PUBLIC PRIVATE PARTNERSHIPS, BIG DATA NETWORKS AND MITIGATION OF INFORMATION ASYMMETRIES

Roberto Moro Visconti*

* Department of Business Administration, Università Cattolica del Sacro Cuore, Milan, Italy
roberto.morovisconti@morovisconti.it

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Abstract

Public Private Partnerships (PPP) represent an increasingly frequent investment pattern where composite stakeholders interact in joint initiatives. Alignment of interests and consequent composition of conflicts is driven by the business purpose of the shared corporation, represented by a private Special Purpose Vehicle (SPV) within a Project Financing (PF) investment package.
Corporate governance implications go beyond the traditional contraposition between ownership and control, showing cooperative patterns where the value is co-created and distributed.
Big data-driven networks represent a trendy issue that connects public and private stakeholders through digital platforms where data are shared in real time. Information asymmetries and governance concerns are consequently softened.

Keywords: Project Finance, Stakeholders, Information Asymmetries, Corporate Governance, Theory of the Firm, Network Theory, Leverage, Value Chains, Value Co-creation, Digital Networks

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1. INTRODUCTION

This study addresses to complementary issues:

1. how PPP initiatives differ from standard corporations and
2. to which extent the information asymmetries that they incorporate are affected by big data through shared digital networks.

The major research question concerns the interaction of PPP stakeholders, connected through digital platforms that convey big data-driven information, to generate shared and co-created value. PPP stakeholders go beyond the traditional principal – agent relationship that shapes classic ownership and control issues, since they embody public actors interacting with private players and their backing financial lenders. In this triangular relationship, risk is professionally minimized and attributed to the part that can better manage it.
It will be shown that the targets of this public-private cooperation go beyond the traditional vision of the firm, also because this relationship is typically long-termed, with a consequential emphasis on economic, social and environmental sustainability.

The innovative aspect of this paper is also represented by the consideration of two further approaches for the examination of how information asymmetries work: digital networks and big data. Digital networks represent a bridging platform for interacting PPP stakeholders, whereas big data fuel in real time with massive information these platforms. The impact of big data on the informative set is relevant, albeit still largely under investigated.

Information asymmetries have significant impact on corporate governance traditional issues, since they increase the conflicts of interest among diverging stakeholders, tempted by opportunistic behaviours as moral hazard or adverse selection. The cost of collected capital consequently increases, representing a funding issue that in capital intensive investments, as long-termed PF, may represent a serious drawback; hence the importance of mitigation strategies that can find in the big data reservoir an unprecedented opportunity for more timely and shared information.

All these aspects are not present in the current corporate governance debate, especially considering the innovative combination of PPP

governance issues with big data and networked digital platforms.

Questionable issues also involve the ontological explanation of the theory of the firm, considering in particular its evolving and less clear-cut boundaries. The PPP firm, represented by a private SPV, is a synthesis of the heterogeneous relationships of several private stakeholders that share their joint venturing targets. This is a further concern that is synthetically examined in the paper, again with an innovative perspective.

Value co-creation is another aspect that will be examined, considering the constant interactions among PPP stakeholders through digital platforms nurtured in real time by big data. Even this approach is innovative, since it deals with interdisciplinary issues that are not traditionally linked to corporate governance issues. Trendy issues as governance applications to smart cities or fintech projects, driven by artificial intelligence and machine learning, will be shortly illustrated in the conclusion as a new research frontier.

Corporate governance implications can be extended to other sectors and circumstances, even beyond the PPP context, with innovative explanatory patterns.

This paper follows an interdisciplinary approach where several different topics, apparently unrelated, are examined together. They so need to be shortly defined, to better understand their meaning and their belonging to a shared area that deals with the peculiar corporate governance issues analysed in this study.

PPP is "a long-term contract between a private party and a government entity, for providing a public asset or service, in which the private party bears significant risk and management responsibility, and remuneration is linked to performance" (PPP Knowledge Lab; http://ppp.worldbank.org/public-private partnership/overview/what-are-public-private-partnerships).

PPP investments are often conceived with PF schemes. PF is a financial package that backs an infrastructural investment with extended duration and long and complex gestation process, substantially illiquid due to its lumpiness and indivisibility, capital intensive, highly leveraged and difficult to evaluate - all characteristics that make the investment intrinsically risky. When complexity grows, risk increases and supervision becomes more important (Moro Visconti, 2013a): hence the importance of information that can be fuelled by big data sharing among PPP stakeholders. Being PPP/PF investments typically highly leveraged and with a peculiar public-private relationship, they raise unusual corporate governance issues.

In contract theory and economics, information asymmetries deal with the study of decisions in transactions where one party has more or better information than the other. This creates an imbalance of power in transactions, which sometimes cause the transactions to go awry. Examples of this problem are adverse selection, moral hazard, and information monopoly (examined in par. 2.5). Most commonly, information asymmetries are studied in the context of principal–agent problems and so influence corporate governance concerns and conflicts of interest among stakeholders. They represent an important governance concern, particularly in long-termed PF investments; hence the relevance of information sharing among composite stakeholders.

Big data is the term for any gathering of large-volume information sets from multiple sources and is so expensive, fast changing, and complex that it can become hard to process. The explosive growth of data in almost every industry and business area is driven by the rapid development of the web, Internet of Things (IoT), and cloud computing (Jin et al., 2015). It will be shown in par. 3. that big data can soften information asymmetries and consequent governance concerns.

The best transmission channel of big data is represented by digital platforms and networked value chains. Digital platforms are the virtual marketplace where products and services are exchanged by buyers and sellers, often through B2B, B2C or C2C e-commerce transactions, thus feeding the high volume of information that will be analysed with data mining.

