Georgia State University
Digital Archive @ GSU

Finance Dissertations | Department of Finance

8-4-2010

An Empirical Analysis of the Determinants of Project Finance: Cash Flow Volatility and Correlation

Zinat S. Alam
Georgia State University, onzsalam@yahoo.com

Follow this and additional works at: http://digitalarchive.gsu.edu/finance_diss

Recommended Citation
Alam, Zinat S., "An Empirical Analysis of the Determinants of Project Finance: Cash Flow Volatility and Correlation" (2010). *Finance Dissertations.* Paper 18.

This Dissertation is brought to you for free and open access by the Department of Finance at Digital Archive @ GSU. It has been accepted for inclusion in Finance Dissertations by an authorized administrator of Digital Archive @ GSU. For more information, please contact digitalarchive@gsu.edu.

An Empirical Analysis of the Determinants of Project Finance: Cash Flow Volatility and Correlation

Zinat Alam

Department of Finance
Robinson College of Business
Georgia State University

Dissertation Submitted
in Fulfillment of the Requirements for the Degree of
The Doctor of Philosophy in Finance

August 04, 2010

An Empirical Analysis of the Determinants of Project Finance: Cash Flow Volatility and Correlation

Zinat Alam*

Department of Finance
Robinson College of Business
Georgia State University

Abstract

This paper investigates the effect of correlation and volatilities of firm and project cash flows on the choice of project finance. I use a pure-play approach to measure unobservable project cash flows for a sample of 440 US and non-US firms that invested in 577 projects from 1990 to 2008 and find evidence that the probability of project finance is increasing in cash flow volatility difference between firm and project cash flows. The likelihood of the project finance is greater when volatilities are different and the correlation between firm and project cash flows is high. I also find that firms are likely to choose corporate finance for low correlation and low and similar volatilities between firm and project cash flows. This empirical work is consistent with the theoretical predictions in Leland (2007) that provides a potential explanation for the existence of project finance based on financial synergies.

JEL classification: G31; G32; G34; L22

Keywords: Project Finance, Capital Structure, Financial Synergies, Cash Flow Volatility

---

* I am grateful for the guidance and support from my dissertation committee members: Lixin Huang, Jayant Kale (Chair), Harley E. Ryan Jr., and Krishnamurthy Subramanian. I acknowledge the helpful comments made by Jarrad Harford, Omesh Kini, Costanza Meneghetti, Vallapuzha Sandhya, Jaideep Shenoy, Isabel Tkatch, LingLing Wang and seminar participants at the FMA PhD consortium, Reno, Nevada. All errors and omissions are mine.

An Empirical Analysis of the Determinants of Project Finance: Cash Flow Volatility and Correlation

1. Introduction

Project finance is a financing mechanism where a firm (project sponsor) forms a separate legal project company whose assets and cash flows are separated from the firm and provides equity and raise non-recourse debt to carry out a specific business operation for a finite period of time.[1] On the other hand, the firm (non-sponsor) can finance a project without legally separating it from its existing assets; I call this method of financing corporate finance. In recent years, global project finance investment has experienced a phenomenal growth from about $10 billion in the late 1980s to $328 billion in 2006. Project finance expenditure by US firms in 2006 was $47 billion surpassing venture capital funding of $41 billion or initial public offerings (IPOs) of $43 billion (Esty and Sesia, 2007). There are a number of papers, theoretical and empirical, dealing with various aspects of corporate finance, IPOs or venture capital. Project finance, on the other hand, has received considerably less attention; in particular there are only a few empirical papers that examine issues related to project finance.[2]

In this paper, I use a pure-play approach to measure unobservable project cash flows and identify the projects of non-sponsor firms. Then I examine how two determinants suggested by extant theory (Leland (2007)), namely, the correlation ($0< \rho <1$) between firm and project cash flows and volatilities of the firm and project cash flows, affect a firm's choice to resort to project finance. Leland's theoretical model predicts that project finance is more likely when the magnitude of difference between firm and project cash flow volatilities is large. Further, for a

[1] Project finance is a type of structured finance, a non-conventional way of raising funds. Other types of structured finances include acquisition finance, leveraged buyout, leasing, and securitization.

[2] See, for example, Byoun, Kim, and Yoo (2010), Corielli, Gatti, and Steffanoni (2008), Esty, and Megginson (2003), Gatti, Kleimeier, Megginson, and Steffanoni (2008), Kleimeier, and Megginson (2001), Kleimeier, and Versteeg (2010), Sawant (2010), and Subramanian, Tung, and Wang (2009).

given level of volatility difference, the likelihood of project finance is increasing with the correlation between firm and project cash flows. I examine a sample of 577 projects financed by US and non-US sponsors and find evidence consistent with both these hypotheses. I show that project finance is most likely when volatility difference is high *and* correlation between firm and project cash flows is high. I present evidence that these findings hold both at the firm and the industry levels and are also robust to different methods of identifying project cash flows, two volatility measures, alternate econometric model specifications and potential selection bias.

In the literature, the firm's decision to combine or separate its activities are explained primarily by positive or negative operational synergies created by economies of scale, market power, incomplete contracting and agency costs (Coase, 1937; Jensen and Meckling, 1976; Wiliamson, 1994; Hart and Moore, 1990; Chandler, 1990). Several theory papers also model firm's choice of project finance as a function of the agency cost of debt (Berkovitch and Kim, 1990; John and John, 1991; Flannery, et. al., 1993) but do not look at financial synergies that arise from increased debt capacity. The theoretical framework of Leland's (2007) focuses on the effects on the financial synergies from combining assets under a single firm. Total financial synergies in the Leland framework arises from changing a firm's capital structure and are determined by two effects, namely, the leverage effect and the limited liability effect. The leverage effect consists of the change in the value of debt tax shield and the change in expected default costs. The diversification benefits from combining assets with low cash flow correlation increases debt tax shields by increasing debt capacity and reduces expected default costs (Lewellen, 1971). Thus, the magnitude of the leverage effect is decreasing in correlation between firm and project cash flows. The limited liability effect, on the other hand, is due to the valuable option that shareholders have of walking away from a potentially unprofitable firm. The value of

this option to walk away is increasing in cash flow volatility (Scott, 1977; Sarig, 1985). Since combining assets reduces volatility, the limited liability effect always favors separation of assets. Low correlation between the cash flows of the project and the firm can, therefore, imply a preference for combining assets (corporate finance) because of the leverage effect or for keeping them separate (project finance) because of the limited liability effect. For any less than perfect correlation between firm and project cash flows, financial synergies from combining assets increase because of leverage effect and decrease because of limited liability effect. In other words, Leland shows that combining assets does not necessary lead to higher financial synergies as opposed to Lewellen (1971) who asserts that combining assets with imperfect correlation always creates positive financial synergies. Using numerical simulation, Leland then shows that the financial synergy from combining assets is maximized when the volatilities of the firm and the project are low and of similar magnitude. He also shows that when the volatilities of the firm and project cash flows are sufficiently different, combining assets with different cash flow volatilities decreases the expected default cost of high volatility asset, which may not be sufficient to compensate the increase in the expected default cost of low volatility asset. Under this scenario, each asset can separately optimize its debt; the leverage effect and limited liability effects are both negative and result in negative financial synergy. Therefore, for a given level of correlation, when the volatilities of the firm and project cash flows are different, project finance may be the favorable outcome.

