960s. Contributions from celebrated 20th century economists include Arrow and Lind (1970), Baumol (1968), Diamond (1967), Harberger (1968), Hirshleifer (1965, 1966), Sandmo (1972), and Samuelson and Vickrey (1964), among many others. In their seminal 1970 paper, Arrow and Lind argue that, under certain conditions, the social cost of bearing the risk of a given public-sector project approaches zero as risk is spread over an increasing number of taxpayers. That conclusion is driven not by greater diversification or public investment "pooling" (as argued by Samuelson and Vickrey, for example) but by the large number of taxpayers over which project risk can be distributed.[1] This is known as the Arrow-Lind Theorem, which continues to influence economic thought.

This debate has continued for decades, but has gained renewed relevance today as governments increasingly turn to private partners to finance (and thus bear the performance risk of) large infrastructure projects. Private equity funds raised more than $300 billion in capital between 2013 and 2018 for investments in energy, transportation, telecom and other infrastructure assets, with 2018 the highest fundraising year on record (Infrastructure Investor; Gottfried). Some argue that, due to Arrow-Lind risk spreading and other forces, the public

1 Investors today have access to a wide range of financial products, including direct or indirect investments in private equity funds that offer exposure to infrastructure projects. Depending on the jurisdiction of a public-sector project (i.e., in the United States, the federal government can achieve broader diversification than state and local governments) and the identity of equity providers in a particular project (which often include private equity funds with large pension funds as a substantial portion of their LP base), private sector investment vehicles may spread risk more effectively than traditional public financing. Rather than empirically analyzing this question, we focus on the tradeoffs between greater risk-spreading and agency problems that arise with ownership dispersion, and study the different governance mechanisms available to taxpayers and private equity investors as residual claimants in infrastructure projects.

sector has an inherent advantage in risk-bearing over the private sector (e.g., Quiggin 2004, Klein 1997). Others argue that the public sector's cost of capital is not systematically lower than that of the private sector (e.g., Bumstark and Gollier 2014, Lucas 2014). The cost of capital debate has long been viewed as a critical input into regulatory decisions (Jenkinson, 2006). Although private firms participate in many facets of infrastructure provision, including design, construction, operation, and maintenance, much of the literature on public-private-partnerships (PPPs) has focused on the role of private financing.

Proponents of PPPs point to many advantages over traditional project procurement, including risk transfer, cost savings, time savings (i.e. faster project delivery), greater scrutiny of net benefits in project selection, access to technology, process innovation, and enhanced alignment of incentives between construction contractors and operating entities. PPP detractors often point to higher project transaction costs and financing costs. We focus on one aspect of this question, examining differences in governance mechanisms and how those differences impact the cost of capital if taxpayers are viewed as project residual claimants.[2]

Allocation of risk-bearing via PPP contracts has important economic implications. Just as society gains from assigning certain stages of production to those who have a comparative advantage in that particular stage, parties have varying abilities to bear risk, and efficient allocation of risk across those parties can generate social value. For example, if private investors are better positioned to bear performance risk for certain types of projects than are taxpayers (whether arising from risk tolerance, ability to diversify, or other reasons), then risk transfer to

[2] Since public pensions often represent a significant portion of the limited partner (LP) base of infrastructure-focused private equity funds, the distinction between public and private residual claimants may be less pronounced than is often realized.

the private sector generates a net social gain. If, however, taxpayers are more efficient risk-bearers, per Arrow-Lind, then such risk transfer creates a net social loss.

We offer no firm conclusion as to whether taxpayers or investors bear this risk more efficiently; relative risk-bearing ability likely varies across contexts. Rather, we provide an overview of issues arising from incorporating standard elements of institutional analysis into the cost of capital debate. In particular, we examine corporate governance mechanisms that have evolved to manage agency problems in private firms, and consider how those institutions affect the relative social cost of risk bearing across the public and private sectors. Our analysis draws on literature linking corporate governance in publicly-traded firms to their equity cost of capital. Although that literature studies the impact of institutional arrangements such as limited liability on firms' cost of capital, it does not distinguish between those arrangements' impact on public-sector versus private-sector entities. We consider several key differences in institutional arrangements. For example, investor residual claims feature limited liability and are freely transferable, while taxpayer residual claims are inseparable from residence in a particular jurisdiction, and do not include the same limited liability protections.

One key contribution of our analysis is our explicit recognition that the terms "public" and "private" are not monolithic or univariate. They each instead represent a broad set of legal and institutional arrangements. Each element in the set may impact the cost of capital. Although we cannot assess the impact of all elements here, we consider two in detail. We thus hope that our analysis points the way forward in the PPP cost-of-capital debate.

We proceed as follows. In Section II, we begin our discussion of the cost of capital for infrastructure financing and review the concept of taxpayers as project risk bearers. In Section III, we discuss the weighted average cost of capital for infrastructure under different financing

methods and the returns that taxpayers and investors demand for risk-bearing services. In Section IV, we analyze the implications of differing institutional arrangements on the cost of capital. We summarize and conclude in Section V.