Value chains, based on traditional databases, become networked when they are linked to other chains through value-adding networks. Being digital platforms networked by web applications, they are naturally fit to interpret interactions among networking public and private stakeholders.

Chains are linked by networks, and network theory (see Caldarelli, Catanzaro, 2012; Newman, 2010; Jackson, 2008) is the study of graphs as a representation of (a)symmetric relations among discrete objects. A network can be defined as a graph in which nodes and/or edges have attributes (e.g. names). Networks are intrinsically consistent with interacting stakeholders, especially in PPP agreements.

The paper is organised as follows: after a preliminary analysis in par. 2. of the peculiar nature of the private SPV (PPP investment company), general corporate governance issues will be adapted to the PPP / PF context (par. 2.1.), considering also agency problems (par. 2.2.), partially deriving from incomplete contracting.

Control rights of large shareholders and large creditors are then examined in par. 2.3., as they represent the typical situation of PF investments where shareholders are typically concentrated (at least in the beginning, since the private SPV is normally unlisted) and so are creditors, mainly represented by banks (sometimes syndicated) or large project bond underwriters.

Even if SPVs are typically highly leveraged (Moro Visconti, 2013b), agency costs of debt are different and somewhat milder than in other situations, due to the different understanding of risk patterns and to the asset composition (being intangibles typically under-represented).

Information asymmetries are also different from standard corporate governance cases (Cai et al., 2015), and so are adverse selection and moral hazard temptations. A compared analysis of standard corporate debt finance and the PF model (par. 2.5., Table 1) will show the reasons and governance implications.

The impact of big data on information how pervasive and timely data affect the behaviour of composite PPP stakeholders. Value co-creation (Galvagno, Dalli, 2014) may represent a positive outcome of cooperative strategies, when shareholders find proper incentives to align their naturally divergent interests.

While Yan et al., 2015, examine the impact of big data on information asymmetries in Peer-to-

Peer lending, to the author's knowledge, big data has not yet been related to PPP, PF and corporate governance concerns.

Further research results and open issues will be examined in the conclusion (par. 4).

2. THE PPP INVESTMENT COMPANY AS A COASIAN NEXUS OF CONTRACTS

An "ontological" analysis about the reasons behind the existence of the PF firm (typically represented by an investment company under the form of a private SPV) seems useful not only on the theoretical side, but also considering insightful practical applications, particularly intriguing within the PF industry, where different companies – from the public buyer, to the SPV, its backing banks and other related companies – coexist and interact in a complex scenario.

The private entity activity may well be unbundled in different companies, each performing a single task (building, management, supply of technical services …): considering just one SPV makes the model simpler and reduces the counterpart risk of the public part, to the extent that it has just one interlocutor. Competition among different private bidders takes place during the tender, but then the game is over and the "wedding" between the public and the private part is celebrated (De Clerck et al., 2012), with few and painful divorce possibilities till the expiration of the concession.

It should not be forgotten that each SPV is unique, with its long-term responsibilities and legal liabilities. Consequently, even if basic rules and best practices of PF are increasingly standardized, each investment has its intrinsically risky peculiarities.

The SPV can be considered as a nexus of contracts both internally, so justifying in a Coasian way its very existence, and externally, should agreements with third parties be considered, within a broader framework. Within the PF industry, external relationships are particularly important, since investment companies typically have complex multi-task assignments, where the traditional "make it or buy?" strategic trade-off becomes even more important than elsewhere.

External nexuses of contracts typically involve synergic stakeholders, linked to the SPV with pass-through contracts or other cooperative agreements. The Coasian rationale behind the ontological existence of the firm, considered as a nexus of contracts, may tentatively be extended to a wider framework, where the PF firm (investment company – SPV) is analysed within its broader legal "web" within a PPP framework that must be convenient for all the stakeholders.

The internal nexus of contracts may so be expanded to consider also external legal agreements of the PF firm (De Bettignies, Ross, 2008), starting from the public counterpart, in a PPP framework, and from the lending institutions. This triangular relationship (Moro Visconti, 2014a) maps most of the infrastructural economic and legal connections that shape the overall PF picture. What lies behind the public entity, albeit not being formally involved in the investment, is an essential prerequisite, being concerned with public policy issues (availability of State funds; social targets; overall infrastructural planning, etc.).

Rationale for infrastructural investments is to be realistically matched with growing public budget constraints, especially in Western countries where unprecedented levels of public debt prevent the public sponsoring - and so the bankability - of many projects. PPP investments have a well-known proactive impact on economic growth. Without them growth is hampered, and tax incomes are dwarfed, so making disinflation of the public debt bubble more difficult.

The nature of the investment company and its governance issues, concerning the relationships among its stakeholders, strongly depends on its informative contents. Hence the importance of big-data driven information, increasingly available in massive terms and in real time.

2.1. The Corporate Governance Puzzle: an Adaptation to Public Private Partnerships and Project Financing

According to Shleifer, Vishny (1997) "corporate governance deals the ways in which suppliers of finance to corporations assure themselves of getting a return on their investment. How do the suppliers of finance get managers to return some of the profits to them? How do they make sure that managers do not steal the capital they supply or invest it in bad projects? How do suppliers of finance control managers? At first glance, it is not entirely obvious why the suppliers of capital get anything back. After all, they part with their money, and have little to contribute to the enterprise afterward. The professional managers or entrepreneurs who run the firms might as well abscond with the money. Although they sometimes do, usually they do not. (…). In fact, the subject of corporate governance is of enormous practical importance". And again, "people who sink the capital need to be assured that they get back the return on this capital. The corporate governance mechanisms provide this assurance".