Three empirically testable hypotheses regarding the choice of project finance over corporate finance follow from the discussion above. First, if cash flow volatilities of the firm and the project are significantly different, limited liability effect may dominate leverage effect and create negative financial synergy. In this case, project finance is preferable to corporate finance.

Second, for a given difference in cash flow volatilities, increasing the correlation of the assets decreases leverage effect. At the same time, the higher is the volatility, the more valuable is the walk-away option and hence the greater is the value of the limited liability effect. Thus, when cash flow volatilities of the firm and the project differ significantly, high correlation between the firm and the project cash flows increases the likelihood of project finance. Finally, if asset volatilities are low and similar, low correlation between the firm and the project cash flows increases leverage effect, minimizes the loss from limited liability effect and thus decreases the likelihood of project finance.

However, the practical difficulties involved in conducting empirical tests in project finance arise from two sources. First is the inability to observe project cash flows. Since almost all the projects are formed as private companies or joint ventures or subsidiaries, the information on project cash flow is not publicly available. The second difficulty arises due to the unobservability of the projects of the non-sponsors. Non-sponsor firms do not structure their projects as separate legal entities. However, in order to compare project finance with corporate finance, one must also observe projects selected by non-sponsor firms. In my empirical analysis, I circumvent these two problems in the following manner. With respect to the difficulty in identifying project cash flows of the sponsor firms, I assume that project cash flow characteristics are similar to that of a single segment firm operating in the same three-digit SIC code. Second, for each project by the sponsor, I identify a non-sponsor firm that has investments in the same industry as the project of the sponsor firm. To be classified as a non-sponsor, I require that the firm not have engaged in project finance during the sample period from 1990-2008. I assume that this is the firm that chooses to finance a similar investment using corporate finance rather than project finance. This non-sponsor firm can be a multi-segment firm with a

segment in the project's industry or a single segment firm. When the non-sponsor is a multi-segment firm, the cash flow of the segment is the cash flow of its investment/project. For a single segment non-sponsor firm, the firm is its segment and therefore, the cash flow of the firms equals the cash flow of the segment. This way, the cash flow of a single segment non-sponsor corresponds to that of the single segment sponsor who invests in a project in the same industry. Similarly, the cash flow of a multi-segment non-sponsor corresponds to that of the single /multi segment sponsor who invests in a project in a different industry. This construction allows me to compare the volatility difference between two different pairs of entities (a) *sponsor – project* and (b) *non-sponsor – segment/project* from the same industry. The final sample consists of 631 firm-year observations of 240 US and 200 Non-US sponsors totaling 577 projects. The non-sponsor sample includes approximately 20,000 firm-year observations of 4,016 US and non-US firms.

The findings from my empirical analyses offer strong support for the three hypotheses relating to the determinant of project finance described earlier. First, I find that the higher is the volatility differences, the greater is the likelihood that the firm will choose project finance. The results are qualitatively similar for industry level analysis. Second, the likelihood of project finance is the highest when the correlation between sponsor and project cash flows is *high* and the risk of the project is *different* from the risk of the sponsor. Finally, when the cash flow volatility of the project is *low* and *similar* to that of the firm and there is a *low* correlation between the firm and project cash flows, corporate finance is the preferred choice. In addition to that, firm's size, project size, and leverage play positive and significant roles in the choice of project finance. The findings are robust to various definitions of project cash flow and volatility measures, alternative econometric specifications and selection bias.

In general, this article is closely related to research on the relation between firm's capital structure and the decision to joint/separate incorporation. For example, this study is similar in spirit to the existing literature that analyzes how separate incorporation (project finance) can mitigate agency problems of debts, namely underinvestment (Berkovitch and Kim, 1990; John and John, 1991; and Flannery, et. al., 1993). The findings in my paper are consistent with Flannery, et. al. (1993), John and John (1991) and John (1993) with the exception that in their models, differences in cash flow volatilities lead to investment distortion and potential asset substitution and increases the likelihood of separating the project from the firm. The results in this study also complements the body of research that explains the existence of project finance from different perspectives, such as managerial ability and control benefit (Chemmanur and John, 1996), information asymmetry (Shah and Thakor, 1986; Krishnaswami and Subramaniam, 1999), organizational substitute for incomplete contracting (Faure-Grimaud and Inderst, 2004; Inderst and Muller, 2003; Rhodes-Kropf and Robinson, 2004; and Subramanian, Tung and Wang, 2009).

The rest of the paper proceeds as follows. The following section provides background information on project finance. I develop the conceptual background for the empirical tests in section 3. Section 4 describes data collection, sample construction and variable design. Section 5 presents main findings. Section 6 discusses the results of robustness tests. Section 7 concludes the paper.

2. Project Finance: Organizational Aspects

International Project Finance Association defines project finance as "*the financing of long-term infrastructure, industrial projects and public services based upon a non-recourse or*

limited recourse financial structure where project debt and equity used to finance the project are paid back from the cash flow generated by the project".[3] This definition highlights two key features of project finance – *large investment* and *limited* or *nonrecourse debt* but omits the important organizational aspect- *legal independence* of the project entity. Also, project financing is not limited to the type of economic/business units specified in the definition. Firms in a wide variety of industries, such as oil and gas exploration, plant construction, hotel and entertainment, mining, telecommunication, agriculture, medical facilities, and research and development, use project structure (Kensinger and Martin, 1988).

Three important structural characteristics of project finance companies are (a) legal independence, (b) concentrated equity and debt ownership and (c) non-recourse leverage. Project is a separate legal entity with limited life and specific purpose, created by a firm known as project sponsor. The sponsor provides equity; however, the project, its assets and cash flows are separated from the sponsor. The project usually appears as an off-balance sheet item in the sponsor's financial statements. In cases where a single sponsor assumes 100% ownership, the project does appear on the sponsor's balance sheet. The common legal structures used by project companies are corporation, limited-liability company, subsidiaries, partnership, unincorporated joint venture and trust.

Projects are heavily debt financed; debt accounts for about 70 to 90 percent of total ownership in project company compared to 25 to 35 percent for a typical industrial firm. Syndicated bank debt is the predominant mode of financing. Most projects also have a fewer number of shareholders, usually two or three (Esty and Sesia, 2007).

[3] Limited recourse feature implies that sometimes the sponsor/parent company offers additional guarantees to the debtholders of the project. This guarantee may take the form of a partial payment of the principal, and/or the guarantee is valid for a defined time period.

The limited/non-recourse nature of project debt implies that the project's debt service depends only on the project's cash flows and the lenders do not have a claim on the asset of the sponsor firm in case of a default.[4] Therefore, unlike traditional corporate lending, where creditors check the creditworthiness of the total firm before they offer the loan, the lenders in project assess purely the cash flow generation capability and the assets of the project. The reputation of the sponsor firm does not influence the debt raising capability of the project, however, the reputation of the lead arranger in the project finance syndicated loans decreases the spread of the project loan (Gatti, Kleimeier, Megginson, and Steffanoni, 2008).

Project finance is also known as *contract finance* as number of contracts for larger projects can range from several hundred to several thousand (Esty, 2003). Setting up a project involves various transaction costs such as fees to financial and legal advisors, payment to consultants who assess the feasibility of the projects, cost of tax advice and loan documentation, etc. The time to set up a project company ranges from six month to eighteen months and contracting costs absorb 5 to 10 percent of total project costs (Esty, 2004). Cost of debt is also typically higher for a project finance loan compared to a corporate loan. The premium for a project finance loan ranges from 50 to 100 basis points above and over a corporate loan with the anticipation that contractual commitments might fail to support debt servicing in some unforeseen events (Finnerty, 1996).