I. Taxpayers as Residual Risk Bearers

Following Grout (2003), we consider a hypothetical infrastructure project to illustrate taxpayers' role as residual claimants and to examine the relative cost of capital. A well-defined example separates questions surrounding the comparative advantage of government provision more broadly from the cost-of-capital discussion specifically. We assume that there are no information asymmetries which, in combination with weak enforcement mechanisms, may cause market failure (Stiglitz and Weiss, 1981).

Suppose that a jurisdiction plans a toll bridge in a congested area. The bridge will be designed, constructed, and operated by a private company or consortium. The bridge will be financed through bonds backed by revenue generated from tolls and either investor or taxpayer-provided equity.[3] Toll rates are set by a regulator, or in the PPP contract, to keep traffic at free flow (i.e. at the market clearing level) regardless of how the bridge's equity is financed. The toll level, the amount of traffic (and thus project revenue), and the costs of operation are independent of the identity of the bridge's equity holders. We also assume that private investors are able to buy and sell residual claims to the bridge's equity, either through limited partnership interests,

[3] Revenue bonds are backed only by project revenue, as opposed to general obligation bonds. We assume that taxpayers do not either explicitly or implicitly guarantee the bridge's debt. Taxpayer guarantees of project bonds represent an implicit transfer of risk from bondholders to taxpayers. Our goal is to abstract away from such implicit risk transfers.

tradable common stock, or other direct means.[4] Under these assumptions, the bridge's financial performance can be described by a normal, known distribution that does not vary with the identity of the project's risk bearers.[5]

That risk is borne either by taxpayers or by private investors. Taxpayer risk bearing does not eliminate the risk. It instead remains unpriced. Just like private investors, taxpayers are residual claimants because they are the ultimate owners of a jurisdiction's assets and bear the risk of variations in a public project's net value and cash flows (e.g Lucas 2012, Fama and Jensen, 1983a, 1983b).[6] If a project performs better than expected, taxpayers benefit through better public services and economic growth. If a public project underperforms, taxpayers face worse-than-expected public services, and slower growth. The ongoing PPP cost-of-capital literature effectively debates the price that taxpayers would charge for bearing residual project risk. The fundamental implication of Arrow-Lind is that the correct price is zero.

Numerous risks affect the bridge's net cash flows (Spackman 2002). For example, because traffic demand is uncertain, the utility or toll revenues that the bridge will provide are also uncertain. On the cost side, risks include design flaws, unforeseen environmental or geo-technical issues, construction costs, and time delays, among many others.

The bridge generates a stream of net cash flows, which could be either positive or negative, and which vary over time. The residual claimants to the project's net income after debt

[4] Under both financing scenarios, the public retains ownership over the bridge (PPP contracts often include a long-term lease to the operating private consortium). Private financing through a PPP, however, at least partially separates performance risk from project ownership.

[5] We assume that the β in the capital asset pricing model discussed below does not vary with the identity of the risk bearers. A more complete model would allow the project's revenue and costs to depend on the identity of the residual claimants. Although managerial performance is likely to affect the amount of cash flow generated by the project, we assume for simplicity that the choice of financing (i.e., PPP vs traditional public financing) does not affect project quality or the amount of cash flows.

[6] Most observers (e.g., Lucas 2012) view this as occurring through the tax and transfer system.

service and other costs—whether taxpayers or investors—bear the risk of variance in those cash flows. Private investors bear project risk through changes in equity value in the case of tradable residual claims, or expected returns on non-tradable investment stakes. Taxpayers cannot trade their residual claims, but nonetheless bear project risk through expected changes in future tax payments, public debt levels, and service levels, among other mechanisms (Lucas 2012).

In the event of an adverse outcome, equity investors are the first to absorb losses. Bondholders enjoy strong contractual protections whether a project's equity is financed through a PPP or through more traditional financing. Under traditional public financing, when taxpayers are residual risk bearers, there is no cushion provided by outside equity to absorb downside risk as under private financing. If, for example, construction costs exceed expectations or if expected benefits fall short, taxpayers bear the loss.[7]

We expect that the differing nature of the residual claims between public and private "shareholders" and the accompanying institutional mechanisms for addressing agency costs hold key implications for the relative cost of capital of public- and private- sector investors. Those implications should be considered in future literature on the PPP cost-of-capital debate.

II. The Weighted Average Cost of Capital Considering Taxpayers

The weighted average cost of capital (WACC) represents the cost of each financing type weighted by its proportion in the capital structure. Suppose that our hypothetical bridge project is financed with only one type of debt and one type of equity. We describe the project's WACC as:

$$WACC = \frac{E}{V} E(R_e) + \frac{D}{V} R_d \qquad (1)$$

where:

[7] Relatedly, Lucas (2012) and others have expressed concern with reliance on the risk-free rate as the cost of capital, since taxpayers ultimately bear risk of cost over-runs and asset performance.

