Asset-Based Structured Finance of Infrastructure Projects

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Abstract

Over the last decades, OECD countries have steadily reduced their level of infrastructure investment. Furthermore, the economic and financial shocks that occurred in the last decade have adversely affected many economies around the world, in terms of fiscal deterioration and public debt buildup. Under this context, governments around the world are going to invest massively in new projects to sustain economic and social development, with private capital becoming considerably relevant in complementing public investment. Therefore, governments have been resorting to various forms of asset-based structured finance solutions to finance public infrastructure projects. This paper examines how project finance, asset securitization, and structured leases can support the financing of public infrastructure projects, namely, to improve resilience and meet the Sustainable Development Goals. We provide an overview of the theoretical and empirical background of infrastructure investment as an asset class and the core financial economic foundations of asset-based structured finance. In addition, we characterize the main structured finance instruments and present the main reasons behind and limitations of their usage. Finally, we describe the recent trends in asset securitization, non-recourse project financing (project finance and PPPs), and structured leasing markets, and examine the deals originated in the worldwide markets over the 2000-2020 period.

Key words: Infrastructure financing; financial innovation; structured finance; asset securitization, project finance, public-private partnership, and structured leases.
JEL classification: G23; G24; G32; H54.

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I. Introduction

The provision of public goods is a State primary responsibility, and, arguably, a driver of economic growth, and individual and societal welfare. Therefore, investing in public infrastructure should be a budgetary priority for governmental decision-makers (e.g., Lucas, 2012; Kumari and Sharma, 2017; Glaeser and Poterba, 2021; OECD, 2021; Ramey, 2021).[1]

It is widely acknowledged that government capital expenditure in public infrastructure is, ultimately, funded with taxpayers' money (Dahlby, 2008). Yet, typically, infrastructure investment needs 'far exceed the resources that countries can hope to raise in a fiscally responsible and macroeconomically sustainable way' (Schwartz et al., 2020).

Therefore, to sustain public investment expenditure on infrastructure commensurate with society's needs, governments ought to either resort to incremental borrowing (ultimately paid out with fiscal income), or mobilize private sector funding (e.g., Xu *et al*., 2021). Further, as noted by South et al. (2019), 'the growing gap between a global infrastructure deficit and the availability of public funding sources suggests private participation in the provisioning of public infrastructure will persist and even expand in the coming decades.'[2]

However, as asserted by Weber et al. (2016), 'over the last four to five decades all OECD countries have steadily reduced their level of infrastructure investment both in absolute and relative terms.' Similarly, Välilä et al. (2005) point out that public investment in the European Union 'has been on a trend decline for the past three decades.' Furthermore, the

[1] For this study, we define public infrastructure as a greenfield project requiring a large and irreversible, up-front fixed, capital assets outlay with a long, economic, and useful life expected. Due to these features, its design, procurement, contracting, financing, and decision-making are prone to significant uncertainty. The scope of this infrastructure definition encompasses transportation facilities, power generation, water, sanitation, waste management and telecommunication systems, and social infrastructure such as schools, universities, hospitals, courts, correctional, and recreational facilities (e.g., Inderst, 2010; Chen and Bartle, 2022).
[2] See, also, Bitsch et al. (2010), Estache (2010), and Lu et al. (2018).

economic and financial shocks that occurred in the last decade have adversely affected many economies around the world, notably, in terms of fiscal deterioration, public debt buildup, capital formation rationing, and the increase in the public infrastructure gap (e.g., Erel et al., 2012; Roxburgh et al., 2012; Kalemli-Özcan *et al*., 2019; Engel et al., 2021).[3]

Due to the indebtedness build-up, governments have been limited in allocating fiscal income to infrastructure investment, making the need to rely on private capital considerably relevant. Namely, as pointed out by Fouad *et al*. (2021), 'to complement public investment.' In this framework, governments have been resorting to various forms of asset-based structured finance, namely, in the form of limited recourse project financing – more specifically, project finance public-private partnerships (PPPs) –, asset securitization, and structured leases, to finance public infrastructure projects.[4]

For example, in Europe, the European Commission (EC) and the European Investment Bank (EIB) launched the 'Europe 2020 Project Bond Initiative' in 2012, designed to mobilize the necessary funding for the project financing of large EU infrastructure projects, which exceeded EUR 2 trillion between 2012 and 2020 (Scannella, 2012). In addition, Macht *et al.* (2020) argue that the COVID-19 pandemic may have endangered the progress of several Sustainable Development Goals (SDGs), which together with the fact that many countries may have reached a potential debt overhang state, emphasizes the relevance of private sector capital for pursuing those goals (e.g., Helm, 2010).

It is widely predicted that the level of greenfield (or replacement) infrastructure investment expenditure globally should remain significantly high during the decades to come, to sustain the global needs of infrastructure services (e.g., Lucas and Montesinos, 2020). Such

[3] See, also, Buttiglione et al. (2014), Weber et al. (2016), and EIB (2023).
[4] Hereafter, we use asset-based structured finance and structured finance interchangeably.

predictions reflect the aggregated concerns with infrastructure structural deficits, governmental financial and budgetary constraints, economic efficiency on the usage of public resources, and improvements in resilience towards decarbonization, climate change, and environmental, social, and governance (ESG) sustainability (e.g., Garonna and Reviglio, 2015; Della Croce and Gatti, 2014).

While George et al. (2019) claim that 'the world is facing a $15 trillion infrastructure gap by 2040', Oxford Economics (2017) predicts global infrastructure investment requirements during the 2016-2040 timespan 'to reach $94 trillion, and a further $3.5 trillion to meet the United Nations' Sustainable Development Goals for electricity and water.' Similarly, Mirabile et al. (2017) estimate global infrastructure investment needs at $95 trillion between 2016 and 2030, 'without considering further climate action'; and Zelikow and Savas (2022) point out that an additional $2.6 trillion annually would be necessary through to 2030 to meet the United Nations Conference on Trade and Development and International Energy Agency's SDGs. However, the annual budget available for infrastructure funding worldwide is close to $2.5 to $3 trillion (UNCTAD, 2022).

In this paper, we: (*i*) provide an overview of some of the economic and financial and the theoretical and empirical background that are the foundations of our study of the public infrastructure sector, focusing on whether infrastructure investments are a 'new' asset class (see section II.1); (*ii*) review the core financial economics of structured finance mainstream literature, discussing the role of financial innovation on the development of asset-based structured finance instruments (see subsection II.2). Section III characterizes the principal structured finance instruments and presents the main reasons behind and limitations of their usage. Section IV describes the recent trends in securitization, non-recourse project financing

(project finance and PPPs), and structured leasing markets, and examines the deals originated in the worldwide markets over the 2000-2020 period. The final section summarizes and offers concluding remarks.

II. Background

This section aims to provide an outline of some of the conceptual frameworks associated with infrastructure investment financing. In the first subsection, we discuss the economics and finance of infrastructure investment, namely, reviewing the main theoretical and empirical arguments of infrastructure investment as an asset class. The second subsection offers an overview of the core financial economic foundations of asset-based structured finance.

2.1. The Economics and Finance of Infrastructure Investment[5]

The provision of public infrastructure raises several issues that are still unsettled among economists. Among them, two are of paramount relevance for this study: (*i*) the amount of capital allocated to public infrastructure spending over time; and (*ii*) how to efficiently finance infrastructure projects.

It is widely accepted that increasing public infrastructure investment spending, however necessary, is not a sufficient condition for improving economic and social welfare. Indeed, achieving expected welfare gains requires compliance with the good governance practices of projects, namely, to improve the allocative efficiency of public resources, and loosen eventual financing, fiscal, and budgetary constraints (e.g., OECD, 2015; Lucas and Montesinos, 2021 Andonov et al., 2021).

[5] For more details on recent financing infrastructure literature reviews see, e.g., Uppenberg et al. (2011), Della Croce and Gatti (2014), Kumari and Sharma (2017), Beckett-Camarata (2020), and references cited therein.

Although infrastructure investment markets have been relatively active over the last decades, capital spending in public investment at large has been on a downward trend since the early 1970s (Uppenberg et al., 2011; Della Croce and Gatti, 2014; Chen and Bartle, 2022). Furthermore, according to Weber et al. (2016), 'over the last four to five decades all OECD (Organization for Economic Cooperation and Development) countries have steadily reduced their level of infrastructure investment both in absolute and relative terms.' However, according to de Brux and Saussier (2018), the 'total global infrastructure investment requirements by 2030 for transport, electricity generation, transmission and distribution, water, and telecommunications are no less than USD 71 trillion. This represents 3.5% of the annual World GDP from 2007 to 2030.'[6]

Overall, whether the needs of infrastructure investment are too high, or the availability of financial capital is too low, it remains an empirical question. For Bitsch et al. (2010), the provision of infrastructure assets has been constrained by the 'lack of financing resources.' According to PwC (2020), more important than the eventual shortage in financing supply is working out the alleged infrastructure demand-supply bottleneck. For that end, 'building a pipeline of feasible projects and creating the structures, incentives and confidence levels needed to convince private capital to invest' would be necessary.

Infrastructure investments can, arguably, be seen as an Asset Class. According to Andonov et al. (2021), 'over the past decade, there has been a surge in the allocation of institutional investor assets to infrastructure investments.' The risk-return and income stream profiles of infrastructure assets became a potentially interesting asset class for specific private

[6] According to South et al. (2019), 'the growing gap between a global infrastructure deficit and the availability of public funding sources suggests private participation in the provisioning of public infrastructure will persist and even expand in the coming decades.'

investor clientele, with a preference for investment opportunities exhibiting, inter alia, long maturities, low-income volatility, and hedge against inflation (e.g., Bitsch, 2010; Weber et al., 2016; Panayiotou, 2017). Given the nature of the financial intermediary function of long-term investors, institutional investors, such as pension funds, investment banks, insurance companies, and sovereign wealth funds, have strong incentives to: (*i*) broaden the allocative diversification of their investment portfolios; and (*ii*) match the duration of asset and liability interest rate sensitive portfolios (Inderst, 2010; Della Croce and Gatti, 2014; OECD, 2015; Panayiotou, 2017).

In short, we can consider infrastructure investments as an asset class from the perspective of a twofold story. On the one hand – the demand side – supports the idea that there is potential clientele (investors with *preferred habitats*) looking at infrastructure assets to accommodate their investment needs (e.g., Bitsch et al, 2010; Weber et al., 2016; Andonov et al., 2021). On the other hand – the supply side of the story – suggests that financial markets and intermediaries offer financial instruments promising infrastructure investor clientele, among other features, relatively inelastic demand profiles, low volatile and foreseeable income streams, and built-in inflation hedge (e.g., Della Croce and Gatti, 2014).