Overall, project finance has the following advantages - (a) high debt levels discipline managers and mitigate the agency costs of free cash flow (b) claims are limited to project cash flows, which mitigates underinvestment problems due to both the agency cost of debt and information asymmetries, (c) joint ownership can resolve the hold- problem among the sponsors

[4] Limited recourse debt maintains the primary criterion that debt servicing must come from the specific project for which it has been raised.

and (d) off-balance sheet financing allows the sponsor to transfer risk from existing shareholders to new investors.[5] However, the dark side of the off-balance sheet financing is that firm may use project finance to avoid reporting assets and liabilities and to defer losses (Powers, 2002). The other disadvantage includes the costs associated with complex project finance structures. The following section discusses how project characteristics such as separate incorporation and high leverage create sufficient financial synergy and provide the firm an incentive to choose project finance above and beyond the four advantages mentioned above.

3. Conceptual Background and Hypothesis Development

Change in capital structure creates financial synergy. Lewellen (1971) argues that since the cash flows from two assets are never perfectly positively correlated, combining assets always increases debt capacity and associated tax benefits. Therefore, financial synergies of a joint entity are always positive. On the other hand, total financial synergies in the Leland (2007) framework are determined by two effects, namely, the leverage effect and the limited liability effect. Through numerical solutions, Leland shows that when cash flow volatilities of two assets are different from each other, financial synergies from combining them under a single firm can be negative and sufficiently large to explain the existence of separate incorporation.[6] The following paragraphs discuss how leverage and limited liability create financial synergies.

3.1 Leverage Effect

Leland (2007) describes leverage effect as the net outcome of the gain/loss from debt tax shield and the expected cost of default. Combining assets with imperfectly correlated

[5] Esty (2003) provides a thorough analysis of the advantages of project finance.

[6] Negative operational synergy is often claimed to be the prime reason for separate incorporation. See Rajan, Servaes, and Zingales (2000) for a discussion on diversification discount. Spin-off and divestiture literature also suggests that breakups create values by reversing negative synergies (Eckbo and Thorburn, 2008).

cash flows reduces the overall risk due to diversification. Therefore, the combined firm can raise more debt, sometimes at a cheaper rate, compared to separate stand-alone firms. More debt, hence more interest deduction usually provides a tax savings for the combined firm. This gain can, however, also be negative if the combined firm's lower cost of debt reduces interest expense. On the other hand, the probability of default is always lower for a combined firm compared to stand-alone firms as diversification reduces operational risk for the former. In summary, there is a benefit from the reduction in expected default cost but there could be a tax gain or loss depending on total interest deductions. Therefore, the *net leverage effect* from combining multiple assets could be positive or negative. When there is a low correlation between the firm and project cash flows, combining the project with the firm's existing assets reduces the probability of default and the cost of debt. It creates a positive leverage effect; however, the magnitude of the leverage effect is decreasing in correlation. In addition to that, if the assets have similar cash flow volatilities, the loss from limited liability effect is minimal (discussed in the next section). Therefore, combining assets with similar volatilities and low correlation can achieve positive financial synergies.

3.2 Separate Incorporation and Limited Liability Effect

Separate incorporation provides an option, coined as limited liability effect in Leland's model, to the shareholders to walk away from future losses if the asset generates negative cash flows (Scott, 1977; Sarig, 1985). Combining two separate assets implies giving up two options for a less valuable single option, thus limited liability effect always favors separation. The higher is the cash flow volatility of the asset, the higher is the probability that the asset will generate negative cash flow and thus the more valuable is the walk-away option. Therefore, when the magnitude of the volatility difference between the assets is high, keeping

them separate increases the limited liability benefit. Additionally, if there is a *high* correlation between the cash flows of the assets, diversification benefit is negligible. Leland (2007) shows that under this scenario, financial synergy is maximized by keeping the assets separate.

One of the implications of Flannery, et. al. (1993) is similar to the limited liability effect discussed above. In their model, a diversified holding company can optimally choose its debt level if the parent company allows the subsidiary to issue its own debt. If the cash flow volatility of the subsidiary is significantly different from the cash flow volatility of the parent and the correlation of cash flows between the subsidiary and the parent is high, then issuing debt at the subsidiary level will mitigate asset substitution problem. Thus, the predictions from both the models are similar. From an empirical standpoint, asset substitution effect is incremental to limited liability effect and is expected to strengthen the findings of this paper.

3.3 Empirically Testable Hypotheses

In brief, Leland's (2007) theoretical model shows that the interplay of the leverage and limited liability effects creates positive (negative) financial synergies. For any less than perfect correlation between firm and project cash flows, financial synergies from combining assets increase because of leverage effect and decrease because of limited liability effect. Correlation and volatility difference between the cash flows of the project and the firm then create a preference for combining assets (corporate finance) because of the leverage effect or for keeping them separate (project finance) because of the limited liability effect. The discussion above leads to the following empirically testable hypotheses.

Hypothesis 1: For any level of correlation between firm and project cash flows, when the project's cash flow volatility is *different* from that of the firm, project finance is more likely than corporate finance.

Hypothesis 2: When the cash flow volatilities of the firm and the project are low and similar, the likelihood of project finance increases in correlation between firm and project cash flows.

Hypothesis 3: The probability of project finance is the highest when the cash flow volatilities of the firm and the project are different *and* correlation between firm and project cash flows is high.

4. Data, Variable Definition and Univariate Results

4.1 Sample

I compile the list of sponsor firms that invest in project finance and the information on projects from Global Public Finance (GPF) database of the Thomson Financial Securities Data Corporation (SDC). The sample of sponsors includes both US and Non-US sponsors who have invested in at least one project finance transaction during the period from 1990 to 2008. I exclude the sponsors that are not public companies or trade in foreign stock exchanges and the projects that are cancelled/conventionally financed or rumored/pipeline projects or defaulted at some point in their life cycle. Some projects in the sample have government guarantees on the output produced.[7] After carefully examining project synopses, I also drop projects that are not financed by limited/non-recourse debt and announced but non operational projects. The resulting initial sample consists of 3,149 sponsors with 2,460 completed or ongoing projects from 76 countries. In the sample, there are 633 US sponsors who invested in 626 projects within and outside the US. The total number of sponsors is greater than total number of projects because some projects have multiple sponsors (See Appendix A1).

[7] I repeat the tests including the firms that are traded in foreign stock exchanges and the results (Table 11: Panel C) are qualitatively similar. I drop defaulted projects due to the unavailability of appropriate matches - defaulted single segment firms - to proxy the cash flows of the projects as explained in detail in the following paragraph. Inclusion of projects with government guarantee does not bias the result since non-sponsor firms can also have similar guarantees.

This paper involves several stages of data collection on two pairs of entities: *sponsor - project* and *non-sponsor – segment/project*. In the following paragraphs, I describe the process of sample construction for the US firms. The main variable of interest in this study is the cash flow volatility difference between the sponsor and the project. Since almost all the projects are formed as private companies or joint ventures or subsidiaries, the information on project cash flow is not publicly available. To circumvent this problem, I identify single segment US firms from the Compustat database operating in the same three-digit SIC industry as the project. The rationale is that single segment firms operating in the same industry in the same country as the project will have similar cash flow volatilities and thus their cash flows can proxy for project cash flows. To mitigate the effect of firm size on cash flows, I scale the cash flow of the proxy firm by its total asset. Additionally, those single segment firms (proxy project) must have financial information for at least past five years starting from the fiscal year when the project is announced. I exclude 1,188 sponsor firms from the sample because there is no proxy match for their projects.