- $E(R_e)$ is the cost of equity capital (i.e. the expected return paid to equity investors)
- R_d is a fixed return paid to debt investors (i.e. the cost of debt capital)
- *E* is the market value of the project's equity
- *D* is the market value of the project's debt
- *V* is the total value of the project's financing from (in this case all) sources, where V = E + D
- *E/V* is the proportion of project financing from equity
- *D/V* is the proportion of project financing from debt

We denote taxpayers' cost of capital as $WACC^T$ and private investors' cost of capital as $WACC^P$. Under Arrow-Lind, $(WACC^P - WACC^T) > 0$; taxpayers can spread risk more widely. Applying this notation to Equation 1:

$$WACC^P - WACC^T = \left(\frac{E^P}{V}E(R_e{}^P) + \frac{D^P}{V}R_d{}^P\right) - \left(\frac{E^T}{V}E(R_e^T) + \frac{D^T}{V}R_d^T\right) \quad (2)$$

Assuming that the project's bonds are backed only by expected toll revenue along with the absence of tax-induced distortions ensures that $R_d^P = R_d^T$. That is, bondholders will demand the same interest rate on the bridge's bonds regardless of equity financing's source. We further assume that the project's capital structure is independent of whether taxpayers or investors bear its residual risk, so that: $\frac{E^P}{V} = \frac{E^T}{V}$ and $\frac{D^P}{V} = \frac{D^T}{V}$. This is consistent with the Modigliani-Miller Theorem (Modigliani and Miller 1958).[8] Equation (2) becomes:

[8] The Modigliani-Miller Theorem holds that, under certain assumptions, the value of the firm is independent of its capital structure. We recognize that our analysis suggests that the optimal financing structure $\left(\frac{E^{P*}}{V}, \frac{E^{T*}}{V}\right)$ likely depends on the identity of project risk bearers, and that differentiating between the two equity types implies that V should also vary based on the risk-bearing group. If, for example, taxpayer-provided equity capital were less costly than private-investor capital, then the optimal capital structure may include a greater proportion of equity in the taxpayer case. We leave those issues for future work.

$$\text{WACC}^{\text{P}} - \text{WACC}^{\text{T}} = \frac{E}{V}\ (E(R_e^P) - E(R_e^T)) \qquad (3)$$

Under these assumptions, differences in the cost of capital are driven entirely by differences in the expected return on taxpayer versus private investor equity, or $E(R_e{}^P) - E(R_e{}^T)$.

Equation 3 addresses valuation of taxpayer-provided risk-bearing, (E^T), relative to private capital (E^P). If institutional arrangements cause taxpayers to demand a higher expected return for bearing a given amount of project risk, then ($\text{WACC}^{\text{P}} - \text{WACC}^{\text{T}}$) < 0, contrary to Arrow-Lind.

Surprisingly, taxpayers' role as risk bearers is sometimes ignored entirely. That implies taxpayer equity should include no risk premium over the cost of comparable debt. At least in the federal government context, taxpayers then are willing to provide equity at the risk-free rate: $E(R_e^T) = 0$.[9] This in turn suggests that taxpayers are willing to accept zero returns on their residual claims and thus offer risk-bearing services for free. As several scholars have noted, the federal government's ability to borrow at the risk-free rate reflects the government's taxing power, and does not imply that there is no cost to taxpayer-borne risk (e.g., Lucas 2010; Allen 2007). In some circumstances, the public sector explicitly recognizes that taxpayer risk bearing is costly. For example, the Monetary Control Act of 1980 requires that the Federal Reserve Bank include an imputed cost of equity in pricing certain services that compete with private banks (e.g., ACH and check processing). This is known as the private-sector adjustment factor.

How much should each group be compensated for bearing the project's risk under alternative institutional arrangements? In order to attract equity capital, the bridge must offer sufficient expected returns to compensate investors for bearing project risk. The capital asset

[9] We include the subscript e in all subsequent equations for brevity.

pricing model is the standard approach to determining the expected return required on an investment (e.g, Baumstark, Luk and Gollier 2014). Its central implication is:

$$E(R_{ei}) = R_f + \beta_i (E(R_m) - R_f) \quad (4)$$

where:

- $E(R_{ei})$ is the expected return on capital asset or project *i*, in our case on the bridge
- R_f is the risk-free interest rate, usually assumed to be the interest rate on Treasury bonds
- $E(R_m)$ is the expected return on the market portfolio
- $E(R_m) - R_f$ is the market premium, or the difference between the market return and the return on the risk-free asset.
- β_i is the sensitivity of returns on the bridge to expected market returns:

$$\beta_i = \frac{Cov(R_i R_m)}{Var(R_m)}$$

Rearranging (4) gives:

$$E(R_i) - R_f = \beta_i (E(R_m) - R_f) \quad (5)$$

The risk premium for bearing the bridge's project-specific risk equals the market premium multiplied by the beta for the bridge project. The larger the beta, the higher the expected return demanded by the investor to bear that risk. Both the market premium and the project beta are independent of whether the bridge is financed through taxpayer or privately provided equity.