2.2. The Financial Economics of Asset-Based Structured Finance

In this subsection, we examine the role that asset-backed structured finance instruments play in the process of the financing of public infrastructure investment, from origination through to due diligence, contracting, monitoring, and management. (e.g., Abiad et al., 2015; Lu et al., 2018; Chen and Bartle, 2022; EIB, 2023).[7] In addition, we discuss the

[7] For a comprehensive recent overview of infrastructure investment financing markets, structures, and instruments see, e.g., OECD (2015).

key role financial innovation has in the development of new asset-based structured finance solutions.

Do asset-based structured finance instruments matter as public infrastructure investment financing? Under a complete, perfect, and frictionless market economy framework, any asset-based structured finance instrument would be a matter of irrelevancy because both individual and institutional investors could replicate any combination of asset-backed securities on their own. In other words, in a Modigliani and Miller world, asset-based structured finance transactions would not matter, because they would offer no value advantages over other market alternatives.

For example, in a world of real financial markets, where asymmetric information is an issue, tranching, or the act of encapsulating an initiative or a pool of assets in an ad hoc organization – a special purpose vehicle (SPV) – would not add value, and therefore would be irrelevant. By implication, the presence of market imperfections and frictions, such as market and contractual incompleteness, and market segmentation, can explain this form of off-balance sheet financing which, arguably, may contribute to the mitigation of informational and incentive problems, improving risk management, and lessening long-term financial flexibility (e.g., Caselli and Gatti 2005; Fabozzi et al. 2006; Leland 2007).

Under this framework, financial intermediaries, namely, investment banks, developed a large spectrum of, typically, custom-designed financing instruments, encompassing, asset securitization, non-recourse project financing (project finance and PPPs or P3), and structured leases (e.g., Davis, 2005; Roever and Fabozzi 2003; Caselli and Gatti, 2005).

A structured finance arrangement tends to be, *ceteris paribus*, more complex and lengthier to structure than the conventional financing alternatives because of, notably, the

embedded uncertainty associated with the long maturity of the transaction, its non-recourse nature, and the allocation of risk, ownership, and control rights (e.g., Fabozzi et al. 2006; Gatti et al. 2013).[8] Under this framework, a comprehensive network of hard contracts enforceable in a court of law may contribute to mitigating costly potential informational problems and improving the governance of the contractual relationship (e.g., Berglöf and Claessens, 2006; Engel et al., 2010; Barnett, 2015).

The development of innovative financial instruments has been explained in the literature and is mostly grounded on arguments promoting the efficiency or completeness of financial markets. Or, in other words, aiming at mitigating the market's frictions and imperfections that 'prevent participants in the economy from efficiently obtaining the functions they need from the financial system' (Tufano, 2003).[9]

Hence, financial innovation, developed as the endogenous response to market and contracting incompleteness, imperfections and frictions of a different nature, aims at, most notably: (*i*) complete inherently incomplete markets (e.g., Duffie and Rahi, 1995; Grinblatt and Longstaff, 2000; Lucas, 2012); (*ii*) mitigating agency and informational problems (e.g., Iossa and Martimort, 2012); (*iii*) lowering transaction, search, and marketing costs (e.g., Tufano, 2003; Dewatripont and Legros, 2005); (*iv*) alleviating taxation and regulatory burdens (e.g., Miller, 1986, 1992; Tufano, 2003; Frame and White, 2004); and (*v*) managing risk (e.g., Bitsch, 2010; Iossa and Martimort, 2012; Fouad et al, 2021; Lucas and Montesinos, 2021).[10]

[8] Under a costly state verification (CSV) framework, a project's income stream realizations are only costlessly observed by the entrepreneur. Other parties can only verify those realizations at a monitoring cost. In this set-up, there are incentives for rent-protection of ownership excess control rights (Townsend, 1979; Bebchuk, 1999; Belcredi and Caprio, 2004; Dewatripont and Legros, 2005).

[9] For more details on financial innovation see, among others, Silber (1983), Miller (1986, 1992), Merton (1995), Chen (1995), Pesendorfer (1995), and Gennaioli *et al.* (2012).

[10] Finnerty (1988) argues that deregulation in the financial services industry, and the associated intensification in competition among investment banks, was also a catalyst for financial innovation. See Arthur (2017) for a historical perspective on the literature on financial innovation and its governance.

The development of the capability of designing tailormade asset-based financing instruments was a major contribution to the financial innovation wave of the second half of the last century, for the global financial system. Advances in contracting technology complemented the ability to engineer financing arrangements, namely, to fit the risk-return preferences of the various classes of financial market participants, allow repackaging and allocating risks, and develop risk management and insurance strategies, aiming at potentially benefitting both originators and investors (e.g., Beuve et al., 2022).

Therefore, structured finance instruments represented a key financial innovation anchored in: (*i*) risk transfer; (*ii*) 'adherence' to investors' risk-return preferences; (*iii*) reduced issuance costs; and (*iv*) tax arbitrage (e.g., Merton, 1992; Miller, 1992; Duffie and Rahi, 1995; Coval et al., 2009).[11] Due to their large scale, long maturity, technical requirements, governance specificities, and contracting idiosyncrasies, the financing structure of infrastructure investments tends, *ceteris paribus*, to be more complex and potentially costlier to design and contract than non-infrastructure investments (e.g., Fabozzi et al. 2006; Bitsch et al., 2010; Gatti et al. 2013).

The financial services industry has been offering infrastructure assets characterized by steady and reasonably predictable income streams, especially, in the case of regulated natural monopoly infrastructures, and relatively stable risk profiles (e.g., Yescombe and Farquharson 2018). However, the recent surge in investors' appetite towards environmental, social, and governance (ESG) compliant assets, brought with it new challenges, inter alia, in terms of asset allocation and risk decision-making, for infrastructure investment market participants (e.g., Weber et al., 2016; Brinkman and Sarma, 2022; OECD, 2022). For example,

[11] For further details see, e.g., Pinto (2013) and references cited therein.

infrastructure investment addressing climate change has introduced 'three new sources of uncertainty that greatly complicate infrastructure design and management. These are uncertainties about climatic conditions, about carbon prices and about technologies able to tackle both a changing climate and higher carbon prices' (Fay et al., 2010).

Moreover, there has been growing interest in the market for social services infrastructure investing. According to Inderst (2015), the investment expenditure in the EU's health and education segments represented, over the 2006-2009 period, approximately 1 percent of GDP, and over 25 percent of total infrastructure spending. However, while education infrastructure is nearly 90% government financed, health infrastructure is about two thirds privately financed. This contrast in their investment financing models adds an additional challenging layer of complexity for private investors gathering the information required to (re)assess the risk-return profiles of their allocative decision-making (e.g., OECD, 2015).

III. Infrastructure Financing and Asset-based Structured Finance

In this section, we focus on securitization, non-recourse project financing (project finance and PPPs), and structured lease arrangements. As some LBOs are implemented without an SPV (a key feature of a structured finance transaction), we did not consider this type of structured finance instrument in our analysis.

These asset-backed structured finance arrangements are important funding vehicles to raise infrastructure capital stock, namely, to fulfill the new investment needs arising from population aging and climate change; promote the involvement of private sector financing in the provision of society's infrastructure needs and allow governments to address key public policy issues, including, long-term structural challenges: e.g., climate transition and

digitalisation, and sustained economic, and greener and climate-resilient growth (Finnerty, 2007; Fay et al., 2010; Uppenberg et al., 2011; Merk et al., 2012).

As the EIB (2023) highlights, 'as growth slows and budgetary pressures mount, public investment must be protected to reduce economic scarring and to stimulate the private sector.' Arguably, asset-based structured finance solutions can be an important tool, combined with other economic policy measures, to promote investment in environmentally sustainable economic and social infrastructures, hence creating conditions to achieve these economic and social goals.[12] Further, as ESG issues have been assuming increasing relevance in the development infrastructure related to climate change, namely, renewable energy asset classes and technology (e.g., wind, solar, geothermal, and hydroelectric power, and community-based renewable energy projects), project finance/PPPs as well as asset securitization and sale and leaseback have an important role to play in this transition, providing the necessary capital and creative financing structures (Weber et al., 2016).

3.1. What is asset-based structured finance?

Asset-based structured finance is often adopted when the established forms of external finance are unavailable for a particular financing need or conventional sources of funding are too expensive (Cherubini and Della Lunga, 2007). It is generally used wherever there are reliable cash flow streams across the life span of the loan/bond, which the owner wants to make use of to obtain a sizable cash payment from financing proceeds, in a situation where the owner would like to retain the ownership of, and manage, those cash streams (e.g., Davis,

[12] Investments to limit climate change are increasing, but are still well below what is needed to meet Europe's target of net-zero emissions by 2050: an investment of €1 trillion a year is needed in the European Union to reduce greenhouse gas emissions 55% by 2030, which is Euro 356 billion more a year than in the 2010-2020 period.

2005).[13] Another key feature of asset-based structured finance transactions is the presence of an ad hoc (separated from the sponsors of the transaction) entity – an SPV or special purpose entity (SPE) – also designated as a 'bankruptcy-remote corporation', which is vested, among others, with managerial responsibilities over the funds raised. The SPV/SPE is instrumental in the segmentation of cash flows and risks, to match investors' preferences (e.g., Leland, 2007; Engel et al., 2010).

Asset-based structured finance arrangements can usefully be conceptualized as a 'nexus of contracts', designed, namely, to curtail asymmetric information problems, mitigate agency conflicts, and promote risk sharing between borrowers and lenders (Esty, 2004b; Corielli et al., 2010). In such transactions, the requirements of the owner of the assets or cash flows refer to liquidity, funding, risk transfer, efficient risk allocation, favorable capital, tax and accounting treatment, or other needs. Instruments are usually designed, in terms of covenants, warrantees, corporate structure, contract, and trusts, to achieve segregation of those assets or cash flows from the originator or sponsor of the transaction (Fabozzi et al., 2006; Leland, 2007). Additionally, credit enhancement mechanisms are implemented, namely, the use of warrantees to enhance recoveries and tranching to define risk attachment points (Pinto and Santos, 2019; Marques and Pinto, 2020).