Next, I identify non-sponsor firms that did not engage in project finance transactions during the period from 1990 to 2008. In my sample, US non-sponsors are firms in the Compustat North America database that are not listed in SDC Global Project Finance database as project sponsors and are not treated as proxy projects. Unlike the sponsors, non-sponsor firms do not structure their projects as separate legal entities. Hence, it is difficult to identify their projects. I treat the segments of a multi-segment non-sponsor firm as its projects and include the firm in the sample if it belongs to the same three-digit SIC industry as the sponsor and if at least one of its segments shares the same industry as the project.[8] For a single segment non-sponsor

[8] I do not match sponsor and non-sponsor firms by size, because I want to see the effect of sponsor's size on project finance choice.

firm, the firm is its project/segment and therefore, the cash flow of the firms equals the cash flow of the segment. This way, the cash flow of a single segment non-sponsor corresponds to that of the single segment sponsor who invests in a project in the same industry. Similarly, the cash flow of a multi-segment non-sponsor corresponds to that of the single /multi segment sponsor who invests in a project in a different industry.[9] For US non-sponsors, I obtain segment information from the Compustat Segment database and define same industry at the three-digit SIC level.

I follow a similar procedure as described above to create the non-US sample. I collect the data on non-US sponsors and non-sponsors from Datastream Worldscope database. Non-sponsors' segment information is gathered primarily from Mergent Online, which provides four-digit SIC code for non-sponsor's primary and secondary business segments. I use company financial report and company web site to collect segment information for firms which are not available on Mergent. Next, I create a one to one match between the segment definition and the SIC code and assign a three-digit code to these segments of non-US non-sponsors.[10]

This multi-stage data collection process results in a sample such that each *sponsor - project* pair has at least one *non-sponsor – segment/project* pair from the same industry and the country. Since I compare the cash flow volatility between the sponsor and the project with that of the non-sponsor and segment/project, volatilities need be measured in the same year. Matching by year is also important because firms' cash flow volatilities might change over time.

[9] As proposed by Scharfstein and Stein (2000), due to divisional rent seeking and inefficient investment by the manager, multi-segment non-sponsor firm may cross-subsidize poor performing projects by using the cash flows of the better performing ones. This may increase the overall cash flow volatility of the firm. On the other hand, Campa and Kedia (1999) find that conglomerates sell at a discount before they implement diversification strategy, implying that diversification does not destroy firm value and hence, may not increase the cash flow volatility of the firm. Thus comparing cash flow volatilities of sponsor and multi-segment non-sponsor firms does not create any systematic bias in my tests. I also include single-segment non-sponsor firms in the sample, whose cash flow volatilities are not susceptible to this sort of influence.

[10] I also match the project and the proxy and the non-sponsor with the sponsor at the two-digit SIC level and the results are quantitatively similar.

Therefore, I match each sponsor–project with non-sponsor – segment/project by project initiation year.

After obtaining data on other firm characteristics, the sample consists of 631 firm-year observations of 240 US and 200 Non-US sponsors with 577 projects during the period from 1990 to 2008. There are 285 multi-segment and 155 single segment sponsors in the sample (see Appendix A2 for details). About 52 percent of the projects (305) are originated in the US and 272 projects are originated outside the US. The non-sponsor sample includes approximately 20,000 firm-year observations of 4,016 US and non-US firms. Total number of firm-year observations varies for different samples and volatility measures. The largest sample is obtained when cash flow volatility measure is used and consists of 19,797 firm-year observations for non-sponsors.

Table 1 provides a snapshot of top 25 US and non-US sponsors and the number of projects undertaken by them. Approximately 32 percent of sponsors are from South America and 12 percent of them are from the US. Most of these top 25 sponsors are large diversified companies in their respective countries and operate in many market segments. These sponsors have invested in about 42 percent of 577 projects. All sponsors in my sample (not reported in the table) come from 36 different two-digit SIC industry categories, however, approximately 48 percent of them are from power, transportation, oil and gas, and leisure and property industries.

Table 2 shows the distribution of projects over time in two-digit SIC industries. There is a significant increase in project finance activities in recent years, especially from 2001 to 2005. The sample excludes many deals from the year 2007 and 2008 due to the unavailability of financial and accounting information from Compustat and DataStream databases. Most of the projects are from electric and electronics, energy, telecommunication and chemicals industries.

However, project finance activities have extended over a wide variety of industries in the recent years. Table 1 and 2 taken together suggest that the number of projects in my sample is concentrated among a few sponsor firms; sponsors and projects are mostly concentrated in a few industries and there is a time trend in project finance investment. Industry clustering suggests that industry characteristics can influence the firm's choice of financing structure.[11] Firm level clustering raises the possibility of self selection of sponsors who invest in project finance, which I explore in Section 6. In brief, these statistics demand that firm, industry and year effects need to be addressed in subsequent multivariate tests.

Table 3 provides further evidence that sponsors rely extensively on external borrowings for the projects. The debt to asset ratio for an average project is 79.76 percent, which is consistent with Esty and Sesia (2007). There are 88 cases of 100 percent debt financed deals in the sample which are mostly in power, oil and gas, petrochemical and telecommunication sectors. The average number of sponsors in a typical project is 1.11 suggests highly concentrated equity ownership. There is a wide variation in project costs in the sample. The average project cost is $998.49 million with a standard deviation of $2,204.89 million.[12] Panel B presents the statistics on the types of financing used by a project. Syndicated bank loan is the most prevalent source of project financing; 81.46 percent of the projects have raised money through bank loans. The average amount for a syndicated loan is $644.45 million with a standard deviation of $1,653.91 million.[13] The next predominant source of financing is sponsors' equity; sponsors have provided an average amount of 259.84 million for 72.44 percent of the projects in the

[11] Theoretical, descriptive and empirical literature suggest that project finance in used in industries with high free cash flow and in countries with lower investors' protections (Subramanian, Tung, and Wang, 2009); firms use project finance structure for highly risky, capital intensive, high cash flow generating investments with relatively low control benefit (Shah and Thakor, 1986; Chemmanur and John, 1996, Esty and Sesia, 2007).

[12] The project cost does not reflect sponsors' total investment in the projects since there can be multiple sponsors for a project.

[13] The summary statistics on syndicated loans are based on 564 project deals, since for 13 projects, the project cost is less than the loan amount,

sample. Though very few projects have raised funds through subordinated bonds, the average amount ($508.48 million) exceeds that of equity financing.[14]

4.2 Variables Measuring Volatility Difference and Correlation

The main variable in this study is the volatility differences between the sponsor and the project or the non-sponsor and its segment. First, I construct two measures of volatility - *cash flow volatility* and *sales volatility*, where cash flow is defined as operating income before depreciation.[15] I normalize both cash flow and sales by total asset and calculate volatility as the standard deviation of the cash flows / sales for the five years preceding the project initiation year. If a project is originated in a different country than the sponsor's, it is difficult to find a segment of the non-sponsor located in the project country. In this case, I multiply cash flow/sales volatility of the non-sponsor's segment by the ratio of stock return volatility in the project country and the sponsor country. For example, if a US sponsor invests in a project outside the US, I multiply the cash flow/sales volatility of the US segment by ($\sigma_{\text{project country}}/\sigma_{\text{sponsor country}}$), where σ is the stock return volatility of the respective countries. The stock market return volatility of a country should roughly reflect the volatility of the returns of the firm in that country.[16] Following Edmans, et. al., (2010), I use daily total return index data from Datastream. I use a price index when total return index is unavailable. Next I calculate yearly returns and convert these returns in US dollar at the average exchange rate of the year. I use return data of five years preceeding project initiation year to compute the stock return volatility of the market.