The above approach can be modified to include other factors, such as a small-firm effect (e.g. Lutig and Leinbach 1983), an industry-specific factor (e.g. Easterbrook and Fischel,1991), or a governance factor (e.g. Gompers, Ishii, and Metrick, 2003). Each factor can be represented by an additional factor-specific risk premium. We include a factor that we refer to as an *institutional risk factor* or *z*. The premium for exposure to the institutional risk can be represented as $\gamma(E(R_z) - \overline{R_z})$. We denote the expected return required by taxpayers as:

$$E(R_i^T) = R_f + \beta_i (E(R_m) - R_f) + \gamma^T (E(R_z) - \overline{R_z}) \quad (6)$$

This can be viewed as the expected return on taxpayer equity, or the return required by taxpayers to voluntarily bear risk under the set of legal and institutional arrangements facing them.

The expected return required by investors is:

$$E(R_i^P) = R_f + \beta_i(E(R_m) - R_f) + \gamma^P(E(R_z) - \overline{R_z}) \quad (7)$$

Because the first two terms are the same under taxpayer and investor risk bearing, the difference in expected returns is driven only by differences in risk premiums charged to bear the bridge's residual risk:

$$E(R_i^P) - E(R_i^T) = (\gamma^P - \gamma^T)(E(R_z - \overline{R_z}) \quad (8)$$

$(\gamma^P - \gamma^T)$ captures how much taxpayers and investors, respectively, will charge to bear that risk. If $(\gamma^P - \gamma^T) > 0$, then private investors will charge more than taxpayers for bearing institutional risk and vice versa.

III. Institutional Arrangements and the Cost of Capital

A substantial academic literature links firm performance to corporate governance. Some studies assume that governance mechanisms impact firm valuations by impacting expected cash flows (e.g., Black et al 2003, Claessens et al 2003, Gompers et al 2003, La Porta et al 2003). Others examine the impact of corporate governance mechanisms on a firm's equity and debt cost of capital. We provide an overview of that literature, focusing on equity cost.

Corporate governance structures vary widely across countries. Zhu (2014) examines the impact of firm-level corporate governance on the cost of both equity and debt capital for 22 developed countries. She finds that improved corporate governance structures are consistently associated with a lower cost of both debt and equity capital. Moreover, better firm-level governance reduces the cost of equity more in countries with enhanced disclosure requirements

and legal systems. Similarly, Hail and Luez (2006) find that firms in countries with more extensive disclosure requirements, stronger security regulations, and better legal enforcement enjoy a significantly lower equity capital cost. Examining 17 emerging markets, Chen, Chen and Wei (2009) find that firm-level governance has a significant negative impact on equity capital cost that is more pronounced in countries with relatively poor legal protections.

Other studies examine this relationship in U.S. firms. Those U.S. studies find links between governance attributes such as institutional ownership and board structure and the cost of capital, in anticipated directions (Ashbaugh et al (2006), Bhoraj and Sengupta (2003), Anderson et al (2004), and Klock et al (2003)). There is also a strand of this literature examining the effects of corporate disclosure on the cost of equity and debt. Botosan (1997) and Botosan and Plumlee (2002), for example, examine the level of disclosure and the cost of capital, finding that a reduction in information asymmetry between managers and shareholders lowers the cost of capital.

The studies cited above examine firms that share standard legal elements, such as limited liability for shareholders and tradable residual claims. Although it is well established that agency problems exist between taxpayers and government officials (e.g. Lucas 2014), the relative effectiveness of institutions arising to control agency costs in the public versus private sectors has been overlooked in the PPP literature. We next draw attention to the fundamental differences in the legal elements surrounding taxpayer versus investor residual claims. We focus on understanding potential impacts on the cost of capital by considering two elements only: limited liability and the tradability of residual claims.

A. Limited Liability

We first consider limited liability, which is a common feature of modern firms and projects (Easterbrook and Fischel 1991). Limited liability is found in limited liability companies (LLCs), limited liability partnerships (LLPs), limited partnerships (LPs), and corporations, among other forms. The absence of limited liability for taxpayer risk bearing is a key difference in public- versus private-sector equity finance.

Limited liability helps constrain the cost of capital in several ways. First, it caps investors' maximum exposure to losses at the amount of their respective investments in the limited-liability entity. That is, if a firm has exhausted all of its assets and still has obligations under contract or in tort, the firm's creditors have no recourse to the personal assets of the firm's residual claimants.[10] Conversely, creditors of individual investors in a firm have no recourse to a firm's assets in the event of the individual's insolvency.[11] Investors generally seek compensation commensurate with the risk they bear in a project or firm. The certainty that limited liability provides regarding the maximum extent of losses thus helps to constrain the equity risk premium for such companies.