The practical adaptation of these standard concepts to the peculiar PF firm (SPV) confirms the general framework – suppliers of finance, i.e. equity holders and debtholders still look for repayment – but should also consider the specific PF scenario.

The very first concern, a core point within standard companies, deals with managerial discretion (investment in bad projects, improper retention or diversion of cash, etc.). It is a well-known agency problem (being the manager the agent of the principal's money deriving from equity holders and debtholders). Even if also PF investments can turn out to be bad or wrong, their perimeter and profile is carefully designed and known by financiers since its inception. Little room is so left for excessive discretionary management, squandering on pet projects. It will be shown that information asymmetries are also milder, because the asset structure is typically represented by fixed assets and working capital, with limited if any intangibles.

Absconding with the money – take the money and run – seems difficult not only due to limited information asymmetries, but also because in many cases money from the public buyer to the PF SPV is directly managed by the banks of the latter, with no possibilities of improper spill over.

2.2. Agency Problems and the Utopia of Complete Contracts

A core issue of corporate governance is concerned with the agency problem, sometimes referred to as separation of ownership from control, within firms that can be interpreted as a Coasian nexus of contracts among different resource holders.

Agency relationships arise whenever an individual, called principal, delegates other individuals, called agents, to perform some service; the two main relationships are between:

· The principal-stockholders and the agents-managers, which are delegated to invest shareholders' capital;

· The principal-debtholders and the agents-stockholders, where the former provide funds to the firm, underwriting debt, and these funds are managed by stockholders and their ultimate agents, represented by managers, following the relationship described above.

Since these relationships are not necessarily harmonious, conflicts of interests may easily arise and so agency theory is primarily concerned with the binding mechanisms and incentives that principals may use with agents to get their money back, possibly with a fair and risk-adjusted gain.

According to agency theory, in imperfect labour and capital markets, managers will inevitably seek to maximize their own utility at the expense of shareholders. Agents-managers operate in their own conflicting self-interest rather than in the best interests of the firm. This happens because of asymmetric inside information (since they know better than shareholders whether they can meet the shareholders' objectives) and physiological uncertainty (since myriad factors contribute to final outcomes, it may so not be evident whether the agent directly caused a given outcome, positive or negative).

In PF, agency problems (Farrell, 2003) follow the general principles but need again to be flexibly adapted to its peculiar context (for a comparison, see Table 1). Infrastructural investments are highly capital intensive and managers typically have little if any personal money to finance them, and so they extensively rely on external funding. Due to the high leverage typical of the PF industry, most of the money, at least during the construction period, comes from debtholders, mainly represented by banks which underwrite senior debt. Even uncertainty, albeit being immanently present in everyday life, is in PF somewhat mitigated by a bounded investment pattern, with limited flexibility. Managerial discretion, a classic governance issue, is less likely in PF investments.

The legal protection system of creditors in PF is represented by a complex nexus of loan contracts, together with monitoring powers and duties from the debtholders' side. Loan contracts are the legal backbone behind financial and economic bankability and their binding nature intrinsically minimizes managerial discretion. In PF, contracts, albeit not being perfectly complete, are very detailed.

The utopia of complete contracts, ideally able to cover with their legal provisions all the possible states of the world, should realistically face an imperfect context, where unforeseen and risky events are always possible and likely to occur. To minimize problems and fallacies within necessarily incomplete contracts, two different approaches may be used and confronted, each with its advantages and pitfalls:

1) Detailed contractual provisions, trying to regulate with analytical clauses any possible situation and state of the world, targeting "complete" contracting goals;

2) Extensive referral to existing laws and codes, following and relying on general principles, as far as possible.

Growing experience deriving from PF wider application makes detailed contractual provision easier to conceive, with sound examples deriving from practical cases and, especially, from litigation. On the other side, even the legislative framework is getting more and more detailed, with legal provisions that are easier and more accurate.

While the analytical approach, albeit being "philosophically" sound, aiming at perfect contracting, may seem theoretically preferable, its pitfalls should not be underestimated. Excessive details may lack a general provision of unforeseen events, whereas a more general framework of reference, albeit seeming less binding, may be more elastically applicable to unpredictable states of the world.

Litigation particularly arises in two different delicate stages:

1. When the tender is in progress or to be adjudicated, since excluded competitors often sue either the public part (within a PPP context) or the winning firm;

2. During the life of the investment, because of underperformance of the winning firm or due to claims of the firm against the public buyer, often following an opportunistic "bargaining after winning" well known malpractice.

In the PPP's triangular governance relationship between the public buyer, the private entity and its backing banks, the role of the latter is not to be underestimated. Loan contracts and binding financing provisions are typically targeted at securing repayment, within a cash-flow based guarantee system, where punctual monitoring minimizes information asymmetries and liquidity channelling – from the public to the private entity, through the bank's intermediation and supervision – are the legal and practical cornerstone of proper debt servicing.

Agency problems may undermine reputation of agents acting on their own self-interest and, from the other side, reputation-building, so useful for managers seeking employment, but also for shareholders attempting to collect debt, is a common explanation for why people respect their commitments even if they cannot (always) be forced to do so. In PF, the amount of needed "trust" is proportional to the needed debt - and so is typically not negligible.

Within the capital structure theoretical models, there is a seminal paper of Myers, Majluf (1984) regarding information asymmetries and raised capital. Since managers have superior inside information, these asymmetries increase the cost of collecting external capital. This cost may be minimized raising at first funds that are weakly sensitive to asymmetric information, i.e. for example secured debt; equity may be collected only at a premium that properly discounts these asymmetries. Managers have a self-interest to voluntarily minimize information asymmetries, with self-imposed monitoring and transparency, to ease the equity placement, so decreasing its cost.