---

[14] Public bonds are a growing source of financing for project deals; however, I have few public bonds in my sample as these are mostly issued by governments.

[15] Following Schaefer and Strebulaev (2004), Leland (2007) estimates asset volatility from equity volatility for firms with investment grade debt and uses it as an approximation for cash flow volatility. I measure cash flow volatility directly for sponsor and non-sponsor firms. Further, the correlation between cash flow and sales volatility (not reported in the paper) is 0.51 and significant, which suggests that sales volatility can be used as an alternative measure.

[16] If stock market data at the industry level were available, more precise measure could have been ($\sigma_{\text{Industry, project country}}/\sigma_{\text{Industry, sponsor country}}$), where σ represents the volatility of stock return in the respective industries of project and sponsor countries.

Next, I calculate volatility differences as follows. For a sponsor, volatility difference is the absolute value of the difference in the standard deviation between the sponsor and proxy project. For a non- sponsor, volatility difference is measured as the absolute value of the difference in the standard deviation of the non- sponsor and its segment(s). In addition, I use two *rank* measures of cash flow and sales volatility, where volatility difference is divided in quartiles with 1 and 4 representing the lowest and the highest volatility difference, respectively. Rank measure is more appropriate when volatility tends to have extreme values; such is the case for cash flow volatility in my sample.

I also define two binary variables - *similar volatility* and *different volatility* – that measure how similar or different the volatilities of the sponsor and its project or the non-sponsor and its segment/project are. *Similar volatility* equals 1 if the rank of volatility difference is either 2 or 3 and *different volatility* takes a value of 1 if the rank of volatility difference is either 1 or 4.

Next, I calculate the correlation of cash flows between the sponsor and the project by using the cash flow for five years preceding the project initiation year. Then I create a *correlation* dummy which takes a value of 1(0) if the correlation of the observation is higher (lower) than the median correlation value of the sample. I also use an alternative measure where *correlation* dummy equals 1 if the sponsor and the project are from the same industry defined at the three-digit SIC level. I follow the similar procedure to calculate the correlation of cash flows between the non-sponsor and its segment/project.

Table 4 presents the distribution of volatility differences and correlation measures for the sponsor and the project and the non-sponsor and the segment pairs. Non-sponsors' statistics are based on only multi-segment firms, since there is no volatility difference between single segment non-sponsor and its project. Panel A shows that cash flow volatility of the project is higher than

that of the sponsor for most of the observations in the sample. Only about one-third of the sponsors have higher cash flow volatilities than their projects. On the other hand, sales volatility of each sponsor is greater than the project's. Findings are similar for non-sponsors and their segments. In Panel B, I use the binary measure of correlation which takes a value of 1/0 (high/low) if the sponsor and the project are from the same (different) industry. Similar measure is used for the non-sponsor and its segment. Approximately three - fourth of the sponsors in the sample have a low correlation with the project. However, almost all the non-sponsors (92.29 percent) have segments from a different industry. The observed frequency of low correlation between the non-sponsor and its segment is consistent with the notion that multi-segment firms derive diversification benefit from low correlation.

The interaction of correlation and volatility difference between the sponsor and the project is another interest variable in this paper. Panel C provides observed frequency and the percentage of sponsors and non-sponsors in each interaction category. In low correlation × similar volatility category, more than sixty percent of non-sponsors invest in segments/projects with similar cash flow volatility. Compared to that, only 39.04 percent sponsors invest in projects with similar volatility. This finding is consistent with the hypothesis that project finance is less likely when the cash flow volatility of a project is similar to that of the sponsor and there is a low correlation between sponsor and project cash flows. In high correlation × different volatility category, most of the sponsors (57.89 percent) as well as non-sponsors (89.75 percent) in the sample invest in projects/segments which have different cash flow volatilities. The similar pattern of this interaction for sponsors and non-sponsors is not consistent with the hypothesis that firms choose project finance when correlation is higher and volatility difference is greater. I explore this issue further in the multivariate analysis section.

4.3 Other Variables

To control for other possible determinants of project finance, I use several firm-level control variables. Firm size, project size, and leverage capture the extent to which the firm needs to raise external capital. I measure *Firm Size* of sponsors and non-sponsor by the natural log of the book value of the total assets. *Project Size* is the natural log of project's initial cost for a sponsor and the natural log of the book value of the segment's assets for a non-sponsor, respectively. *Leverage* equals the book value of long-term debt plus debt in current liabilities divided by the book value of debt and market value of common equity. Unlike the non-sponsor, the observed leverage level of the sponsor firm might be understated since the sponsor is able to keep the project off-balance sheet. I construct a weighted average leverage of the sponsor and the project weighted by their total assets to reflect the combined debt level of the sponsor and the project if the project were internally financed.[17]

Project finance structure can mitigate potential agency problem between management and shareholders when project are large, tangible and have high free cash flows; can solve hold-up problems among sponsors through joint ownership; and can reduce the opportunity cost of underinvestment by creating projects with low growth options (Esty, 2003). Leland's (2007) model also derives the result under no agency cost between shareholders and managers, information symmetry and no operational synergies through asset substitution. Following Lehn and Paulsen (1989), I calculate *Free Cash Flow* by subtracting interest expense, taxes, preferred and common dividends from operating income before depreciation scaled by total assets. I measure hold-up problem by *Research & Development* (R&D) scaled by total assets. I set R&D value to zero if the firm does not report R&D expenditures. I use *Market to Book* as a proxy for

[17] Since a project is usually 80 to 90 percent debt financed, calculating leverage in this manner overestimates the leverage for the sponsor. In reality, a firm does not issue such a high level of debt. Nonetheless, it demonstrates that a firm can increase its debt capacity by investing in project finance.

growth options, which is calculated as the book value of debt plus market value of common equity divided by total assets. To control the effect of diversification (*Diversified)* on project finance choice, I calculate sales-based Herfindahl Index calculated as the sum of the squared market share of each firm in its three -digit SIC code industry. Alternatively, I construct a binary variable that takes a value of 1 if the firm operates in more than one business segments.

Shah and Thakor (1986) suggests that a firm finances its risky ventures through project finance to minimize the signaling cost; the empirical literature on spinoffs (Krishnaswami and Subramaniam, 1999) also finds that firms with higher information asymmetry spin off to disseminate information in the market. I construct two measures to proxy for information asymmetry. First, I calculate *Intangibility* as one minus property, plant, equipment (PPE) plus inventory scaled by total asset. Intangibility is positively correlated with information asymmetry. The second measure is *capital intensity* which is computed as capital expenditure scaled by total assets and decreases with information asymmetry.