Second, limited liability lowers the cost of equity capital by facilitating investment in a diversified portfolio of companies. Investors rationally incur monitoring and due diligence costs when evaluating prospective investments. However, the extent of such monitoring and diligence would be greater and more costly in a world of unlimited liability, where an individual investor

[10] Although the bar is quite high, courts are willing to "pierce the corporate veil" and see through legal entities to pursue the assets of a firm's residual claimants in circumstances where they find shareholders are exploiting the corporate form to commit fraud or violate laws. The test for veil-piercing varies across jurisdictions, but courts typically look for evidence of abuse of the corporate form, such as commingling of assets among a firm and its shareholders, nonfunctioning officers and directors, fraud, siphoning of funds, or failure to observe corporate formalities.

[11] For a detailed discussion of entity shielding, see Hansmann, Kraakman, Squire (2006).

exposed her entire asset base in purchasing even a small stake in a large publicly traded company. Under unlimited liability, investors would scrutinize not only each company's financial statements and growth prospects, but also the identity and wealth of all other investors to ascertain how much of the company's liabilities they may be left to bear in the event of insolvency (Easterbrook and Fischel, 1985).

Limited liability thus significantly lowers firms' cost of equity capital by allowing potential investors to evaluate securities free of concern about unlimited losses. As a result, they can build diversified portfolios with exposure to many more companies. Such diversification allows investors to eliminate idiosyncratic risk and accept a lower equity premium in return for bearing a specific firm's or project's risk (Fama and Jensen 1983b).[12]

In contrast, taxpayers do not benefit from limited-liability protection in their role as project residual claimants. Although states enjoy sovereign immunity and municipalities have some protection from liability under Chapter 9 of the Bankruptcy code, managers of political bodies have the unique power to impose taxes. For our purposes that is analogous to the power to compel additional capital contributions from residual claimants. That is, where states or political subdivisions encounter fiscal difficulties, they can increase tax rates to raise revenues to meet obligations. Furthermore, the public nature and high visibility of many large infrastructure projects make it politically difficult for officials to abandon projects midstream where construction costs exceed budgeted levels or where the net benefits of a project disappoint. Thus, project managers may continue to invest taxpayer funds in projects even where predicted

[12] Limited liability may affect expected returns by providing prospective investors with greater certainty as to future net cash flows, rather than directly affecting the cost of equity. Through either mechanism, however, it reduces the risk-bearing compensation that equity investors require for a given company or project.

economic returns do not justify follow-on investments. If the sponsoring jurisdiction uses general revenues to subsidize the project, then taxpayers are effectively contributing additional capital, and their liability via the tax system is limited only by indirect, imperfect, and poorly defined political constraints.

In the PPP context, some of the risk that would be borne by private investors under an unlimited liability regime may in fact be transferred to taxpayers; a common criticism of PPP financing. For example, in extreme circumstances, policymakers may inject public funds to bail out private corporations or PPPs, particularly where they provide essential services or where their failure may have significant negative externalities or systemic implications. Notably, the federal government took a number of extraordinary steps in response to the financial crisis in 2008 to ensure the economy's stability, including injections of cash and purchases of stock or warrants in several banks and other companies. Overseas, the Spanish government agreed to a €3 billion rescue package for a group of privately-financed toll road concessionaries that had filed for bankruptcy after toll revenues dropped dramatically during Europe's economic downturn.[13] Because investors in private infrastructure cannot be forced to provide unlimited capital and can seek bankruptcy protection to contain losses, taxpayers may in these circumstances be forced to step in to ensure the continued operating viability of critical privately financed assets such as highways or hospitals. Although this is a hidden public subsidy, it in many cases is justified by the advantages that private financing and PPP structures provide. Policymakers should be transparent in accounting for such risk transfers.

[13] Reuters. February 2018. Spain to take over several failed motorways.

B. *Ownership Concentration and Agency Costs*

Agency relationships arise when the firm's owners (the principals) are distinct from the firm's managers (the agents) (Jensen and Meckling 1976). Agency costs represent both the costs to the principals of monitoring and controlling managers, as well as the value lost from agents' failure to operate the firm in the principals' interest. When managers' interests diverge from those of the firm's owners, managers may shirk duties, overcompensate themselves at owners' expense, steer key contracts toward allies, and otherwise abuse firm resources and opportunities. Jensen and Meckling refer to those costs as the "residual loss."