Moreover, they are designed to meet, as closely as possible, the requirements of the originator/sponsor or owner of an asset (or pool of assets) and the needs of investors/lenders, aiming at efficiently (re)financing such assets, beyond the scope of on-balance sheet financing. Under this framework, the main specificities of asset-based structured finance arrangements typically include: (*i*) an SPV; (*ii*) a high level of leverage; and (*iii*) centrality of

[13] A distinctive feature of structured finance arrangements is the allocation of cash flow rights to the investors who value them the most (e.g., Allen and Gale, 1989).

prospective cash flow to evaluate the feasibility of the transaction. Therefore, most conspicuous asset-based structured financing techniques include asset securitization, project finance, and structured leases (e.g., Fabozzi et al. 2006, Leland 2007).

Asset securitization is the process whereby financial assets are pooled together, with their cash flows (i.e., receivables), transferred to an SPV, and converted into negotiable securities to be placed in the market (Gorton and Souleles, 2007; Gorton and Metrick, 2013; Alves and Pinto, 2016). A key element in asset securitization deals is the issuers' obligation for the investors' repayment to be backed by a pool of financial assets, or any form of credit enhancements provided by third parties to the transaction (Fabozzi et al., 2006). The markets for the securities issued through securitization are composed of three main classes: asset-backed securities (ABS), mortgage-backed securities (MBS), and collateralized debt obligations (CDOs). In the context of the financing of infrastructure projects, ABS, collateralized by cash flows generating assets of a specific project, is the core class used (e.g., Davidson et al., 2003; Choudhry and Fabozzi, 2004; Kothari, 2006).[14]

Project finance is a form of financing based on a standalone entity created by the sponsors, typically, with highly levered capital structures and concentrated equity and debt ownerships (Esty, 2003,2004a,2004b; Gatti, 2008). Due to its contractual idiosyncrasies, it is also used to segregate the credit risk of the project so that lenders, investors, and other parties will appraise the project strictly on its own economic merits (John and John, 1991; Gatti et al., 2013). Thus, the funding does not depend on the reliability and creditworthiness of the sponsors and does not even depend on the value of the collateralized assets made available to financiers (e.g., Kleimeier and Megginson, 2000; Blanc-Brude and Strange, 2007).[15] A

[14] See appendix A for a detailed analysis of the securitization process.
[15] Appendix B presents a typical contractual structure of a project finance deal.

Public-private partnership (PPP) is a sub-category of project finance by which private capital and private companies construct and then operate project assets that historically have been financed with public resources and operated on a not-for-profit basis. Through PPP structures, governments shift part of the risks presented by the project to the private sector, aiming to achieve more effective management of the project, and thereby reduce the need for government borrowing (e.g., Yescombe and Farquharson, 2018; Beckett-Camarata, 2020; Cruz and Sarmento, 2021; Engel et al., 2021; Fouad et al., 2021; Beuve et al., 2022).

Structured leasing is a transaction that involves complex and large-scale assets, such as airplanes, ships, industrial plants and equipment, and large real estate projects, arrangements that build on synergies between funding policy, risk management, and tax planning, aiming at optimizing the deal in terms of cash flow structure, sustainability, and tax responsibility. As in other asset-based structured finance deals, the presence of an SPV incorporated to hold the leased asset(s), to secure cash inflows, and outflows, is a key feature of structured leases (e.g., Caselli and Gatti, 2005; Pacheco and Pinto, 2014).[16]

3.2. Economic Reasons

Several economic reasons for assembling a financing transaction under a structured form are presented in extant literature.

First, it enables the financing of a unique asset class that (*i*) previously may have been financed only by traditional borrowing methods; or (*ii*) could not be financed at all without structured finance. The second economic benefit lies in cost reduction, when the benefits of

[16] A structured lease (SL) is similar to a single-investor lease (also designated as non-leveraged leases or direct leases), but more complex in size and the number of involved parties, at least, a lessee, a lessor, and a non-recourse lender. For more details on SL please refer to, e.g., Slovin et al. (1990), Fowkes (2000), Fabozzi et al. (2006), and Deo (2009), and references therein. See appendix C for a description of the activities and cash flows involved in a structured lease.

the reduced cost of funding are greater than the cost of the required credit enhancement. The third advantage refers to maintaining the sponsors' financial flexibility by creating vehicle companies (SPVs) designated to take on the initiative, helping sponsors protect their own credit standing and future access to financial markets, by improving or maintaining financial and regulatory ratios (in the case of financial institutions). Additionally, structured finance transactions allow originators or sponsors to transfer the risk of assets or liabilities and to carry out additional business without expanding their balance sheet. Structured finance also contributes to improving operational and informational market efficiency, reducing agency costs, and reducing information asymmetries. It also allows the issuer to obtain more leverage, compared to senior unsecured debt, and to increase tax shields/savings. Finally, structured financing deals grant more flexibility to project sponsors, in terms of maturity structure, security design, and asset types (e.g., Fender and Mitchell, 2005; Caselli and Gatti, 2005; Välilä, 2005; Fabozzi et al., 2006; Leland, 2007; Lancaster et al., 2008).

3.2.1. Structured finance as a source of liquidity and funding diversification

The increased liquidity and diversification of funding sources are usually presented as economic advantages associated with asset-based structured finance transactions. Roever and Fabozzi (2003) refer to securitization as a reliable and relatively unconstrained source of off-balance sheet financing, which mitigates traditional funding constraints and may favor company growth. As regards structured leasing, Beattie et al. (2000) argue that poor liquidity and cash flow have significant influence on leasing decisions. They show that structured leasing is usually used by firms using complex and large-scale assets and who face liquidity and cash flow constraints. Similarly, Krishnan and Moyer (1994) point out that 'firms with greater financial distress potential and high debt leverage, ceteris paribus, may find financing

alternatives to leasing unavailable.' Thus, when bankruptcy probability increases, lease financing becomes a more attractive financing option as it offsets the higher transaction costs that are usually associated with lease agreements versus secured debt agreements.

Project finance allows companies with little spare debt capacity to avoid the opportunity cost of underinvestment in positive NPV projects - debt overhang motivation. Brealey et al. (1996) and Esty (1999) argue that PF helps to reduce the debt-overhang problem by assigning project returns to new investors rather than existing capital providers. According to John and John (1991) and Fabozzi et al. (2006), the off-balance-sheet treatment of the funding raised by the SPE is crucial for sponsors since it only has a limited impact on sponsors' creditworthiness and does not impact sponsors' ability to access additional financing in the future. Concerning PPPs, Välilä (2005) presents such transactions as an alternative to traditional public procurement in financing and providing infrastructure services. According to the author, PPPs 'allow governments constrained by binding fiscal deficit rules to safeguard the execution of infrastructure projects that would otherwise never materialise, or would only materialise with a delay.' Similar arguments are presented by Monk et al. (2019), Engel et al. (2021), and Lucas and Montesinos (2021).

3.2.2. Reduction of funding costs

Extant literature identifies the cost of borrowing as a determinant in implementing new structured finance deals. Differently from straight debt financing, asset-based structured finance arrangements provide a framework for extensive and comprehensive contracting, including asset collateralization and restrictive covenants stipulation, which may improve future cash flow predictability, lower asset-in-place riskiness, and decrease default likelihood and expected costs (Flannery et al., 1993). Additionally, the capital structure and limited

liability segregation induced by the SPV may yield higher leverage and lower borrowing costs (Leland 2007). Extant project finance theoretical literature argues that by mitigating the deadweight costs of market imperfections and frictions and improving risk management, project financing contractual structures reduce funding costs (e.g., Brealey et al., 1996; Esty 2003,2004a). In addition, potential lower default renegotiation costs, idiosyncratic risk diversification, and more efficient risk management may also reduce borrowing costs (e.g., John and John, 1991; Corielli et al. 2010; Esty and Kane, 2010).

According to Davidson et al. (2003), firms with high-quality assets may be able to reduce their financing costs through securitization because bonds created through securitization have a higher credit rating or are otherwise perceived to have less risk than the originator's general obligations. The same line of reasoning is presented by Riddiough (1997) and Carow et al. (1999): by reducing asymmetric information costs, securitization may be able to reduce borrowing costs, namely, for non-financial firms with a low credit rating. This happens because the credit quality of the issued securities is based on the underlying pool of assets, not the issuer's credit rating. As a result, the originator is allowed to issue a security with a credit rating superior to its own. Additionally, Lemmon et al. (2014) suggest that AS minimizes borrowing costs by reducing expected bankruptcy costs and providing access to segmented credit markets.

Comparing leasing with purchasing using borrowed funds, Fabozzi et al. (2006) and Caselli and Gatti (2005) present funding cost reduction via tax benefits as one of the major economic forces behind structured leasing. Additionally, Eisfeldt and Rampini (2009) argue that the benefit of leasing is that the repossession of leased assets is easier than the foreclosure of secured loans; i.e., lease financing has an advantage over straight debt and even secured

debt, as far as it offers a stronger financial claim, as it is effectively senior to any other financial claim. Referring to the use of leasing in project financing, Fowkes (2000) argues that structured leases may provide an alternative source of funding at a lower cost, as the lessee forgoes tax depreciation benefits, but negotiates lower lease rates with the lessor. In addition, the minimization of bankruptcy risks *vis-à-vis* traditional loans also reduces borrowing costs.

3.2.3. Reduction of agency costs

Project finance can be used to mitigate costly agency conflicts inside project companies and among capital providers. In Jensen's (1986) line of thought, large tangible assets with high free cash flows are prone to costly agency conflicts. Through the creation of a legally independent company, project finance provides an opportunity to create a new asset-specific governance system to address the conflicts between management and ownership. In addition, project finance can also reduce agency conflicts between ownership and third parties, by deterring opportunistic behavior by suppliers of critical inputs or expropriation by host governments (Esty 2003). John and John (1991) and Flannery et al. (1993) show that SPEs use joint ownership and high leverage to reduce costly agency conflicts among participants. According to Subramanian and Tung (2016), project finance structure enhances the verifiability of cash flows by the lender through contractual constraints on cash flows and private enforcement of these contracts. Välilä (2005), Iossa and Martimort (2012), and Lucas and Montesinos (2021) point out that there is a role for contracting as a disciplinary device to curtail the potential inefficient effects of agency problems as part of public sector investment in infrastructure and public services via PPPs.