In the PF industry, the model needs once again a proper adaptation and information asymmetries are intrinsically reduced by the circumstance that managers and shareholders share the project since its gestation; proper information also should be shared since inception with sponsoring banks. And the "disciplined" perimeter of the investment, with few possible variants, makes managerial discretion a harder option to exercise.

In PF, proper financial packaging becomes essential with detailed and complex contracting. PF mitigates transaction costs arising from specific investments, the threat of opportunistic behaviour and incomplete contracts (Sawant, 2008). Optimal capital structure issues in PF have been initially addressed by Shah and Thakor (1987).

Agency problems are strictly linked to information asymmetries that fuel conflicts of interests and unperceived divergent behaviours. Since big data soften asymmetries, they also reduce agency concerns.

2.3. Control Rights of Large Shareholders and Large Creditors

Since contracts are ontologically incomplete, legal protection may be insufficient for shareholders, in their potential conflicts with managers, and especially for debtholders, conflicting with shareholders. Conflicts may arise also between managers and debtholders, for example if the former illegally extract money for personal abuses, threatening proper debt service and breaching their duty of loyalty, even though they are typically intermediated by shareholders, who appoint the managers. Bank loans are typically contracted by the managers with the lending institutions but even here there might be a role for shareholders, who may smooth the relationship with their reputational standing or with personal guarantees.

In infrastructural projects, especially if dimensions are big, investors – both shareholders and debtholders - are likely to be large. Shareholders tend to be big for two main reasons: their financial strength, necessary to underwrite huge capital and to sponsor big debt collection, and their specialization, important for complex investments where economies of scale and experience are mostly wanted. When the investment is ripe, typically after construction and at least some years of management, it may be suitably placed in the secondary market. Big shareholders may so split into many small stock exchange investors or they may sell to investment funds specialized in infrastructures.

Also, debtholders, mainly represented by banks, tend to be big, since large investments are unsuitable for small lending institutions such as saving & loan banks or credit cooperatives; when the amount of debt to be issued is high, syndicated loans among different banks become likelier, especially if risk diversification is needed. Even bigger banks tend to be more specialized in big projects, again with their own economies of scale and experience. Being infrastructural PF a particularly challenging investment, sophistication matters.

Risk sharing among PPP stakeholders (Zulhabri et al., 2006) is another key issue for Value for Money considerations, bankability and other governance concerns. PESTLE and SWOT analysis, fuelled by big data, may represent in this field a strategic option for a better preliminary analysis of the investment risk patterns (Moro Visconti, 2016).

Large investors protected by necessarily incomplete contracts, should preserve their interests, financially represented by the underwriting of risky or lent capital, with control rights that limit managerial discretion and, from the perspective of debtholders, shareholders' conflicting behaviours.

Large investors are big enough to have sufficient incentives for proper and active monitoring (even using big data's timely information) and enough control rights to have their interests respected. When debt covenants are violated or the firm defaults, control rights become even tighter, as Smith and Warner (1979) illustrate.
Short term lending is a well know strategy to discipline borrowers, which should show that they deserve periodical refunding; in infrastructural PF, short term borrowing however does not match long term investments and suits working capital discounting of accounts receivable, mostly concentrated in the management phase, when leverage should be already decreasing, after its peak typically concentrated at the end of the construction phase.

Large creditors, such as big banks, are also potentially active investors, especially when debt repayment is at risk and covenants are broken, with control rights that they may reluctantly exercise. Interference in management is however an ultimate option, since banks are typically reluctant to go beyond their core business and may risk being called for responsibility in case of default.

Substantial cash flow rights are a powerful control device for banks, enabled to intermediate funds from the public buyer. These rights allow banks, to first repay themselves, following an absolute priority rule, and to secure funds from improper investments, beyond the agreed perimeter.

Managerial duty of loyalty regards all stakeholders, but shareholders may command a priority, to the extent that their commitment is typically represented by a riskier sunk initial investment. Other stakeholders such as employees or short-term creditors have a more effective inside power, limiting their exposure to short term monitored engagements and periodically threatening misbehaving managers.

Both large shareholders and big creditors have an incentive (due to the significance of their stake) in investing in big data analysis, participating to digital platforms and databases where information is fuelled and shared.

2.4. The Paradox of Leverage: Is Risk Mitigated by Milder Governance Problems?

If you were a bank, would you finance a project with 80-20 debt / equity ratio, knowing that the assets - mainly consisting of capitalized construction costs - are not suitable collateral and that a ring fence mechanism protects the private entity's shareholders?

Addressed this way, the question is tricky and would unavoidably bring to a negative answer. The green light to bankability should consider the abovementioned paradox, considering also other issues: relatively stable and growing cash inflows

are the key parameter to modify an otherwise negative judgment. And since operating cash flows mainly consist of positive economic margins, reliance on a positive and sustainable operating leverage is the true key of bankability (Moro Visconti, 2013b).

As the operation is typically highly leveraged, repayment constraints represent a strong incentive for the SPV to meet the performance level contractually required.

Even small but relatively stable marginal surpluses between the return and the cost of capital can bring to positive capital returns, especially if amplified by leverage, intrinsically risky but well known as a possible wealth multiplier.

According to Subramanian, Tung, Wang (2009), PF makes cash flows verifiable, enhancing debt capacity, through:

· Contractual arrangements, made possible by structuring the project company as a single, discrete project, legally separated from the sponsor;

· Private enforcement of contracts through a network of project accounts that ensures lender control of the PF cash flows.