The extent to which a firm faces agency costs – and the firm's ability to control those costs – impact the firm's cost of equity capital (Ashbaugh, Collins and LaFond, 2004). In their seminal book, Adolf Berle and Gardiner Means identify a key problem with the publicly held corporation: as ownership becomes more dispersed through broader ownership of residual claims, those who bear the risk of managerial decisions and those making such decisions are more separated (Berle & Means, 1932). Moreover, as dispersion increases, each individual group member realizes a smaller share of the benefits of monitoring the agents and otherwise participating in the firm's stewardship. The benefits an individual shareholder receives from managerial monitoring exceed the costs, and it becomes less likely that any individual will undertake monitoring activities. This leads to a suboptimal aggregate level of monitoring, or the "free rider" problem in managerial monitoring. However, institutions have evolved to address the corporate agency problem and to help residual claimants monitor managers and control agency costs (Geddes 1994).

Although broadly ignored in the cost-of-capital literature, the Berle and Means problem also manifests in taxpayer risk bearing. The number of risk bearers, and thus the degree of

dispersion, is determined exogenously by the size of the taxpayer's jurisdiction. The free-rider problem increases in severity with the size of the firm or jurisdiction. Citizens of a small village, for example, have stronger incentives to monitor their local police force than they do the U.S. Postal Service, and investors in a small business are more compelled to oversee firm affairs than are retail investors in public corporations.

Notably, the characteristic that Berle and Means identify as generating agency costs is the same effect that Arrow and Lind credit with *lowering* the cost of capital for taxpayers. Those two canonical contributions in each field thus adopt opposing views of the impact of ownership concentration on social welfare. Arrow and Lind focus on the gains from risk spreading but do not consider the possibility that dispersed ownership may increase cost of capital by introducing agency costs.

Our review of the PPP finance literature suggests that scholars tend to follow Arrow and Lind by focusing on the benefits of risk spreading while discounting or ignoring agency costs.[14] This is in direct tension with the separation between taxpayers who bear project risk and the managers who operate a public facility, as well as with the extensive literature focusing on agency costs in public-sector procurement (e.g., Laffont and Tirole, 1993).

It is thus useful to consider project-generated wealth changes borne by each taxpayer in the sponsoring jurisdiction. Returning to our example, suppose that there is a total of $n = 1 \ldots N$ taxpayers in the jurisdiction, and that the bridge lasts for $t = 1 \ldots T$ years. If ρ represents project net cash flow from the bridge in period t, then in discrete time the net present value of the

[14] This is also true of early literature in finance. The Modigliani-Miller Theorem, for example, assumes zero agency costs.

bridge project is $\sum_{t=1}^{T} \frac{p_t}{(1+r)^t}$, where r is the discount rate. The value of both taxpayers' and private investors' equity (E^T and E^P) is given by the discounted present value of the project's net cash flows. Taxpayer residual claims are inherently attached to residence in the jurisdiction incurring the public risk. That is, taxpayers cannot separate the bearing of project risk from their tax residence without incurring very high transaction costs. Separation requires leaving the jurisdiction. We thus view taxpayers as providing "captive equity" because they cannot exit their risk-bearing obligations at reasonable cost.[15]

The equity stake of the n^{th} taxpayer in the jurisdiction is fixed at $S_n^T = NPV/N = E^T/N$. This represents each taxpayer's exposure to the bridge's risk over time. The proportion of project ownership borne by a particular taxpayer is determined by the total number of taxpayers in the jurisdiction. Each taxpayer's proportion of the bridge project, $1/N$ is exogenous to the bridge project's net cash flows. A taxpayer thus cannot increase or decrease her ownership concentration depending on the characteristics of the investment. Arrow-Lind implies that the cost of taxpayer risk bearing declines because $S_n^T = NPV/N$ approaches zero as N rises.

In contrast, the degree of ownership concentration among private investors can adjust endogenously to its costs and benefits (Demsetz and Lehn 1985). If there are p = 1 . . . P private investors, then the equity stake of the p^{th} private investor is $S_p^P = E^P/P = NPV/P$. The total

[15] Severability of risk-bearing obligations from tax residence requires tradable residual claims. Charles Tiebout (1956) argues that taxpayers "vote with their feet" by changing jurisdictions in response to varying baskets of government services at a variety of prices (i.e. tax rates). The transaction costs of this option are so high relative to selling tradable ownership shares in firms that we do not consider the two as substitutes. It is unlikely that taxpayers would change jurisdictions solely in response to the costs and benefits of a particular infrastructure project. We thus view the fraction of taxpayer ownership as fixed over time.

number of private investors is determined through the market for the project's equity. Each investor is able to adjust his or her individual exposure to project risk by purchasing or selling tradable shares. If expected returns do not justify the risk assumed, an investor can reduce her risk exposure entirely by selling shares.[16] As investors sell equity stakes, P falls and the equity exposure of the remaining investors becomes more concentrated.

C. Transferability and Agency Costs

The lack of transferability also has important implications for the cost of capital. Because captive equity is non-transferable, there is no transparent, liquid market (and thus no readily-observable price) for taxpayer-provided equity.[17] This impacts equity capital cost both directly and indirectly. Fama and Jensen (1983), for example, show that non-transferability results in discounted valuations relative to those a robust market would assign. The illiquidity of residual claims also makes it difficult for owners to control the agency problem.