5. Determinants of Project Finance

5.1 Univariate Analysis

I hypothesize that volatility difference between the firm and project cash flows affect the choice of project finance. In Table 5, I present univariate results on cash flow/sale volatility, correlation of cash flows and other firm characteristics for sponsors and non-sponsors. Non-sponsors include both single and multi-segment firms. The sponsor consists of about 3 percent of the total sample. Panel A reports the differences in cash flow/sales volatilities between sponsor and project and non-sponsor and segment pairs. The mean/median difference in cash flow volatility between a sponsor and the project (0.54/ 0.09) is significantly greater than that between

a non-sponsor and its segment (0.12 / 0.02).[18] The pattern is similar for sales volatility difference measure. The mean /median correlation of cash flows between the sponsor and the project (0.34/0.25) is also significantly higher than that between the non-sponsor and its segment (0.22/0.18). These findings are consistent with the hypothesis that the volatility difference between the sponsor and the project is significantly higher compared to that between the non-sponsor and its segment.

Panel B further divides sponsors and non-sponsors into US and non-US subsamples and examines if there is a difference between them in other firm characteristics. Firm characteristics variables are winsorized at 2 percent and 98 percent. I conduct t-tests to determine whether the mean (median) values across different sub-samples are statistically similar. The findings for US samples are described here. The mean/median cash flow volatility of sponsors (0.07/0.03) is significantly lower than that of non-sponsors (0.14/0.06). Taken together with cash flow volatility difference statistics in Panel A suggests that sponsors tend to choose projects with higher cash flow volatilities. On the other hand, sales volatility of sponsors is significantly higher than that of the non-sponsors. Sponsors are, on an average, larger in size; their projects are bigger than the segments of non-sponsors; they have higher leverage and free cash flows.[19] Sponsors have significantly lower R & D expenditure, higher tangibility compared to non-sponsors. Mean (median) market to book values show that sponsors have less growth opportunities. Finally, sponsors are more likely to be diversified than non-sponsors. The findings are qualitatively similar for non-US subsample except for sales volatility, the mean of which is significantly lower for sponsors (0.15) at 10 percent level. Also, the mean of R & D expenditure

[18] Cash flow volatility of a few *proxy project* firms is extremely high, which affects mean calculation. I do not drop these observations; instead I use a rank measure of volatility difference in multivariate analyses that takes care of the outliers.

[19] Leverage of the sponsors is the weighted average leverage calculated as described in Section 4.3.

loses its significance in this subsample owing to the fact that a significant proportion of R&D is reported as zero. Overall, the differences in the means and medians for sponsors and non-sponsors are statistically significant for almost all the firm level variables for both US and non-US subsamples suggesting that sponsors have different firm characteristics than non-sponsors.

5. 2 Multivariate Analysis

Univariate results in Section 5.1 provides some evidence that there are differences in volatilities, correlation and other characteristics across sponsor and non-sponsor firms. In this section, I conduct multivariate analyses modeling the probability of project finance. First, I conduct a firm level analysis on various subsamples of sponsor and project pairs within and outside the US. Next, I analyze how industry characteristics affect the choice of project finance. Then I model the probability of project finance for two subsamples of firms where extreme differences persist in firm and project volatilities as well as in the correlation between firm and project cash flows. The regressions include country dummies and robust standard errors clustered at either firm or industry level, when appropriate.

5.2.1 Volatility difference as a determinant of project finance: firm level analysis

I use a logistic regression to analyze whether the volatility difference between the firm and the project affects the probability of project finance. I construct a matched pair sample of *case and control* firms matched by industry at the three-digit SIC level and project initiation year. Each pair is grouped in a stratum and at least one firm in each stratum is a sponsor (*case*) firm. Given that sponsors comprise a very small fraction of the total sample (approximately 3 percent), using a matched pair produces more efficient estimate of the parameters compared to the full sample of firms (Manski and McFadden, 1981). Besides, since sponsors are clustered in some specific industries and project finance is more prevalent in recent

years, modeling the cluster produces more efficient estimates than using clustering correction for industry and year.

Matching approach using a small sample of cases demands conditional (limited information maximum likelihood approach) logistic regression estimation. The asymptotic results of the conditional logistic model for stratified data rely on the number of strata rather than the total number of observations in the sample.[20] Case-control matching allows me to study firm level differences in determining project finance choice, implicitly controlling for industry and year. The matching approach treats the matching variables as nuisance variables, and their effects are 'integrated out' and not estimated. This approach, just like the conditional differences in differences approach, allows the identification of the effects of the independent variables but it does not allow estimating the effects of the matching variables. For example, I will be able to identify the effect of the volatility difference on the probability of project finance but I will not be able to estimate the effect of industry on the choice of project finance. I use the following conditional logistic regression model.

$$Project\ Finance\ Dummy_{ij} = b_1 Volatility\ Difference_{ij} + b_2 Correlation_{ij} + b_3 Firm's\ CFVolatility_{ij} + b_4 FirmSize_{ij} + b_5 ProjectSize_{ij} + b_6 Leverage_{ij} + b_7 FCF_{ij} + b_8 Diversified_{ij} + b_9 R\&D_{ij} + b_{10} Intangibility_{ij} + b_{11} MarketBook_{ij} + e,$$

$$where,\ j(SIC\text{-}year\ stratum) = 1, 2, 3\ldots.$$

Table 6 estimates the effect of volatility difference between the firm and the project on the probability of project finance for US firms. Sponsors and non-sponsors are either single or multi -segment firms. The sample is further divided into the sponsors who invested in US

[20] Though I started with a large number of US and non-US sponsors and non-sponsors, the sample size reduces significantly when I match the sponsor with non-sponsor firms at the three-digit SIC level. The effective sample size varies from 213 to 78 strata for different subsamples, a size much lower than what is often used in corporate finance papers.

originated projects and those who invested in non-US projects. The results using a rank measure of volatility differences are presented in the table. The findings are also robust to the use of continuous measure of volatilities. I include the control variables described in Section 4.3 as well as project country dummies, whenever appropriate. The statistical significance is based on robust standard errors clustered at the firm level.

Leland (2007) shows that project finance is more likely when the magnitudes of the differences in cash flow volatilities of the project and firm are higher. Volatility difference creates negative financial synergies due to limited liability effect and provides incentive for the firm to separate its project. In column one, the coefficient on *difference in CF volatility* is positive (1.120) and significant at the 1 percent level for US sponsors who invested in projects within the US. A 10 percentage point increase in the volatility difference corresponds to 11.85 percent increase in the odds of project finance investment by the US sponsors in the US.[21] These findings are consistent with the hypothesis that higher volatility difference between the firm and the project/segment increases the probability of choosing project finance. The coefficient of correlation between cash flows of the firm and the project/segment is also positive (2.947) and significant suggesting that higher correlation between the firm and project/segment reduces diversification benefit from corporate finance and increases the probability of project finance. In column (1), a 10 percent increase in the correlation of cash flows increases the odds of project finance by 34.27 percent. Consistent with Leland (2007) and Flannery, et. al. (1993), these findings suggest that if project's cash flow volatility is much higher or lower than that of the

[21] Odds is calculated as prob(Project Finance)/(1-prob(Project Finance)) = $e^{X\beta}$, where X is the vector of explanatory variables and β is the vector of logistic regression coefficients. Ceteris paribus, increasing the cash flow volatility difference by 10 percentage points increases odds for column (1) by $e^{1.120\times0.10}$ = 1.1185 or 11.85%.

firm, keeping the project separate hedges the firm against uncertain outcome and/or mitigates asset substitution problem, especially when diversification benefit is not that high.