Securitization may redress conflicts of interest between creditors and shareholders in the capital structure choice of firms concerning possible agency costs due to underinvestment

and asset substitution. Using optimal risk allocation models, Benveniste and Berger (1987) show that securitization can improve risk sharing and increase project funding by avoiding the underinvestment problem. In addition, Jobst (2006) argues that securitization may help to mitigate creditor-shareholder conflicts of interest, concerning possible deadweight costs associated with suboptimal capital allocation. However, the 2008 global financial crisis has somehow tarnished the positive role played by securitization in helping to mitigate costly agency conflicts. Several authors argue that securitization may lead to a severe principal-agent problem where the firm, which originates the assets to be ultimately sold and securitized, retains little or no interest in the pool of securitized assets (e.g., Benmelech and Dlugosz, 2009; Brunnermeier, 2009; Demyanyk and Van Hemert, 2011; Purnanandam, 2011). They argue that, in the 2008 global financial crisis, originators and issuers were tempted to pursue their own economic incentives, which imposed a substantial agency cost on otherwise efficient asset securitization. This subject will be further developed in section 3.3.

3.2.4. Reduction of information asymmetries

Asset-backed structured finance arrangements are structured as extensive and detailed multiparty networks of contracts, which may significantly lower the levels of informational asymmetries (e.g., John and John, 1991; Riddiough, 1997; Corielli et al., 2010). Asset securitization can help reduce information costs: securitization offers a credible and less costly way for information about the firm's receivables to be produced and provided to investors. Iacobucci and Winter (2005) argue that 'asset securitization is driven by the propensity of the market to allocate assets to investors who are best informed about asset values', while DeMarzo (2005) stress that pooling and tranching allow intermediaries to leverage their capital more efficiently, enhancing the returns to their private information. According to

Fulghieri and Lukin (2001), originators may reduce asymmetric information costs, by pooling assets and issuing securities with different degrees of seniority against the pool of cash flows. Lemmon et al. (2014) show that tranching activities create value when markets are segmented.

Iossa and Martimort (2012) and Engel et al. (2021) also present PPPs as important mechanisms for moral hazard mitigation, as banks exercise tight control over changes in the project's design and disbursing funds, which are made available gradually as project stages are completed.

3.2.5. Higher leverage and tax benefits

Several works analyze the advantages and disadvantages of project finance in the context of a firm's capital structure. Among them, Shah and Thakor (1987) argue that 'project financing enhances the values of some of these projects by permitting higher optimal leverage than with conventional financing.' This allows, as presented by John and John (1991), the value of interest tax shields to be increased when compared with corporate debt financing. Nevitt and Fabozzi (2001) present the maintenance of financial flexibility as a key benefit for firms when segregating a financing operation such as project finance. Separation into two different legal entities, whereby the sponsor manages the assets-in-place, and a new SPE runs the project's assets, may be beneficial in terms of the potential reduction in the overall business risk of the combination of the sponsor plus the vehicle company (Pinto and Santos 2019). In addition, segregating the financing structure and the limited liability of each of those entities may allow their combination to increase leverage and retain its potential associated benefits, namely, in terms of cost of capital, default risk, and debt capacity (e.g., Leland 2007).

Jobst (2006) argues that asset securitization may redress conflicts of interest between creditors and shareholders in the capital structure choice of firms, concerning possible agency

costs from underinvestment and asset substitution, due to excessive levels of debt or the presence of non-value maximizing investment behavior respectively.

According to Beattie et al. (2000), tax considerations are an important factor in the choice between debt and leasing, because leasing provides the option of 'selling' tax allowances to a lessor, in exchange for lower rental payments. Caselli and Gatti (2005) and Fabozzi et al. (2006) present the capture of tax benefits as a reason for structured leasing. Capturing tax benefits means taking advantage of the differences in taxation between leasing and other forms of financing, with the aim of reducing the lessee's cost of capital - reduction of debt all-in cost. Fowkes (2000) analyses the use of leasing in project financing and points out that 'lease finance can provide sponsors with significant accounting earnings and tax benefits.'

3.2.6. Improve/Preserve Financial and Regulatory Ratios

The off-balance sheet treatment of the funding raised by the SPV is crucial for sponsors, since it only has a limited impact on sponsors' creditworthiness, and does not impact sponsors' ability to access additional financing in the future. This argument is presented by Gatti (2008), who asserts that the use of project finance may enable sponsors to obtain 'insurance' against any potential negative impact of the project. From the government's perspective, Välilä (2005) argues that PPPs allow a project to proceed without being a direct burden on their budgets.

Fabozzi et al. (2006) argue that the improvement of the originators' key financial ratios is a common economic benefit referred to by either a bank or non-bank corporation, in asset securitization. If the transaction is classified as a true sale of assets, firms can realize a gain (or a loss) upon sale, thereby accelerating income recognition. Additionally, by removing

assets from the balance sheet, securitization can improve a company's return on assets and return on equity ratios. Regarding banks, several authors argue that securitization allows originators to benefit from regulatory and/or tax arbitrage (e.g., Jones, 2000; Krebsz, 2011).

Comparing leasing with purchasing using borrowed funds, Fabozzi et al. (2006) present credit capacity preservation as a reason for selecting structured leasing. According to reporting standards for leases, a capital lease - a lease that transfers substantially all of the benefits and risk incidents to ownership of a property, should be accounted for as the acquisition of an asset and the incurrence of an obligation by the lessee - has to be capitalized as a liability and the equipment recorded as an asset on the balance sheet. Conversely, a structured lease is not capitalized, and thus preserves credit capacity: the debt-to-equity ratio will be lower. Most long-term leases are structured to achieve the classification of operating leases for accounting purposes, and thus are treated as off-balance sheet financing, which allows the lessee to preserve financial ratios.

3.2.7. Risk management

Asset-based structured finance creates value by improving risk management. Esty (2003, 2004a, 2004b) points out that underinvestment problems due to distress costs and/or managerial risk aversion can be reduced through project finance. According to the author, risk sharing with other sponsors and debtholders reduces incremental distress costs. Along the same lines of reasoning, Corielli et al. (2010) argue that project finance can reduce the amount of assets subject to costs related to financial distress and bankruptcy by separating some assets from sponsors' balance sheets. For projects with high expected distress costs, project finance can dramatically reduce the sponsoring firm's potential risk of contamination by using separately incorporated SPEs financed via non-recourse debt. Leland (2007) asserts that the

limited or non-recourse debt provides a sponsoring firm with the valuable option of walking away from the project when cash flows are negative and that the value of such an option is higher for high-risk projects. Additionally, project finance creates value by improving risk management inside the project. Risks are allocated with the goals of reducing costs and ensuring proper benefits; i.e. they are allocated to the parties that are in the best position to manage them (e.g., Engel et al., 2021; Lucas and Montesinos, 2021).

Similarly, asset securitization arrangements have the potential to manage the risks involved more transparently, and ultimately more efficiently, than traditional lending (e.g., Alves and Pinto, 2016; Marques and Pinto, 2020).

Concerning structured leasing, Caselli and Gatti (2005) point out that a structured lease is based on the establishment of an SPV exclusively for the transaction, which works as a key risk management device. The SPV acts as an owner of the assets, and off-balance sheet operating lease treatment for the lessee is achieved (Fowkes, 2000). Additionally, all of the risks are substantially transferred to the lessor.

3.3. Problems related to the use of structured finance

Despite the previously mentioned economic benefits for sponsors and investors, structured finance transactions also have disadvantages, especially when used inappropriately. One can identify the following problems related to the use of asset-based structured finance transactions: (1) complexity; (2) off-balance sheet treatment; (3) asymmetric information problems; (4) agency problems; (5) higher transaction costs; and (6) wealth expropriation. Besides the fact that these instruments are complex *vis-à-vis* straight debt finance transactions or products, two major problems are commonly pointed out, underlying the roots of the 2008

global financial crisis and related to securitization: (i) asymmetric information problems; and (ii) agency problems.

The increased complexity of structured products related to securitization - like CDOs, squared CDOs, and even more complex securities - destroyed information, thereby making asymmetric information worse in the financial system, and increasing the severity of adverse selection and moral hazard problems. The originate-to-distribute business model, which lay behind the subprime mortgage market, was subject to the principal-agent problem because (*i*) the mortgage originator had little incentive to make sure that the mortgage was of good credit risk, (*ii*) commercial and investment banks had weak incentives to ensure that the ultimate holders of the securities would be duly paid for, and (*iii*) even the credit rating agencies evaluating these securities were themselves also subjected to conflict of interest (e.g., Benmelech and Dlugosz, 2009; Brunnermeier, 2009; Demyanyk and Van Hemert, 2011; Purnanandam, 2011). This is consistent with Ammann et al. (2023), who find that information frictions induce issuers to design structured instruments that appear more profitable for investors.

It is commonly agreed that asset-based structured finance instruments are complex vis-à-vis straight debt finance transactions or products. The risk and return evaluation of such an instrument requires modeling the risk of the underlying assets, which can be particularly difficult if the asset pool is composed of heterogeneous assets (e.g., in securitization) or if the SPVs' cash flows are difficult to measure (e.g., in project finance or PPPs). Additionally, it is necessary to evaluate the deal's specific features, including how the cash flows will be distributed to the tranches or loans, the main covenants presented in the transaction, the rights and duties of various parties involved, and the elected credit enhancement mechanisms.

Public infrastructure investment projects, due to their scale and complexity, normally require significant amounts of resources, namely, financial capital, which typically exceed project sponsors' funding capability. To try to overcome such potential debility, projects tend to be structured under increasingly more complex contracting designs. However, it is widely acknowledged that writing incomplete contracts is an inefficient governance mechanism for economic relationships contingent on the future states of the nature, which may become a source for potential opportunistic behavior, and costly agency problems (e.g., Bolton and Scharfstein, 1998).

Fender and Mitchell (2005) and Marques and Pinto (2020) argue that the increasing complexity of structured finance products creates incentives to rely more heavily on ratings than on other financing instruments. Although they are useful, structured finance ratings have limitations that market participants and public authorities need to take into account in their assessment of structured finance instruments and their markets. Asset securitization transactions are fairly complex and involve a significant amount of due diligence, negotiation, and legal procedures. According to Fender and Mitchell (2005) and Fabozzi et al. (2006), asset securitization structuring costs tend to be higher *vis-à-vis* traditional corporate financing transactions because of relatively higher up-front and ongoing costs versus traditional bonds. Davidson et al. (2003) estimate, for a Euro 100 million securitization transaction in Europe, that up-front and ongoing costs add to the overall financing costs by about 15–50 basis points, assuming a 7-year bullet bond issuance (see, also, Cardone-Riportella et al., 2010).