Where residual claims are tradable, markets can assign more accurate prices to the value of those claims. Stock prices rapidly incorporate the expected effect of managerial decisions on current and future net cash flows and reflect the market's aggregate views on managerial effectiveness. Lay investors who would not otherwise have the resources or expertise to monitor managers can rely on market pricing as a proxy, however imperfect, for managerial performance.

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[16] Today, private capital for infrastructure is largely delivered by special purpose vehicles controlled by private equity firms specializing in infrastructure and real assets. While limited partner (LP) interests in these firms are typically not tradable, the funds compete for LP capital, and the management fees, carried interest, and other terms they negotiate with their investors can be seen as analogous to market prices. LPs are often restricted from withdrawing committed funds, or face penalties for doing so. Some infrastructure investment vehicles (e.g., energy yieldcos) are publicly traded. For simplicity, we assume that residual claims in private infrastructure investments are tradable.

[17] Some scholars argue for a fair value approach to valuing government obligations, through which one could impute a price on these residual claims.

Large abnormal changes in equity prices lead to corresponding gains or losses for shareholders, who have an incentive to hold managers accountable for such returns.

By replacing cash compensation with stock options and other forms of compensation, tradability and transparent pricing help owners tie managerial pay to firm performance and thus align principal and agent interests. The stock-price mechanism exerts considerable pressure, both externally and internally, on management to contain agency costs and operate in the interest of owners.[18] This form of compensation—a key tool for controlling agency costs in the private sector—is unavailable to taxpayers in their role as equity providers for public projects. Because there is no market for equity stakes in public institutions, taxpayers do not have access to this relatively low-cost tool for monitoring managerial performance.

Moreover, since taxpayer residual claims are non-tradable, individuals cannot diversify their public sector risk as they can with their tradable securities. This inability to use portfolio diversification—one of the most basic tools for reducing investment risk— means that the true cost of taxpayer risk bearing, and public-sector borrowing, is higher than often assumed. Taxpayers have different mechanisms, which we consider below.

D. Takeovers and the Market for Corporate Control

Transferability of ownership rights also allows management teams to compete for control. Competing management teams can circumvent entrenched boards and managers to gain control of a firm's decision process by purchasing the voting rights that attach to the firm's stock, or through tender offers or proxy contests.

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[18] Numerous empirical studies support the proposition that stock markets help mitigate agency problems. Managerial removals are correlated with negative abnormal stock returns. Also, managerial pay packages are often structured to align managerial and shareholder incentives *(e.g.* Coughlan and Schmidt 1985; Weisbach 1988; Warner, Watts and Wruck 1988).

Takeovers are a costly but effective way of allowing competition among managers for asset control (Manne 1965). This competition implies that poor management teams will be replaced when the cost of their inefficiency exceeds the transactions costs of a takeover.[19] The market for corporate control disciplines managers to use the firm's assets effectively in creating shareholder value. Empirical evidence demonstrates that takeovers enhance shareholder wealth (Jensen & Ruback, 1983; Jarrell, Brickley & Netter, 1988).[20] Hostile takeovers of taxpayer equity, by contrast, are not possible because residual claims are not tradable. Instead, managers of government agencies and state-owned enterprises are accountable to voters through democratic processes.

E. Elected Representatives and Shareholder Interests

Both taxpayers and investors can elect representatives to manage their equity. Shareholders in corporations elect members of a board of directors, who owe a fiduciary duty to manage the firm in furtherance of shareholder interests and are directly accountable to shareholders. Delaware law requires at least annual elections for directors, and proscribes a range of steps designed to protect the integrity of shareholder representation (Allen, Kraakman, Subramanian 2009). Of course, these representative processes are not perfect. Most retail investors fail to vote their shares, and institutional investors (e.g., mutual fund sponsors) have emerged as important representatives of shareholder interests (PWC 2017). Under certain

[19] As discussed above, limited liability facilitates takeover transactions by allowing shareholders to invest without considering the identity and wealth of other shareholders (Easterbrook and Fischel, 1985).

[20] Notably, some literature shows that the takeover threat can induce officers and directors to take protective measures that destroy shareholder value. For example, see Bebchuk and Cohen (2003).

circumstances, activist hedge funds can exploit ownership dispersion and imperfect proxy voting processes to pursue their own narrow interests.

The equivalent representation of taxpayer equity holders is more attenuated in the taxpayer risk bearing context. Elected officials (directly) and government managers (appointed by elected officials) are accountable to voters through regular elections. If voters are sufficiently dissatisfied with their leader's managerial performance, they can vote them out. Elected leaders, knowing this, will ensure that projects under their direct control meet at least some minimum level of voter approval. The problem, however, is that project performance under taxpayer risk bearing can be difficult to monitor. As noted above, pricing of tradable claims provides a proxy for performance under private-investor risk bearing, but not under taxpayer risk bearing.