In PF, extensive contracts combined with private enforcement mechanisms limit borrower discretion on cash flows. To the extent that cash flows are verifiable, agency costs of debt are reduced and debt capacity is enhanced. A network of non-financial contracts is set up to limit the managerial discretion of project sponsors, to make cash flows better verifiable for lenders, and to reduce the negative impact of unexpected events on project cash flows (Corielli et al., 2010).

Risk distribution is, once again, asymmetrically distributed and affects the Free Cash Flow to equity, regarding dividends: when debt is reimbursed, there is obviously much more room to remunerate capital but the very fact that this happens later and in a residual way makes equity injections intrinsically riskier and cost of equity consequently more expensive (Moro Visconti, 2013a).

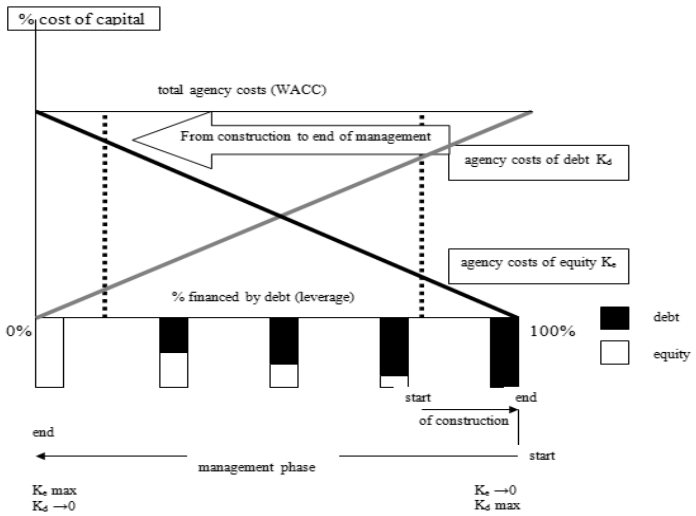
The very fact that cash flows are more verifiable in PF than in corporate debt financing makes Free Cash Flow abuses less harmful for debtholders.

If the interest rate tax shield is a typical argument in favour of the leverage, conversely risk of default of the private entity is a topic against excessive debt; this standard trade-off should be adapted to the peculiar characteristics of the SPV. Its default, theoretically always possible, would have disastrous consequences for the public part, to the extent that it would bring to an interruption of strategic services (e.g. clean up; maintenance …). Aware of this, contractual provisions regulate the case to avoid any interruption of core services; this intrinsically makes the risk of default less dramatic for the public counterpart but not automatically so for the creditors of the private entity. Some may wonder if, just in case, they can replace the equity holders in managing the private entity and the answer, provided that the public part accepts and that the service is not worsened, may well be positive. In such a case, the private entity would have a residual value (the discounted value of future contracts), limiting its default risk, that seems however reasonably unlikely - if compared with other businesses.

(High) leverage is sustainable also if debt service cover ratio is sufficiently robust, ranging well above unity - but this is the case in the final years of management, where operating cash flows tend to be stable but residual debt, thanks to reimbursements, is consistently lower.

The standard agency problems of debt concern the conflict of interests between a potential lender (the principal), who has the money but is not the entrepreneur, and a potential borrower (the agent), a manager with business ideas who lacks the money to finance them. The principal can become a shareholder, so sharing risk and rewards with the agent, or a lender, entitled to receive a fixed claim. Agency theory explains the mismatch of resources and abilities that can affect both the principal and the agent: since they need each other, incentives for reaching a compromise are typically strong. As leverage grows, risk is increasingly transferred from equity to debt holders.

Figure 1. Agency costs of equity and debt when leverage changes



Note: Big data help monitoring debt exposure and repayment capacity, fuelling bankability indicators.

2.5. Information asymmetries, adverse selection, and moral hazard

Typical corporate governance problems between lenders and borrowers, represented by banks and the private SPV, are somewhat milder than the ones present in other private companies and standard corporate investment. It is well known that information asymmetries traditionally arise since borrowers have better information about their creditworthiness and risk taking that has the lending bank. They originate conflicts of interest which might seriously prevent efficient allocation of finance: the liquidity allocation problem derives from the fact that although money is abundant, it is nevertheless not easy to give it to the right borrowers. In the case of PF, the investment should be carefully designed and analytically described, so reducing the information gap between borrowers and lenders.

Corporate governance issues are different with complementary shareholders and triangular stakeholders (public and private entities; banks) that represent the typical PPP framework.

Relationship lending, relies on personal interaction between borrowers and lenders and is based on an understanding of the borrower's business, more than to standard guarantees or credit scoring mechanisms. It can take place when the sponsoring banks are part of the private entity's shareholders or - to a lesser extent - if they already have strong ties with the main private entity's shareholders, whose credit trustworthiness is positively acknowledged.

Adverse selection is another typical problem in money lending. It occurs when banks - not knowing who is who - cannot easily discriminate between good and risky borrowers, who should deserve higher interest rate charges.

Moral hazard is a classical "take the money and run problem", since borrowers might try to abscond with the bank's money or try not to fully engage them in the project for which they have been financed.

To the extent that there is symmetric information between debt and equity holders, PF simultaneously alleviates the classical inefficient managerial problems of under - and over - investment.

Another positive characteristic of PF is the presence of relatively few information asymmetries in the assets of the SPV. According to the Leland and Pyle's (1977) seminal paper, borrowers typically know the value of their assets, to be used as collateral, much better then lenders, so rising moral hazard conflicts that prevent optimal resource allocation; this produces an incentive to minimize information asymmetries.