Among other variables in column one, the effects of firm size (0.550) and project size (1.312) on the probability of project finance are significant at 1 percent level. These results imply that the larger the firm, and the greater the investment required by the project, the more likely it is to be separated from the firm. Since the leverage of a non-sponsor reflects the combined leverage of its segments, to have an equivalent comparison, I calculate a weighted average leverage for the sponsor. It is calculated as the sum of the average market leverage of the sponsor and the project weighted by their total assets. The effect of leverage is positive (0.918) and significant. It suggests that firms with high debt levels are likely to choose project finance.[22] The coefficient estimate of free cash flow is significant and negative (0.60) for column one suggesting that the higher the firm's free cash flow, the lower is the probability of project finance. This finding is inconsistent with the view that project finance is a preferred mechanism to address the agency cost of free cash flow. Intangibility coefficient is positive (0.037) and significant at 5 percent level in column one. This finding supports the notion that US firms with high information asymmetry are likely to choose project finance to minimize the signaling cost to the lender or disseminate information in the market (Shah and Thakor, 1986; Krishnaswami and Subramaniam, 1999).

Column five to eight report the estimations for US sponsors who invested in projects outside the US. Country factor can affect the cash flow/sales volatility of a project for this subsample. To mitigate this problem, I use a single segment firm in the project industry and country to proxy a non-US originated project and use project country dummies in the regression. Similarly, to

[22] I also use un-weighted market leverage as an alternative measure. The estimate is qualitatively similar but not statistically significant for US sponsors with US projects.

account for the country effect in the volatility measure for a non-sponsor, I multiply the cash flow/sales volatility at the segment level by ($\sigma_{\text{project country}}/\sigma_{\text{US}}$), where σ measures the stock return volatility in the project country and in the US. These adjusted volatilities are used to calculate volatility differences from column five to eight.

Similar to the findings for the sponsors who invested in US projects only, the coefficient on *difference in CF volatility* is positive (1.849) and significant at 1 percent level in column five. The odds of project finance increases by 20.30 percent for a 10 percentage point increase in *difference in CF volatility*. The comparison of the odds between column one and five implies that a 10 percent increase in the volatility difference increases the probability of project investment outside the US more than within the US. The coefficient on *correlation of CF* is also positive (2.836) and significant at 1 percent level. The sign and significance for other control variables are similar to those for US sponsors who invested in projects within the US.

Then I repeat the analysis using sales volatility difference measure; results are presented in column (3), (4), (7) and (8). In column three, the coefficient on *difference in sales volatility* is positive (1.001) and significant at 1 percent level. This implies that for a 10 percent increase in the difference of sales volatility, the odds of investing in project finance increases by 10.53 percent. The results are consistent with the findings using cash flow volatility measure and suggest that the higher the difference in sales volatility between the firm and its project/segment, the higher is the likelihood of project finance. Using sales volatility difference does not qualitatively alter any of the key results.

Next, I extend the analysis on the determinants of project finance for the subsample of non-US firms and explore if the result holds. As before, if a project is originated outside the sponsor's country, the proxy project is selected from the project country. Similarly, cash flow/ sales

volatility of non-sponsor's segment is multiplied by the ratio of stock return volatility in the project country and the sponsor country. Both single and multi- segment firms are included in the regression. The estimation results are presented in Table 7. As predicted, the higher is the volatility difference between the firm and the project, the higher is the probability of project finance. The coefficient on *difference in CF volatility* is positive and significant at 5 percent level for both non-US (0.118) and total sample (0.343) in column one and three, respectively. The odds of project finance increases by 1.18 percent (non-US) and 3.49 percent (All) for a 10 percent increase in the volatility difference. Though consistent with the hypothesis, these odds are much lower than the odds of US sample (13.39 percent) in column two. Lower odds could be attributed to two factors. First, non-US financial data from Datastream database are noisier. Second, adjusting cash flow/sales volatility by country factor and using country fixed effect do not adequately capture country level heterogeneity in the data. Similar to Table 6, the coefficients on correlation of cash flows, firm size, project size and leverage remain positive and statistically significant in each subsample and for sales volatility measure.

5.2.2 Industry level analysis of the determinants of project finance

As described in section 4.1, 48 percent of the sponsor firms are from power, transportation, oil and gas, and leisure and property industries. In this section, I investigate the characteristics that distinguish sponsor industries from non-sponsor industries.

In the industry-level analysis, the sample is a pooled time series where industry-year represents a single observation. The dependent variable equals 1 if at least one firm in the industry invests in project finance (sponsor industry), zero otherwise. Unobserved heterogeneity is always a potential problem in pooled time series, especially in this sample where each industry contributes to multiple observations that are not independent from each other. Either fixed effect

(industry specific errors are fixed over time) or random effect (industry specific errors vary randomly over time) models are used to address the issue of unobserved heterogeneity. Fixed effect model needs variance in both dependent and independent variables to distinguish these variables from the fixed effects (Judge et al., 1985). Some industries repeatedly invest in many projects over the period while others do not invest in project finance at all, in other words, there is not enough variance in dependent variable within each industry. Therefore, a random effect model is more appropriate for this sample.

Besides industry, the heterogeneity at the country level can affect the estimate in this pooled time series. For example, project finance is more prevalent form of organization structure in countries with higher risk and weaker investor protection (Subramanian, Tung, and Wang, 2009). However, handling the unobserved heterogeneity at the country, industry and time dimensions requires three- way random effect estimation (Gibbons and Hedeker, 1997). To mitigate the inherent complexity in the data, I run the analysis only on the subsamples of sponsors who have invested in projects in their home countries, model random effect for industry and use country and year fixed effects.

The industry characteristics variables are median values calculated at the three-digit SIC level.[23] In each year, I calculate median cash flow/sales volatility difference for each sponsor and non-sponsor industry. Project size is the natural log of industry median value of the project's initial cost for a sponsor and the natural log of industry median book value of segment's assets for a non-sponsor industry, respectively. Leverage for a sponsor industry is calculated as the sum of the median debt of the sponsor and the project weighted by their median total assets. Leverage for a non- sponsor industry is the median value of its debt scaled by total asset.

[23] I repeat the analysis using mean values and find similar results.

Table 8 reports the estimation results of the regressors on the probability of project finance. The first column reports the coefficients of the industry level regression for 2,160 industries in the US. The coefficient on cash flow volatility difference is positive (1.109) and significant at 1 percent level, which suggests that the difference in cash flow volatility between the median firm and the median project is significantly higher in sponsor industries.[24] The coefficient on correlation of cash flow is positive (0.946) and significant at 1 percent level. This finding implies that higher cash flow correlation between the median firm and the median project in an industry is positively related with the likelihood of project finance and is consistent with firm level analysis in Section 5.2.1.

Among the control variables, the effects of industry size (0.554) and project size (1.313) are positive and significant suggesting that median firm in sponsor industry is larger than median firm in non-sponsor industry and median project of a sponsor industry is larger than the median segment of a non-sponsor industry. The coefficient on leverage is positive (0.816) and significant at 1 percent and consistent with the notion that project finance is one way to mitigate the underinvestment problem of high leverage (John and John, 1991; Flannery, et. al., 1993). The effect of free cash flow is positive (0.063) and significant at 5 percent and consistent with Subramanian, Tung and Wang (2009) which, in a cross-country sample, finds that the industries with high free cash flows are the ones likely to be engaged in project finance. This result on free cash flow is opposite to the findings in the firm level analysis in Table 6 which suggests that US sponsors have lower free cash flows compared to US non-sponsors. Finally, the higher the capital intensity of the median firm in an industry (0.039), the higher is the likelihood of project finance.

[24] I also repeat the analysis for rank measure of volatility difference. The results are quantitatively similar.