Even where voters can rate the quality of elected officials' management of a project or firm, the effect of this assessed quality on voting decisions is somewhat attenuated. Electoral cycles often span several years, and because elected officials oversee a wide range of agencies and policies, the link between performance of certain infrastructure projects and voting choices are diluted by a variety of other voter priorities. Some scholars (e.g., Chamberlain 1997) note that agency problems are especially acute in government-sponsored entities and state authorities where there is an additional layer of quasi-independent managers between elected officials and taxpayers, and where finances are sometimes less transparent than in government agencies. Takeover markets, corporate governance structures and electoral processes are all imperfect, but each helps to keep agents responsive to principals.

F. Intermediaries and Oversight

A range of institutions have evolved over time to monitor elected officials and moderate agency costs under taxpayer risk bearing. We have not empirically examined which set of institutions more effectively aligns monitors managerial performance, but examine the differences under these two risk-bearing settings, and argue that the relative success of such institutions holds significant implications for the relative cost of capital.

On the public side, perhaps the most formal is the Freedom of Information Act (FOIA), along with similar legislation at the state level that, subject to certain exemptions, requires agencies to release public records in response to citizens' requests. Legislative oversight at the federal and state level holds managers accountable via the carrot of appropriations and the sticks of subpoena, hearings, reports, and investigations. Within agencies, Inspectors General often monitor and investigate operations to mitigate agency concerns. Externally, journalists monitor officials' conduct and rating agencies assess managerial performance and factor their effectiveness into their ratings of public credit quality.

Analogous institutions help control managerial behavior in private enterprises. Federal and state agencies promote disclosure by requiring regular reporting on major activities, compensation of key personnel, and financial status. When necessary, the Securities and Exchange Commission, Department of Justice, and state agencies can bring criminal and civil actions to protect shareholder interests. Public stock exchanges and securities industry bodies such as the Financial Industry Regulatory Authority (FINRA) offer another layer of corporate governance protection, giving shareholders transactional approval rights, access to information, and other tools. Finally, the market for corporate control, analyst scrutiny, and institutional shareholder pressure help keep managers responsive to shareholders.

To the extent that they assuage investor concern over agency costs and reduce managerial divergence from owners' interests, the monitoring mechanisms discussed above can hold down borrowing costs for public and private projects. The key question is which set of monitoring arrangements and legal institutions more effectively lowers agency costs: those associated with taxpayer risk-bearing or those available to investors in private firms.

V. Summary and Conclusions

Our analysis suggests that a variety of differences in the institutional arrangements underlying taxpayer versus investor risk bearing may affect the rate that taxpayers and investors would charge to voluntarily bear risk in a market for equity capital. We stress that the concepts of public versus private equity investment actually refer to a broad set of institutional and legal arrangements, many of which may impact the cost of capital. They should not be treated as monolithic or univariate. The elements of each set should be examined individually, resulting in a detailed institutional analysis.

Our analysis can be viewed as an extension of the now-substantial literature indicating that improved corporate governance structures reduce a firm's equity cost of capital. We do not express a view here on which set of residual claimants –taxpayers or private investors—most effectively bear residual project risk, as that outcome likely varies based on circumstances. But in examining the relative cost of financing between PPPs and conventional public procurement, it is important to remember that taxpayer risk bearing is not free, and thus the difference in financing cost between these two project delivery methods may be lower than many PPP critics often assume. This question is gaining in importance as more public-sector projects are delivered through PPPs that include a private-investor financing component and continuing debate over the relative cost of capital of privately financed PPPs and conventional public procurement.

Any decision on whether and how to finance a given project should rest on a complete analysis of the costs and benefits of these alternative models. When comparing the cost of capital in the two approaches, it is critical to trace economic consequences to those ultimately affected. If the true cost of risk is not understood, then risk will be misallocated.

Much additional inquiry is required to reach firm conclusions regarding which group of investors actually hold comparative advantages in bearing public project risk, and how certain institutions contribute to those advantages. For example, one could undertake a similar comparison regarding how bankruptcy processes impact relative capital costs and private infrastructure financing costs. One could also undertake an experiment in which investors are asked to bear risk under conditions similar to taxpayers and estimate the premium for bearing risk that should be assigned to using taxpayer equity. One could also explore the cost of capital and governance mechanisms associated with hybrid public-private institutions for infrastructure financing, such as infrastructure banks seeded with public capital but managed by a board of non-political governors appointed by various public- and private-sector representatives. Finally, since the Arrow-Lind risk spreading principle is more powerful in larger jurisdictions, one could study the effects of federalism on the cost of capital for infrastructure projects, and the merits of varying levels of federal, state and local responsibility for infrastructure in this context.

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