Liquidity does not bear any information asymmetry, but also capitalized construction costs are easily observable by outside providers of finance, who can monitor work in progress during the construction and get evidence of the effective costs of the private entity.

Incentives for borrowers to exaggerate positive qualities of their projects, with costly or impossible verification of true characteristics by outside parties, considered in the Leland and Pyle model, are uncommon in PF.

Strategic bankruptcy is false information that the borrower gives about the outcome of his financed investment, stating that it has failed even if it's not true only in order not to give back the borrowed money.

These classical corporate governance problems are well known in traditional banking - as it will be seen in Table 1. They naturally bring to sub-optimal allocation of financial resources and to capital rationing problems that frequently affect even potentially sound borrowers, if they are not able to differentiate themselves from those who bluff. The signalling effect of debt, according to which only firms with sound borrowing capacity can send a costly message – issue debt – to differentiate them from others, analysed by Ross (1977), is unlikely in the PF context, since the debt pattern should already be known since the beginning. The theory of signalling states that information asymmetry between a firm and outsiders leads the former to make certain changes in its capital structure. Ross (1977) and Myers & Majluf (1984) have shown that under asymmetric information, firms may prefer debt to equity financing.

Within the PF context, these problems can somewhat be mitigated, so reducing agency costs of debt, not only taking profit of lower information asymmetries, but also using simple but effective devices, such as cash flow channelling (with physical control over bank accounts). Since the private entity's cash flows mostly (apart from smaller "hot" revenues) come from one big source, the public part, the bank can compensate cash inflows with expiring debts, so avoiding any potential cash diversion.

PF enhances the verifiability of cash flows through contractual constraints, including a network of project accounts that are under the lender's control and into which project cash flows are required to be deposited (Subramanian et al., 2009).

Moral hazard temptations are relatively unlikely, since it is difficult either to divert the bank's money from its strategic aim - financing the building - or to avoid getting fully engaged in the project, due to the pressure for quality and achievements coming from the public part - building and running a public hospital is not a joke.

Legal clauses, protecting the bank, may consider cash flow verifiability and segregation, using waterfall provisions.

A comparison between standard corporate debt investments and corporate finance, useful also to assess Value for Money (Burger, Hawkesworth, 2011; Moro Visconti, 2014b), bankability issues and profitability, is synthesized in Table 1.

Table 1. To lend or not to lend? Comparison between corporate debt and project financing

Parameter / situation	*Corporate debt finance*	*Project Finance*
Guarantees	Asset based projects bear physical guarantees and, to the extent that they are not sufficient, personal covenants from the shareholders.	The guarantee is given by the cash flows of the project. Limited or no recourse models make private entity's shareholders mildly or not responsible.
Leverage	The (optimal) amount of leverage is a consequence of the guarantees and many other parameters (bankability; conflicts of interests and information asymmetries ...).	Typically higher than in standard corporate investments, with a profile more similar to LBOs. Lower risks, described in many parameters in this table, make this possible, to an extent that should be decided and monitored case by case.
Adverse selection	Adverse selection is a typical problem in money lending, since banks - not knowing who is who - cannot easily discriminate between good and risky borrowers, who should deserve higher interest rate charges.	The track record and reputation of borrowers is less easily identifiable in PF, since the private entity typically has several shareholders, but - to the extent that the borrower is the new private entity and that the investment project is highly detailed, adverse selection problems are not so important in PF.
Moral hazard	Moral hazard is a classical "take the money and run problem", since borrowers might try to abscond with the bank's money or try not to fully engage them in the project for which they have been financed.	Cash flow channelling through the lending bank makes money hiding extremely difficult.
Information asymmetries	In economics and contract theory, an information asymmetry is present when one party to a transaction has more or better information than the other party.	Moral hazard, adverse selection, assets substitution are much less harmful in PF and cash flows pass through the lending institutions and are easier to forecast and monitor, leading to a consistent reduction in information asymmetries, considering also that there is just one well known (albeit complex) investment to monitor.
Strategic bankruptcy	Strategic bankruptcy is false information that the borrower gives about the outcome of his financed investment, stating that it has failed even if it's not true only in order not to give back the borrowed money. The lender's right to liquidate is central to forcing the borrower to repay its debt.	Less probable with verifiable cash flows.
Probability of default	Should the financed corporation go bankrupt, residual value becomes important and companies with a high level of intangibles, mainly valuable in a going concern context, are typically penalized while asking for money. Debt holders may threat to file for bankruptcy, to force repayments. This threat is effective to the extent that there is an expected value from asset liquidation.	A project company private entity is separated and bankruptcy remote from the investing firm sponsors that create it. The project company relies extensively on debt capital provided by creditors to fund project operations. Creditors provide more (less) debt as a percentage of overall project capital when there is less (more) risk of project failure and non-repayment.
Asset substitution	A company's exchange of lower-risk investments for higher-risk investments. Firms may use asset substitution as a form of financing, or as a move to please shareholders. It can be detrimental to the company's bondholders as it increases the possibility of default without any corresponding benefit because bonds have a fixed interest rate. On the other hand, asset substitution can benefit shareholders as it carries the possibility of higher returns. This risk makes debt more difficult and expensive.	This risk is very unlikely in PF, where investments are contractually fixed and observable by financing institutions.
Level of legal protection of debtholders	Asset based, often with guarantees.	Cash flow based, with little if any guarantee (limited or no recourse).
Cash flow volatility	The volatility of the business model and the fact that the demand risk is entirely borne by the company, typically makes cash flows highly volatile and hardly predictable - bad news for lenders.	Even in PF cash flows are volatile, but normally consistently less than in other businesses, especially if cold revenues and cash flows are predominant, leaving core demand risk to the public part.
Cash flow segregation	Difficult with multiple projects; would be a (potentially harmful) impediment to managerial discretion. The lender's right to claim money back central to force the borrower to repay, limiting strategic default temptations.	Contractually envisaged in the agreements between the private entity and its lenders, it allows avoiding most conflicts between equity and debt holders.
Cash flow verifiability	Strictly dependent on the business and market model, normally consistently harder than that of PF.	When cash flows are more verifiable, the entire distribution of cash flows available to all fixed and residual claimants shifts to the right.
Upside potential	Reward and excess return of the investment, typically belonging only to the shareholders. Should the risk / return profile be unbalanced, peculiar sources of funds, more suitable to follow the assets' profile, may be issued (convertible bonds or other hybrid securities ...).	Upside potential is limited, due to the limited presence of hot revenues and to contractual caps (market testing ...) on other revenues. As a consequent, there is little if any need to issue hybrid securities.
Evaluation	Cash flow evaluations are difficult, to the extent that this parameter is hardly predictable. Market comparisons are possible and make sense if there is a sufficiently wide and similar database of other transactions.	The evaluation (assets side ≈ $NPV_{project}$ or equity side ≈ NPV_{equity}) should consider the following peculiarities: • no terminal value, since the private entity is typically dissolved once the concession has expired, its terminal value is zero; • less volatile (more predictable); • precise (contractual) duration of useful life; • market comparisons are hindered by the project's uniqueness.
Change in the business model (mission drift)	Possible and even frequent, especially from a substantial point of view, trying to adapt the business to a wildly changing market. Unperceived changes increase information asymmetries and assets substitution chances.	There is no risk of a change in the business model, due to little competitive threats and binding contractual agreements.
Time extension of the investment	Normally consistently shorter than in PF, often uneasy to be contractually bound, often overlapping with other investments having different amounts and maturities. Consequently, even short-term financing has a roll over implicit option.	Long term investment, typically exceeding 20 years, is an intrinsic risk.
Residual value	Infrastructural investments typically have a residual value, representing a worthy guarantee if debt is by then still outstanding.	Little it any residual value if the project is abandoned - a rare case with public hospitals. In any case, with a free transfer of the infrastructure to the public part, the residual value of the private entity is typically zero.