Regarding project finance, Fabozzi et al. (2006) present complexity, in terms of designing the transaction, writing the required documentation, and the patience and time required for designing financing and operating agreements, as one of the main disadvantages

of project finance: it can be costlier due, at least partly, to legal, financial, insurance, accounting and fiscal, engineering and environmental advisory fees (Caselli and Gatti, 2005; Esty and Kane, 2010); structuring costs involved in fairly extensive, detailed and complex contracting (Fabozzi et al., 2006; Gatti et al., 2013;); greater risk, in part to greater leverage (Esty and Kane, 2010; Esty, 2004); and operational complexity (An and Cheung, 2010). For example, Esty (2003) estimates project finance set-up costs to be, on average, at around 5 percent of the deal value. This is consistent with Välilä (2005) and Lucas and Montesinos' estimates (2021) for PPPs. According to the author, the relatively higher transaction costs in a PPP versus in-house public sector service production and provision is a significant drawback. Those transaction costs are related to, e.g., 'the need to find the right private sector partner, and to negotiate, monitor and renegotiate a long-term contract giving him the right incentives to strive for service quality while containing costs.'

One of the most frequently mentioned disadvantages of structured leases is the costs of complexity (Caselli and Gatti, 2005). This idea is corroborated by Fabozzi et al. (2006), who state that a structured lease is similar to a single-investor lease - in terms of equipment selection and negotiation (rentals, options, responsibility for taxes, insurance, and maintenance) - but appreciably more complex in size, documentation, legal involvement, and in the number of parties involved and the unique advantages that each party gains.

In short, higher leverage in an asset-based structured finance transaction usually induces up-front and ongoing fees which are relatively higher, when compared to straight debt finance transactions.

Another common problem relates to the fact that many structured finance transactions are limited recourse rather than non-recourse, and thus there is a potential grey area in which

accounting rules allow off-balance sheet treatment, but there is nonetheless some contingent liability to the parent company's shareholders. Off-balance sheet treatment is a key concept when we are referring to structured finance. However, the terms non-recourse and off-balance sheet should remain synonyms, which does not always happen. Liabilities effectively having no recourse to a company's shareholders can justly be treated as off-balance sheet.

Fabozzi et al. (2006) issue a warning related to the use of structured finance, namely, the use of SPVs to manipulate accounting statements and commit fraud, and to reduce transparency and disclosure. Even in the absence of fraud, the transfer of assets to SPVs may mislead investors as to the extent of non-recurring earnings or deferred losses. In Europe, rules and regulations were implemented on the conduct of credit rating agencies and to promote a well-functioning - simple, transparent, and standardized (STS) - securitization market in the European Union (Regulation (EU) No 462/2013 and Regulation (EU) No 2017/2402) as a response to the 2008 global financial crisis.

The most commonly mentioned disadvantages of structured leases are the costs of opacity related to the identification of whose balance sheet (lessor or lessee) some leased assets are appended (Caselli and Gatti, 2005). For example, synthetic structured leases are operating leases for accounting purposes and financing operations for tax purposes; i.e., they are off-balance sheet leases, in which the lessee remains the owner of the financed assets and retains the tax benefits associated with ownership, while simultaneously enjoying the benefits of an operating lease - the lessor offers the lessee a lower lease rate because the equity investor passes a portion of his tax benefit back to the lessee in the form of reduced lease payments.

IV. Structured financing market over the 2000-2020 period

In this section, we examine a sample of structured finance deals that originated in the worldwide market over the 2000-2020 period. For the analysis, we draw data from two different sources. We use DCM Analytics and Loan Analytics databases to extract bond and syndicated loan deals, respectively.[17] Regarding project finance, considering the significant growth of project finance bond issuance in the last decade, representing in 2020, 15.3 percent of the global project finance market (bond issuance amounted to $50.2 billion in 2020; $58.6 billion in 2019), we include transactions funded via both syndicated loans and project bonds.

Although DCM Analytics includes several bond types, we retain only those with a deal type code of 'asset-backed security' (ABS) for securitization, and 'project finance' for project finance, with tranche amount available. As we are examining structured finance transactions closed by non-financial firms, we exclude mortgage-backed securities and collateralized debt obligations.

Regarding Loan Analytics, we only examine deals with a specific purpose code of 'project finance' and 'lease financing.' We also require, for both databases, that the sample refers to deals made by a single SPV, the deal status is closed or completed, the primary purpose of each tranche is the same for each specific deal, and that the sum of all traches equals the deal amount.

After applying the defined screens to data from the DCM Analytics and Loan Analytics databases, we end up with a full sample of 18,945 project finance deals worth $3,816.9 billion (763 projects - $282.7 billion - funded through the bond market, and 18,182 projects - $3,534.1 billion - funded through the syndicated loan market), 3,014 ABS deals

[17] DCM Analytics contains information, among others, on publicly traded securitization bonds and project finance bonds, while Loan Analytics details project finance loans and syndicated loans extended to structured leases.

worth $1,221.9 billion, and 363 structured leasing deals worth $56.6 billion. Table 1 presents the distribution of the sample by year, both in terms of number of deals and value. It also describes the distribution of the percent of total value per year.

Table 1 shows that the aggregated value of project finance lending peaked in 2008, dropped in 2009, and rose again in 2010 and 2011. In 2013, a record high of $301.4 billion in project finance arrangements was seen, a 268.8% increase from the $81.7 billion reported for 2000. Regarding the project finance bond market only, $38.1 billion was arranged worldwide in 2017, the year the market hit a global record. The issuance of ABS arrangements rose significantly until 2006, reducing sharply in 2007 and 2008, coinciding with the development and propagation of the 2007-2008 financial turmoil. The increase in the securitization market resumed between 2009 and 2012, dropping in the 2013-2015 period, with 2019 representing 6% of the total amount issued in the sampling period.

The structured leasing market experienced a significant decrease in volume after 2004. Overall, $56.6 billion was raised through structured leases, which represents only 1.1% of the amount raised through asset-based structured finance worldwide. Although the European leasing market reached an all-time high in 2019 (Euro 414.9 billion), in 2020 this figure fell to Euro 351.9 billion.[18] However, these figures include the entire leasing market. The fall in the structured leasing market in the last decade was due to several factors, including the lack of homogeneous accounting and tax rules at a global level. The use of structured leases is closely linked to comparative developments and trends in the various markets. These include the tax framework, investors' appetite for this type of asset, and the development of cross-

[18] Source: Leaseeurope Annual Statistical Enquiry 2019 and 2020.

border leveraged transactions (Caselli and Gatti, 2025).[19] Since 2004, the close of several cross-border lease markets on a variety of assets (e.g., the German, the French, the UK, and the U.S. markets), as well as tax changes and, more recently, accounting changes for this type of operation (that led them to be accounted for as if they were traditional leasing operations), have led to a very significant drop in the structured leasing market.

Table 1 also shows that project finance is an important structured finance market in funding large-scale projects implemented by non-financial firms, representing 74.9% of the market.

[19] Cross-border leasing refers to German (GELL - German Leveraged Leasing), French (FDDL - French Double Dip Leasing), US (USPL - US Pickle Leasing), and UK (BDDL – British Double Dip Leasing) markets where its use offers specific tax advantages to the lessor, making the transaction more attractive both for the foreign lessee and for potential financiers of the leveraged transaction, who can 'participate in' the increased tax benefits produced by the deal. Cross-border leases have become a source of financing for European Companies (Deo, 2008).

Table 1: Distribution of the full sample of deals by year

Year	Project finance						Securitization (ABS)			Structured leases		
	Number of bond deals	Total value | bond market ($Million)	Number of loan deals	Total value | loan market ($Million)	Total value | global market ($Million)	Percent of total value | global market	Number of bond deals	Total value ($Million)	Percent of total value	Number of loan deals	Total value ($Million)	Percent of total value
2000	31	10,038	372	71,673	81,711	2.14	167	70,077	5.73	88	19,330	34.13
2001	23	9,546	359	53,038	62,584	1.64	179	96,784	7.92	92	15,624	27.59
2002	5	1,570	319	43,531	45,101	1.18	164	76,603	6.27	41	5,976	10.55
2003	16	4,265	341	64,928	69,193	1.81	189	79,299	6.49	56	4,234	7.48
2004	19	7,567	388	57,281	64,849	1.70	150	62,227	5.09	37	3,493	6.17
2005	13	5,813	418	129,129	134,942	3.54	175	73,182	5.99	5	397	0.70
2006	20	7,036	398	86,658	93,694	2.45	220	90,280	7.39	9	1,047	1.85
2007	28	10,805	628	149,848	160,653	4.21	189	57,800	4.73	3	681	1.20
2008	6	2,990	1,079	236,209	239,199	6.27	146	21,498	1.76	5	2,296	4.05
2009	18	7,891	843	183,663	191,555	5.02	116	34,893	2.86	3	744	1.31
2010	19	5,383	1,126	218,213	223,596	5.86	87	38,296	3.13	5	263	0.47
2011	18	6,251	1,077	214,222	220,472	5.78	76	39,649	3.24	0	0	0.00
2012	13	6,071	895	195,832	201,903	5.29	97	58,805	4.81	3	622	1.10
2013	59	26,817	990	274,559	301,376	7.90	107	49,212	4.03	6	430	0.76
2014	53	14,159	1,005	239,677	253,836	6.65	92	39,391	3.22	4	1,013	1.79
2015	64	15,934	1,011	181,681	197,615	5.18	94	38,683	3.17	1	20	0.04
2016	90	30,397	1,139	202,797	233,194	6.11	123	43,810	3.59	0	0	0.00
2017	105	38,047	1,335	187,057	225,104	5.90	170	66,425	5.44	1	7	0.01
2018	65	20,255	1,456	236,058	256,314	6.72	174	69,172	5.66	2	52	0.09
2019	43	17,084	1,496	268,159	285,243	7.47	186	73,671	6.03	2	406	0.72
2020	55	34,826	1,507	239,934	274,760	7.20	113	42,237	3.46	0	0	0.00
Total	**763**	**282,745**	**18,182**	**3,534,148**	**3,816,893**	**100.00**	**3,014**	**1,221,994**	**100.00**	**363**	**56,636**	**100.00**

This table describes the distribution of the sample of deals by year. Data are for deals reported in DCM Analytics and Loan Analytics with deal amount available, closed worldwide by non-financial firms during the 2000–2020 period.