3. BEYOND INFORMATION ASYMMETRIES: BIG DATA-DRIVEN VALUE CHAINS AND PPP VALUE CO-CREATION

Information asymmetries are relevant even in PPP and in PF investment schemes, for the reasons indicated in Table 1.

Big data sharing through digital value chains (described in Moro Visconti et al., 2017a) can soften these asymmetries with a constant interaction among composite PPP stakeholders. Digital chains connect stakeholders and represent a practical extension of the network theory. The theory is fully consistent with a PPP governance paradigm, where public and private stakeholders are nodes connected through interacting transactions and data sharing.

Value chains, even in traditional terms irrespective of either big data or networks, are the strategic backbone of business modeling and planning, indicating what the target corporate goals are.

A big data-driven value chain is represented by several consequential steps such as data creation, search and capture, storage, querying, analysis, sharing and transfer, visualization, customization. Each step, codified by software algorithms, is part of an incremental and flexible value chain. Every step adds up value that should be shared among its contributors (providers, intermediating platforms, users, etc.), which participate to value co-creation. This chain produces different stages of information that are embedded in traditional value chains that so become big data-driven.

Big data value chain is based on the following strategic steps:

1. Creation (data capture);
2. Storage (warehousing);
3. Processing (data mining - fusion and analytics);
4. Consumption (sharing);
5. Monetization.

Monetization is crucial for the verification of proper debt service. In collaborative networks, multiple, diverse stakeholders are working together to co-create innovative value (Reypens et al., 2016).

Value chains are linked to supply chains (Moro Visconti et al., 2017b): while the former represent the steps that connect different stakeholders, the latter describe the operational flow of PF activities. Big data make supply chains more resilient (Papadopoulos et al., 2016), as they instantaneously absorb and reflect information. Risk (i.e., the difference between expected versus real outcomes) can consequently be softened, with shared governance benefits (lower cost of capital; higher bankability; milder conflicts of interest, etc.).

Both value chains and supply chains can be connected with digital platforms and interoperable databases where big data-sourced information is shared among PPP stakeholders.

Networking platforms that host data and connect stakeholders so represent a key component of these value-adding supply chains. Value chains are fuelled by the so-called "big data's V-dimensions". Table 2 shows the main impacts of big data on PPP / PF and corporate governance issues.

Table 2. Impact of big data characteristics on PPP, project finance and corporate governance issues