Table 2 presents the industrial distribution of the sample of deals and shows that project finance deals are concentrated in four key industries: utilities (40.8%), transportation (11.7%), construction/heavy engineering (10.5%), and oil and gas (10.3%) account for 73.2% of all project finance lending by volume. ABS deals are concentrated in machinery and equipment, transportation, communications, services-capital intensive, and real estate, with these industries representing 41.7%, 10.1%, 9.5%, 9.3%, and 8.3%, respectively, of all securitization lending by non-financial firms. Structured leasing deals reveal a less concentrated industrial pattern *vis-à-vis* both project finance and ABS lending, with utilities (27.9%), transportation (23.6%), services-capital intensive (12.4%), machinery and equipment (10.9%), and public administration/government (5.2%) industries receiving the highest shares of all structured leases syndicated lending. It is worth noting the important role played by structured finance in the financing of large-scale infrastructure projects, particularly in sectors such as utilities, transportation, machinery and equipment, construction/heavy engineering, and oil and gas. These sectors represent more than 70% of the total structured finance market in our sampling period.

Table 3 details the deal allocation to projects/borrowers in a particular country, revealing striking differences between project finance lending and securitization and structured leasing lending. Perhaps the most remarkable difference is how infrequently project finance deals are extended to U.S. projects: in our sample, whereas U.S. borrowers arrange 59.3% and 66.9% of securitization and structured leasing deals, respectively, U.S. SPEs account for a mere 14.4% of PF lending. On the contrary, in Asia and Europe, the bulk of both syndicated and bond lending is extended to Asian and European borrowers through project finance, with these two geographies accounting for 67.7% of all project finance lending.

Table 2: Industrial distribution of structured finance deals

Industrial category of issuer/borrower	Project finance						Securitization (ABS)			Structured leases		
	Number of bond deals	Total value | bond market ($Million)	Number of loan deals	Total value | loan market ($Million)	Total value | global market ($Million)	Percent of total value | global market	Number of bond deals	Total value ($Million)	Percent of total value	Number of loan deals	Total value ($Million)	Percent of total value
Commercial and Industrial												
Agriculture, Forestry and Fishing	2	525	55	7,063	7,588	0.20	16	1,644	0.13	1	2	0.00
Communications	33	11,239	271	74,497	85,736	2.25	270	116,624	9.54	3	372	0.66
Construction/Heavy Engineering	59	15,359	1,853	383,995	399,354	10.46	128	35,980	2.94	7	597	1.05
Manufacturing												
Chemicals. Plastic and Rubber	6	3,380	492	176,609	179,989	4.72	22	2,338	0.19	13	2,699	4.76
Food and Beverages	1	1,000	49	2,569	3,569	0.09	32	5,383	0.44	13	647	1.14
Machinery and Equipment	9	3,387	433	86,096	89,483	2.34	746	509,788	41.72	37	6,152	10.86
Steel, Aluminum and other Metals	1	175	248	94,624	94,799	2.48	8	784	0.06	2	95	0.17
Other	2	73	189	27,578	27,651	0.72	70	10,977	0.90	13	744	1.31
Mining and Natural Resources	17	3,238	463	95,241	98,479	2.58	4	941	0.08	3	170	0.30
Oil and Gas	118	68,447	721	323,565	392,012	10.27	37	11,380	0.93	10	1,854	3.27
Real Estate	39	12,845	784	128,152	140,997	3.69	305	101,733	8.33	8	2,127	3.76
Retail Trade	5	738	52	3,358	4,096	0.11	356	35,910	2.94	27	2,015	3.56
Services - capital intensive	28	5,877	1,332	177,422	183,299	4.80	280	114,194	9.34	80	7,013	12.38
Utilities	330	118,662	9,374	1,437,501	1,556,163	40.77	166	61,906	5.07	32	15,819	27.93
Transportation	94	33,504	1,390	413,352	446,856	11.71	341	123,757	10.13	93	13,375	23.62
Public Administration/Government	18	4,196	470	102,088	106,284	2.78	126	59,719	4.89	21	2,955	5.22
Other	1	100	6	437	537	0.01	107	28,938	2.37	0	0	0.00
Total	**763**	**282,745**	**18,182**	**3,534,148**	**3,816,893**	**100.00**	**3,014**	**1,221,994**	**100.00**	**363**	**56,636**	**100.00**

This table describes the distribution of the sample of deals by industry category of issuer/borrower. Data are for deals reported in DCM Analytics and Loan Analytics with deal amount available, closed worldwide by non-financial firms during the 2000–2020 period.

Table 3: Geographic distribution of structured finance deals

Geographic location of issuer/borrower	Project finance						Securitization (ABS)			Structured leases		
	Number of bond deals	Total value | bond market ($Million)	Number of loan deals	Total value | loan market ($Million)	Total value | global market ($Million)	Percent of total value | global market	Number of bond deals	Total value ($Million)	Percent of total value	Number of loan deals	Total value ($Million)	Percent of total value
Europe	146	63,889	6,925	1,096,630	1,160,519	30.40	267	212,091	17.36	63	9,021	15.93
Western Europe	136	59,208	6,283	863,664	922,872	24.18	266	211,801	17.33	61	8,779	15.50
U.K.	76	42,052	1,316	225,294	267,346	7.00	105	89,027	7.29	12	5,041	8.90
Eastern Europe	10	4,681	642	232,966	237,647	6.23	1	291	0.02	2	242	0.43
North America	391	152,450	3,378	521,172	673,622	17.65	1,378	766,108	62.69	232	37,881	66.88
U.S.	244	108,729	2,928	441,160	549,889	14.41	1,187	725,038	59.33	232	37,881	66.88
Asia	74	22,510	5,182	1,401,508	1,424,018	37.31	901	208,828	17.09	59	9,342	16.49
Western Asia	13	6,575	1,114	422,156	428,731	11.23	8	4,706	0.39	15	3,906	6.90
Eastern Asia	61	15,935	2,210	554,296	570,231	14.94	893	204,122	16.70	34	4,495	7.94
China	31	6,527	412	283,737	290,264	7.60	192	53,055	4.34	4	415	0.73
Africa	3	3,250	611	124,446	127,696	3.35	5	3,082	0.25	0	0	0.00
Australia and Pacific	36	12,049	734	153,148	165,197	4.33	39	12,932	1.06	3	182	0.32
Caribbean	14	11,045	80	17,601	28,646	0.75	0	0	0.00	4	165	0.29
Latin America	99	17,552	1,272	219,642	237,194	6.21	424	18,953	1.55	2	46	0.08
Total	**763**	**282,745**	**18,182**	**3,534,148**	**3,816,893**	**100.00**	**3,014**	**1,221,994**	**100.00**	**363**	**56,636**	**100.00**

This table describes the distribution of the sample of deals by geographic location of issuer/borrower. Data are for deals reported in DCM Analytics and Loan Analytics with deal amount available, closed worldwide by nonfinancial firms during the 2000–2020 period.

V. SUMMARY AND CONCLUDING REMARKS

The United Nations Commission on Trade and Development estimates an annual investment of $5 to $7 trillion between 2015 to 2030 to meet the Sustainable Development Goals (SDGs). Considering that there is a yearly gap in the financing of SDGs of $4.3 trillion (UNCTAD, 2022), the support of the financial system in directing (private) funds toward sustainable development becomes crucial. This is even more critical for many countries that experience tighter fiscal constraints from the financial crisis and the COVID-19 pandemic. Under this framework, asset-based structured finance arrangements may play a fundamental role. Governments are increasingly relying on PPPs to attract private investment and financing to implement green and social infrastructure projects.[20] Banks are issuing asset-backed securities using sustainable-linked loans as collateral to raise funding to direct new loans to ESG projects. Structured leases can also play an important role in attracting additional private finance from institutional investors (e.g., pension funds and insurance companies) to fund large-scale green projects.

The financing of infrastructure projects can also be promoted via the combination of some of these structures, like project finance and asset securitization, via the issuance of asset-backed securities (Lu et al., 2019). From the supply-side perspective, the outlook is more positive, as over the past decade, there has been a surge in the allocation of institutional investor assets to infrastructure investments. As pointed out by Andonov et al. (2020), 'infrastructure is a new asset class with attractive attributes, such as low sensitivity to swings

[20] Green projects are those that foster a net-zero emissions economy, protect and restore the environment, and facilitate adaptation to climate change, while social projects are those with a primary objective of inducing social benefits or the achievement of positive social outcomes, like affordable basic infrastructure, access to essential services, affordable housing, employment generation, food security and sustainable food systems.

in the business cycle, little correlation with equity markets, and long-lasting, inflation-linked cash flows.' Moreover, these assets (e.g., renewable energy, traditional energy, transportation, utilities, information, and communication technology (ICT), schools and hospitals) are, in some cases, backed by long concession agreements. Finally, ESG preferences and regulations, which drive ESG considerations in investment selection criteria, will lead to an increase in funding available for infrastructure projects (Weber et al., 2016).

The biggest challenges in using asset-backed structured finance solutions to finance ESG infrastructure projects lie in the securitization market. Although there have been a number of sustainable securitizations issued worldwide, including green and social residential mortgage-backed securitizations (RMBS), green securitizations backed by commercial mortgages (CMBS) and auto loans and leases, and green synthetic transactions, there is still no standard approach to sustainability disclosures for securitization transactions. The International Capital Market Association (ICMA) has published various voluntary sets of principles, and some transactions have been aligned with the ICMA Green Bond Principles or the ICMA Social Bond Principles, and also in some cases, certification has taken place under the Climate Bonds Standard. Rating agencies and third-party verifiers may provide evaluations, second party opinions, and/or certifications based on ESG assessments, sustainability principles, and other considerations. However, problems associated with the assignment of ESG ratings and the use of these operations for green- and social-washing by originators remain important challenges.

Appendix A - The typical securitization transaction scheme

A securitization transaction is implemented through a transfer of assets from the originator to an SPV, which then issues securities, in the form of debt instruments, to be placed into the market through a private or public offering. Exhibit 1 presents a graphic representation of the fund flows in a typical securitization transaction.

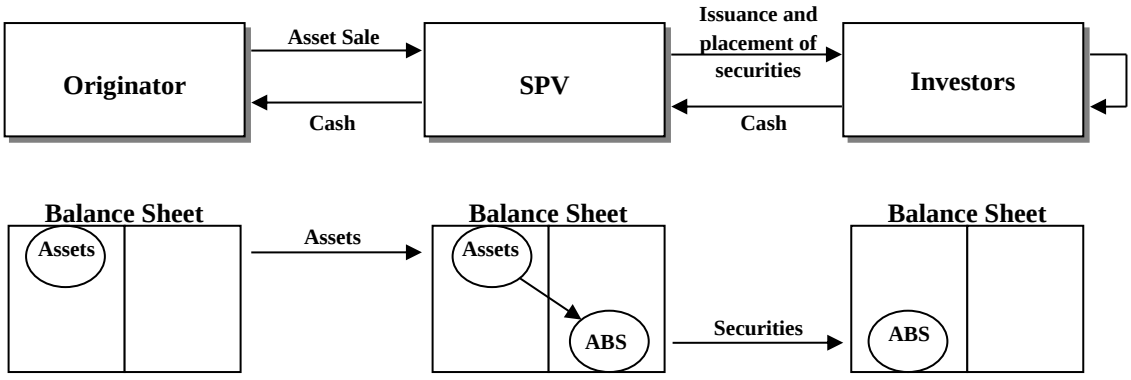

Exhibit 1: Fund flows in a securitization transaction.
Source: Pinto (2013).

Exhibit 1 shows the two basic deals involved: (1) asset sale; and (2) the issuance of securities (considering ABS in this case). For example, if a non-financial firm intends to raise money by selling a specific pool of receivables through securitization, it is possible to identify the subsequent fund flows during the life of a securitization transaction: (1) the firm (originator) sells the assets to a separate entity (SPV); (2) the SPV transforms them into negotiable securities to be placed into the capital market; (3) the issuance of securities (usually debt obligation instruments) – backed by the acquired assets – in order to finance the asset purchase; and (4) the cash flows originated by the acquired pool of assets are then used to pay the principal and interest of the securities to the final investors.

In order to understand the whole securitization process, exhibit 2 describes the major steps required to accomplish a typical securitization transaction. Step 1: the originator

identifies a pool of assets (e.g., receivables generated by an infrastructure project) that satisfy certain features that make them acceptable to be securitized;[21] Step 2: the pool of assets is transferred to an SPV at par value and based on a true sale transaction;[22] Step 3: the SPV holds the asset pool, paying for it by issuing securities;[23] Step 4: securities are offered to capital markets and structured into different classes;[24] Step 5: payment of the asset purchase;[25] and Step 6: the originator – who has proximity with the borrowers and typically has an infrastructure and systems in place for doing so – collects cash flows related to the assets (interest and principal); i.e., retains the servicing function.[26]

The highest rating for Class A (the most senior class) is explained by two factors: (1) segregation of the assets from the bankruptcy risks of the originator; and (2) the implementation of different credit enhancement strategies. One strategy is the creation of a credit risk mitigation device by subordination of Classes B, C, D, …, such that those lower classes provide credit support to Class A. It is possible to say that the size of classes B and C has been determined to meet the rating objective for Class A. Likewise, the size of Class C

[21] The originator typically identifies assets with similar characteristics. Theoretically, any asset producing regular cash flows (e.g., residential and commercial mortgages, a toll road, royalties, etc.) can be securitized.
[22] True sale or mutually exclusive use of an asset pool's cash flows means that the originator would not have any direct claim on the receivables, nor would the investors in the securities issued by the SPV itself have any claim against the general assets of the originator.
[23] To finance the acquisition of the assets, the SPV issues securities sold to investors in the capital markets. The credit rating of those securities will be based solely on the strength of the asset pool. The securities issued may be senior and junior, or they may be senior, mezzanine, and junior, or they may have various classes, such as class A, class B, class C, and so on. These various classes are created to generate differential interests in the pool, such that the senior investors have superior rights over the pool than the subordinated investors.
[24] The SPV sells securities in the capital markets through a private placement or public offering, with the help of underwriters. These securities are usually purchased by banks, insurance companies, pension funds and other institutional investors.
[25] The funds raised by the SPV from the market placement are used to pay the pool of assets originally acquired by the vehicle.
[26] The servicer collects the cash associated with the acquired assets and forwards these cash flows to the trustee, receiving a servicing fee. In the end, the trustee forwards these payments to the final investors. Servicing activities can be implemented by the originator, a subsidiary of the originator or a separate servicer.

has been determined to have Class B allocated the desired rating. In other words, the entire transaction is structured to meet specific investor needs.[27]

Different credit enhancement mechanisms may be necessary to improve the credit rating of the issued securities and reduce the risks transferred to investors; i.e., credit enhancement serves to protect investors from the risk of collateral not being repaid as expected.[28] These mechanisms can be either internally determined within the transaction structure - internal credit enhancement mechanisms - or externally provided by a third party - external credit enhancement mechanisms. The issuer should examine the various mechanisms of credit enhancement prior to issuance to determine the most effective combination of credit enhancement mechanisms. External credit enhancement mechanisms are provided by third-party guarantees, granting first-loss protection against losses up to a certain amount. Examples are: (1) guarantees; (2) letters of credit; and (3) bond insurance. This kind of guarantee can either apply to all the tranches issued or, more typically, only to one particular tranche. Moreover, internal credit enhancement mechanisms are: (1) subordination;[29] (2) overcollateralization;[30] (3) cash reserve accounts;[31] (4) excess spread;[32] (5) trigger events; and (6) minimum debt or interest service coverage levels. The type and amount of credit enhancement employed in a transaction represents the matching point of the issuer's need to

[27] See Fabozzi and Kothari (2007) for further discussion of the process of creating different classes or tranching.
[28] See, e.g., Roever and Fabozzi (2003) and Fabozzi and Kothari (2007) for an in-depth description of internal and external credit enhancement mechanisms.
[29] Issuers can increase their advance rates by selling additional bonds of lesser credit quality, which are subordinated in payment priority to the senior bonds issued from the structuring. Subordinated tranches will absorb collateral losses for the benefit of senior bonds.
[30] The overlying bonds are lower in value compared to the underlying asset pool: for example, Euro 250 million nominal value of assets are used as backing for Euro 200 million nominal value of issued bonds.
[31] Usually from part of the debt proceeds, a cash reserve is maintained in an account and used to cover initial losses.
[32] The excess spread results from the positive difference between cash inflows from assets and the interest service requirements of liabilities. It acts as the first line of credit support for the deal and if losses are low, the excess spread will increase.

maximize deal proceeds and the rating agencies' judgment with respect to how much credit enhancement is required to achieve the desired rating on the senior bond classes.

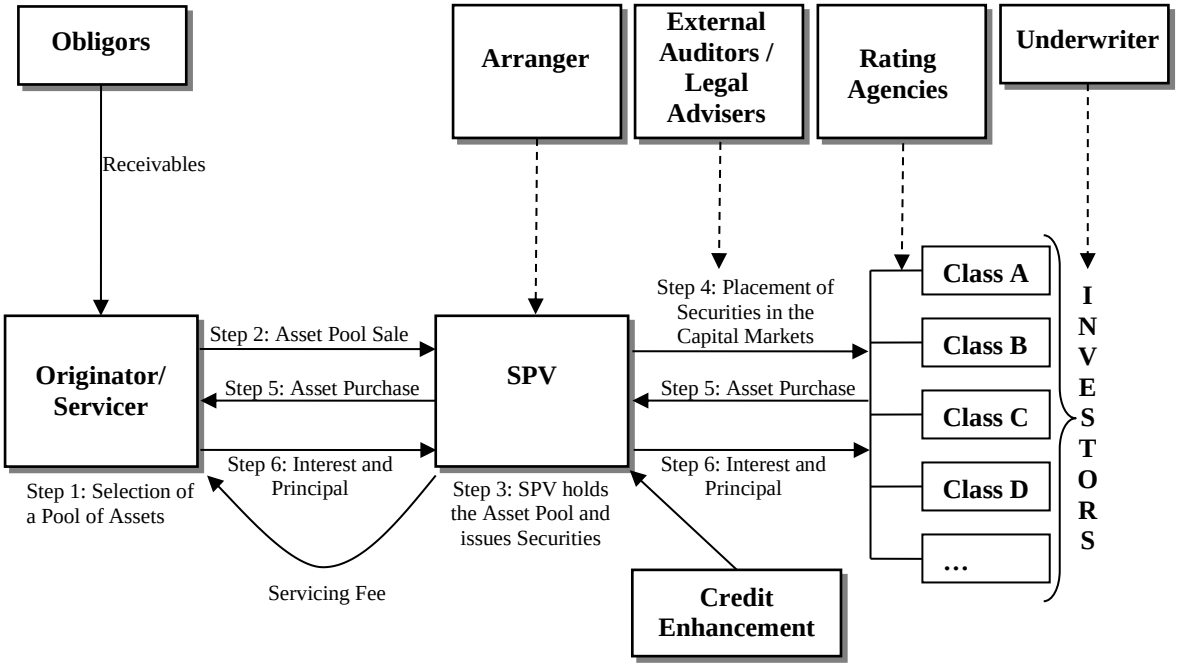

Exhibit 2: Basic securitization process.
Source: Pinto (2013).

Appendix B – Typical contract structure of a project finance deal

Project finance transactions typically exhibit five distinctive features: (1) the debtor is a project company (special purpose vehicle) that is financially and legally independent from the sponsors - project companies are standalone entities; (2) financiers have only limited or no recourse to the sponsors - their involvement is limited in terms of time, amount and quality; (3) project risks are allocated to those parties that are best able to manage them; (4) the cash flow generated by the project must be sufficient to cover operating cash flows and service the debt in terms of interest and debt repayment; and (5) collateral is given by sponsors to financiers as security for cash inflows and assets tied up in managing the project (e.g., Gatti, 2008; Pinto, 2017).

Corielli et al. (2010) argue that one of the key characteristics of project finance transactions is the existence of a network of non-financial contracts (NFCs), organized by the SPV with third parties, often involving the sponsoring firms as well; i.e., a project finance transaction can be viewed as a nexus of contracts between the players involved in such a deal. According to the authors, from among the numerous contracts four are particularly important, these are: (1) construction contracts and engineering, procurement, and construction (EPC) - closed on a turnkey basis; (2) purchasing agreements - to guarantee raw materials to the SPV at predefined quantities, quality, and prices; (3) selling agreements - enables the SPV to sell part or all of its output to a third party that commits to buy unconditionally at predefined prices and for a given period of time; and (4) operation and maintenance agreements - compliant with predefined service-level agreements. This contractual bundle is then presented to creditors to seek debt financing, serving as the basis for negotiating the quantity and the cost

of external funding. Exhibit 3 presents a graphic representation of typical contractual structure in project financing.