Big data dimensions	*Impact on PPP, project finance and corporate governance issues*
Volume	Big volumes of data dramatically increase the width, scale, and quality of available information. Budgeting and reporting become more precise. Differences between forecast and actual data decrease, reducing risk (inversely proportional to Value for Money) and making the PF supply chain more resilient. Relationships among the PPP stakeholders are likely to improve.
Velocity	Data are accumulated in real-time and at a rapid pace. The velocity of proliferating data increases when the system (represented for instance by interoperable databases) improves, due to machine learning and artificial intelligence. Velocity, like volume, minimizes the gap between forecast and actual data.
Variety	Evidence-based samples combine and analyse a variety of structured, semi-structured, and unstructured data, to match forecasts with outcomes, predict risk patterns, and provide more efficient analyses. Variety increases the comprehension of the stakeholders needs.
Veracity	Key parameter in PPP investments, corresponding to data reliability. Increased variety and high velocity hinder the ability to cleanse data before analysing it and making decisions, magnifying the issue of data "trust". Veracity can contribute to minimize opportunistic behaviours and conflicts of interest.
Validity	Data integrity is defined as the validity, accuracy, reliability, timeliness, and consistency of the data. It is linked to veracity.
Variability	Variability of data increases their information value, and should be linked with other parameters as velocity or variety. When variability is considered and promptly incorporated in updated business models, risk is reduced.
Virality	Measures the spread rate of data (sharing speed) across the network. It increases the involvement of different stakeholders, even outside the perimeter of the PPP investment.
Visualization	Information visualization and visual analytics are connected to IT systems through representation technologies that help users to understand data. The synthesis produced by data visualization tools is a key element to transform the information revealed by big data processing, understood only by specialists, into accessible knowledge.
Viscosity	Characterizes the resistance to navigate in the dataset or complexity of data processing. It is a common feature of data in many PPP sectors (as healthcare).
Value	Monetized value (Walker, 2015) is the synthesis of big data V-dimensions, considering data as an asset to exploit to produce innovation and new information-sensitive products and services. In PF applications, the Value for Money is spread among PPP stakeholders, improving the bankability of the overall project.

Big data shared through digital chains influence predictive analytics and business planning (Franks, 2014; Muhtaroglu et al., 2013), a core element of PF long-termed investment patterns that strongly influences the dynamics of corporate governance issues among PPP stakeholders.

Big data descriptive, prescriptive and predictive modelling attitudes can be incorporated in business planning, creating value through appropriate implementation strategies that leverage information value.

To the extent that PPP stakeholders, linked through digital networks, exchange information and blend their ideas, they build value co-creation strategies, jointly producing mutually valued outcomes. Fitter and better PF investments are the ideal result, with positive externalities that minimize conflicts of interest, cost of collected capital, and other governance concerns.

4. RESULTS AND CONCLUSION

This study has shown from a theoretical side how PPP initiatives, incorporated in SPVs or other investment vehicles, differ from standard corporations. Corporate governance issues are also different, as they are concerned with a peculiar firm, within a PPP network where public and private stakeholders interact with their sponsoring banks. The presence of the public actor introduces a new element that goes beyond the traditional contraposition between managers, shareholders and debtholders.

The standard theoretical framework of corporate governance has been adapted to a peculiar case where the PPP investment company is represented by a Coasian network of contracts that goes far beyond its legal perimeter. The SPV is in fact represented by a convergence of PPP interests bundled and coordinated in a joint venture business. This brings to an innovative approach to standard governance concerns, as complete contracts, uneasy to be conceived in normal situations, are even more difficult in presence of long-termed and sophisticated PF investments.

Another classic concern that needs to be adapted to the peculiar case is represented by the control right of large shareholders and creditors that are endemic in capital intensive PPP projects. It is shown that cash-flow based financing, typical of any PF scheme, differs from traditional asset based financing. Guarantees are also different and they involve a divergent composition of conflicts of interest and risk management.

Table 1 investigates about the core differences between standard corporate debt financing versus PF (in a PPP context). These differences describe what happens when the main corporate governance issues, concerning these two models, materialize. This basic comparison is then extended to a new interpretation of the classic governance concerns, investigating what happens to information asymmetries when big data and digital platforms are considered.

The paper has also described the key features of PPP contracts, considering what happens when PPP investments are backed by a cash-flow based PF package.

Information asymmetries (that represent a classic governance concern) have been examined, showing the peculiarities of PPP / PF investments. Even if PF investments are long-termed, they follow a defined business plan schedule that may reduce asymmetries. The paradox of leverage emerges as one of the results of the study: even if PF investments are typically highly leveraged, risk can be somewhat minimized with constant scrutiny of the project evolution and cash flow segregation for debt service.

A further step is represented by the introduction of big data and digital networks, showing that big data improve information, so reducing asymmetries, and that networks are consistent with a PPP framework of interacting stakeholders.

New research avenues should examine a classic problem, crucial for the sustainability of long-termed investments: what happens to business planning when it incorporates big data and information sharing through networked platforms?

Even if the literature (Walker, 2015; Moro Visconti et al., 2017a) shows that big data improve the description, prescription and especially the prediction of events, this general statement is still under investigated, considering its adaptation to circumstances, as the PPP / PF framework. Business plans are nurtured by information and challenged by their asymmetries, up to the point of generating corporate governance dysfunctions, as underinvestment, overinvestment, opportunistic behaviours, or to a complete failure of the project that may become fully unbankable for lack of trust. The link between value and supply chain that shows how stakeholders interact with operations also needs further scrutiny, remembering that better coordination produces shared productivity gains.

A new frontier, still underinvestigated, is represented by results-based financing strategies (Shroff et al., 2017) that remunerate private stakeholders with public savings. They occur in a capital rationing context where public budget is limited, wondering if community can realistically afford the investments that it increasingly needs. Even in this case, prompt information about savings is crucial for proper resource allocation and consequent bankability of PPP/PF investments. Smart cities with integrated PPP investments are the ultimate example of emerging trends, still looking for academic scrutiny.

Further research should also consider new technological patterns, such as those represented by fintech applications. Information technology breakthroughs such as big data-based financial technologies (Fintech) have been identified as important disruptive driving forces for this paradigm shift (Yan et al., 2015).

Artificial intelligence and interoperable databases represent a further example of new technological frontiers that are going to impact the delicate relationships among composite stakeholders. Even these aspects should be examined, considering their corporate governance implications, either in a PPP/PF framework or in classic ownership and control scenario.

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