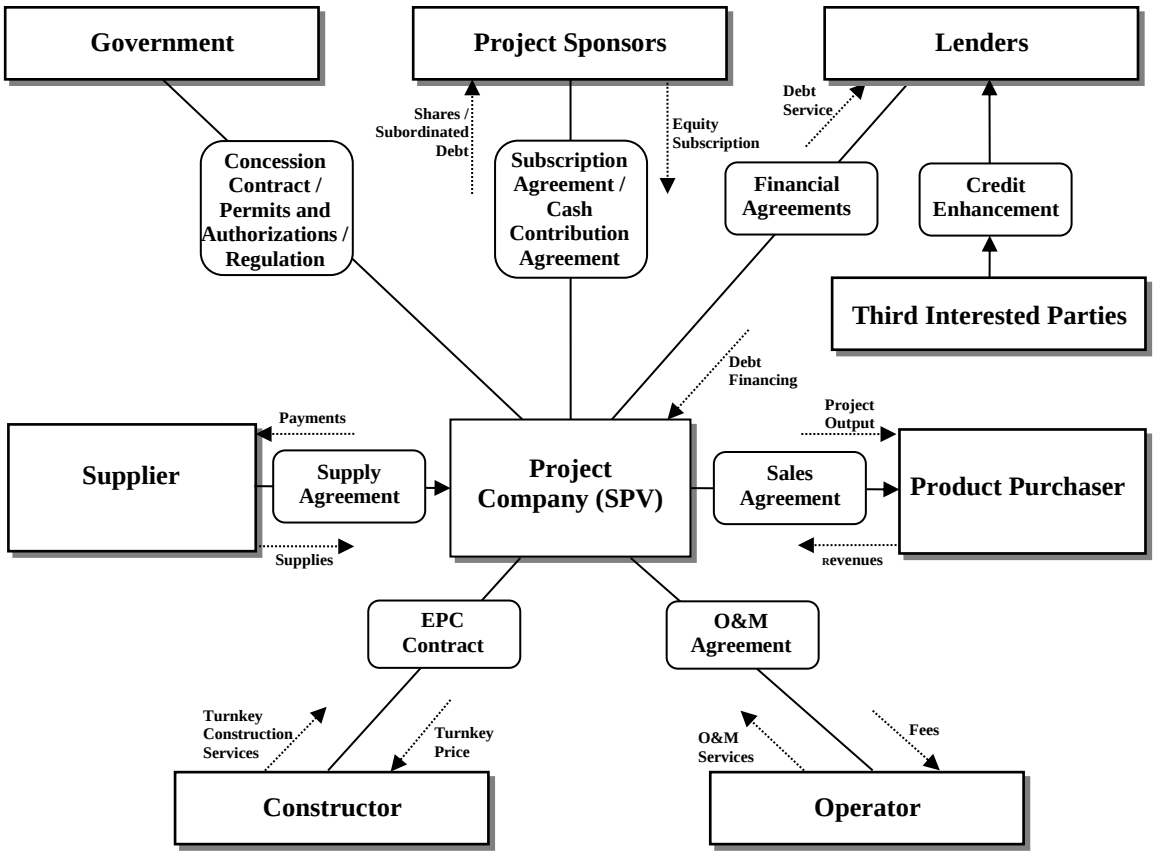

Exhibit 3: Typical contract structure of a project finance deal.
Source: Pinto (2013).

It is possible to identify the following key players in project finance (see exhibit 3): (1) the project sponsors;[33] (2) the host government (and often state-owned enterprises);[34] (3) the constructing and engineering firms; (4) the legal specialists; (5) the accounting, financial,

[33] A controlling stake in the equity of the separate company established for the purpose of undertaking the project will typically be owned by a single project sponsor, or by a group of sponsors. There are four types of sponsors that are often involved in project finance transactions and invest in the SPV (Gatti, 2008): (1) industrial sponsors - see project finance as an initiative linked to their core business; (2) public sponsors - government or other public bodies whose aims center on social welfare; (3) contract sponsors - they develop, build and run the projects and provide equity and/or subordinated debt to the SPV; and (4) purely financial sponsors - they invest capital with the aim of gathering high returns (e.g., commercial banks, multilateral development banks, and private equity funds).

[34] The project company will in most cases need to obtain a concession from the host government. Additionally, sometimes the host government needs to establish a new regulatory framework or provide environmental permits.

and risk assessment professionals; (6) the lead arranging banks;[35] (7) the participating banks;[36] and (8) the suppliers and customers. A single participant in a project finance deal can take on a number of roles; e.g., a contractor can be a sponsor, builder, and operator at the same time; banks can be sponsors and lenders simultaneously. Furthermore, not all the organizations shown in exhibit 3 are necessarily involved. For example, a deal with exclusively private actors would not include sponsors belonging to the public sector. Finally, we present a structure in which financing is provided directly to the SPV. However, financing may also be structured through leasing vehicles or with a bond offer (via the issuance of asset-backed securities) to the financial market.

[35] If the inception of the SPV is the first step in all project finance transactions, the work developed by the lead arranging bank is crucial. We can identify the following three key tasks executed by lead arrangers: (1) perform the due diligence on the vehicle company and the project itself to ensure that all potential adverse information is revealed before loan syndication; (2) design an optimal loan syndicate that deters strategic defaults, but allows for efficient negotiation in the event of liquidity defaults; and (3) spearhead monitoring of the borrower after the loan closes and discourage the sponsor from strategically defaulting or otherwise expropriating project cash flows (see, e.g., Gatti, 2008 for further details).

[36] A large fraction of the finance needed for the infrastructure projects is generally raised in the form of debt from a syndicate of lenders such as banks and specialized lending institutions and, less frequently, from bond markets.

Appendix C – Structured leases

Structured leasing is a versatile financial instrument that 'enables the lessee to position the deal in an optimal manner in relation to cash flow structure, its sustainability over time, and the distribution of tax benefits' (Caselli and Gatti, 2005). As in other tax-based structures, the implementation of a structured leasing transaction generates greater economic benefits when the value of the asset is large and allows for a potentially greater tax benefits' appropriation. The 'leverage' in structured leasing comes from the fact that: (1) the lessor provides only 20 percent or 30 percent of the capital needed to purchase the asset (the remainder is provided by a bank or a bank syndicate), with its liability limited to that amount; (2) the lessor can claim all of the tax benefits related to ownership - with the exception of synthetic leases, SLs are true leases; and (3) the lessor has the right to 100 percent of the lease residual value. It is this leverage that allows the lessor to offer the lessee a lower lease rate than the lessor could offer under a non-leveraged lease or a traditional financial lease – the equity investor passes a portion of his tax benefit back to the lessee in the form of reduced lease payments.

Whenever a sponsor is faced with low expected marginal tax rates, leveraged leasing may provide the lowest after-tax cost of funding. Additionally, in some tax jurisdictions, if a sponsor cannot efficiently use the maximum depreciation or interest deduction benefits associated with tax ownership of assets, an institutional equity investor who can efficiently use these benefits may be willing to give back a portion of these benefits to the sponsor in the form of lower lease payments. Lessees who foresee that they may not be able to fully use the tax benefits of ownership (e.g., tax depreciation) generally tend to use structured leases.[37]

[37] See, e.g., Fowkes (2000) for an in-depth analysis of SLs.

Exhibit 4 depicts the activities and cash flows involved. The main steps are: Step 1: the lessor establishes an SPV, also known as the owner trustee or equity trustee; Step 2: the lessor makes an equity investment (typically 20 percent or more of the purchase price reference) in the SPV; Step 3: the lessee assigns the purchase agreement to the owner trustee; Step 4: the trust borrows the remaining 80 percent or less from lenders; Step 5: the lessor purchases the asset from the manufacturer; Step 6: the lessor becomes the owner of the asset; Step 7: the lessee is being granted permission to use the asset; Step 8: the lessee makes a series of payments, the lease payments.

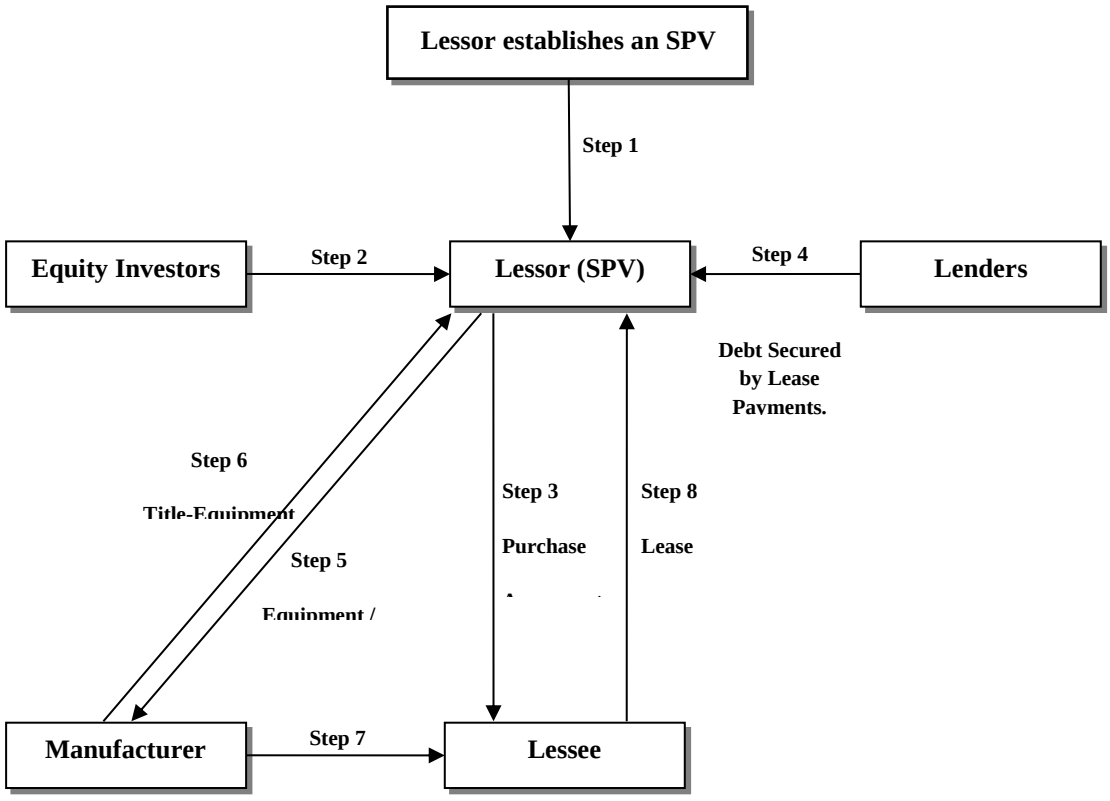

Exhibit 1: Activities and cash flows involved in a Leveraged Lease.
Source: Pinto (2013).

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