Second column presents the results for non-US subsample. Coefficient on cash flow volatility difference is positive (0.638) and significant at 1 percent level. In addition, the comparison between column one and two suggests that the effect of cash flow volatility difference is weaker in the case of non-US subsample (coefficient =0.638) than US subsample (coefficient = 1.109). This implies that for a 10 percent increase in cash flow volatility difference between the median firm and the median project in an industry, the odds of project finance increase by 11.73 percent for US and 6.59 percent for non-US industries, respectively. Signs and statistical significance of other coefficients for non-US subsample are similar to those for US subsample. The key results do not change for the full sample either. The results are qualitatively similar for sales volatility difference measure as well. These findings imply that irrespective of the country, the magnitude of volatility difference between the median firm and the median project in sponsor industries is higher compared to that in non-sponsor industries and is also consistent with firm level analysis.

In brief, the findings from Table 6 and 7 are consistent with the hypothesis that the probability of project finance is higher when there is a high volatility difference between the firm and project cash flows. Furthermore, industry level analysis in Table 8 shows that sponsor industries are significantly different from non-sponsor industries in terms of size, leverage, free cash flow and capital intensity, consistent with the notion than industry structure affects the choice of financing.

5.2.3 Interacting volatility and correlation: firm level analysis

The results thus far consistently indicate that for a given correlation between firm and project cash flows, the magnitude of cash flow/sales volatility difference between the sponsor and project is higher compared to that between the non-sponsor and its segment. In this

subsection, I explore two scenarios. First, I examine the effect of correlation on the probability of project finance if cash flow/sales volatility between the firm and the project is *low* and *similar*. Next, I investigate the effect of correlation on the probability of project finance if cash flow/sales volatility between the firm and the project is *different*.

A. Similar (low) volatility × correlation of cash flows between firm and project

Low and similar cash flow volatility between the firm and the project implies that they have similar risk level and therefore, the 'walk-away' option is less valuable to the sponsor (Leland, 2007). Since the loss from limited liability effect is minimal if the assets are combined, there is a low incentive for the firm to keep its project separate. In addition to that, as the correlation between the firm and project cash flows decreases, combining assets increases financial synergies through the leverage effect. Thus, when the cash flow volatility of the firm and the project is low and similar, the likelihood of project finance decreases as correlation between firm and project cash flows decreases.

The primary explanatory variable in this conditional logistic regression is an interaction term – *low* and s*imilar volatility* × c*orrelation.* It is constructed as follows. First I divide firms and projects/segments in the sample in volatility quartiles. Each firm and each project/segment is assigned a rank from 1(lowest) to 4(highest). *Low* and s*imilar volatility* equals one if both the sponsor and the project in the pair rank either 1 or 2. Similar procedure is followed for non-sponsor and segment pairs. *Correlation* is a continuous variable that measures the correlation of cash flows/ sales between sponsor and project and non-sponsor and segments using cash flows for five years preceding the project initiation year. All analyses are conducted on the firm level.

The estimation results are reported in Table 9. As expected, the probability of project finance is positively related to correlation of cash flows given cash flow volatility between the firm and

the project is similar. In column one, the coefficient of *similar volatility × correlation* is positive (0.673) and significant at 1 percent level for the US sample. It implies that the probability of project finance decreases with a decrease in correlation of cash flows. Since the coefficient of an interaction term in a non-linear model does not fully capture the interaction effect, it is rather useful to interpret the result of the interaction in terms of odds ratio (Ai and Norton, 2003). For example, when similar volatility equals one, decreasing cash flow correlation by 10 percent reduces the probability of project finance by 9.13 percent.[25] Other coefficients in column one indicate that large US firms (coefficient = 0.528) have higher tendency to choose project finance; larger projects (coefficient = 0.800) are more likely to be project financed and firms with higher leverage (coefficient = 0.609) are more likely to engage in project finance. Further, the coefficient on free cash flow (-0.067) is significantly negative, implying that firms with higher cash flows have a lower likelihood of project finance. The findings are qualitatively similar for sales volatility measure.

Column two reports the results for non-US firms. With similar volatilities between the sponsor and the project, the odds for project finance decreases by 6.56 percent for a 10 percent decrease in the correlation between firm and project cash flows. The weaker odds may be the result of a noisier volatility measure for non-US sample. In general, the findings are similar except that coefficient of free cash flow loses its significance, possibly due to a smaller subsample. Findings for the full sample are qualitatively similar to that of the US and non-US subsamples.

[25] Using the coefficient estimates in column one, when similar volatility equals 1, the odds ratio is $[1- e^{(0.285)(-0.10)+(0.673)(-0.10)}] = 0.0913$, which corresponds to a 9.13 percent decrease in the odds of project finance for a 10 percent decline in the correlation between firm and project cash flows.

B. Different volatility × high correlation of cash flows between firm and project

If the project's cash flow volatility is different than the firm's, separating the project hedges the firm against uncertain outcome and allow it to raise debt optimally for both entities (Leland, 2007). Volatility difference also creates financing distortions and asset substitution for the combined entity (John and John, 1991; Flannery, et.al, 1993) and provides incentives for the firm to separate its project. Further, correlation among the cash flow from the firm and the project is negatively related to the diversification benefit of a combined entity. Since high volatility difference increases limited liability effect and high correlation reduces leverage effect, the probability of observing project finance should be the highest in the subsample of firms with *different* volatility and *high* correlation.

The primary explanatory variable in this model is *different volatility × high correlation*, an interaction between two binary variables. It is constructed as follows. *Different volatility* equals one if the volatility difference between the firm and the project are in the highest or lowest volatility difference quartile and *high correlation* equals one if the correlation between the firm and project cash flows is higher than the median correlation value of the sample. Thus *different volatility × high correlation* equals one when *different volatility* = 1 and *high correlation* = 1.

The estimation results are reported in Table 10. The effect of *different volatility × high correlation on* the probability of project finance is positive for US subsample (0.218) in column one and full sample (0.213) in column three. For a change from low to high correlation, the odds of project finance increases by 35.12 percent for US subsample and 36.07 percent for full sample. These findings are consistent with the hypothesis that the probability of project finance is the highest in the subsample of firms with *different volatility × high correlation*. However, the results are significant only at 10 percent level. Though the asymptotic results of the conditional

logistic model rely on the number of strata, asymmetric sample of response variable affects the power of the test. For example, there are only 88 project finance observations (Table 4: Panel C) in *different volatility* × *high correlation* subsample compared to 19,797 observations for the entire sample. It implies a conditional probability of only 0.44 percent (88/19,797) of observing a project finance choice in column three. The coefficient is not significant for non-US subsample since it has fewer than 40 observations (not reported in the paper). The results for the main explanatory variable and control variables are quantitatively similar for sales volatility measure.

Overall, multivariate analyses in this section provide strong evidence that the volatility difference between the firm and the project is positively related to the probability of project finance and are also consistent with Leland (2007). A similar relation is also established in an industry level analysis. Furthermore, high correlation between firm and project cash flows and different volatility between the firm and the project provides the strongest incentive for project finance. When the volatility between the firm and the project is similar, the probability of project finance is sensitive and positively related to the correlation of firm and project cash flows. Next section, I show that the findings are robust to various proxies for projects, alternate specification of the conditional logistic model as well as to the self selection issues related to the firm's project finance decision.

6. Alternative Specification, Subsample Tests and Robustness Checks

6.1 Different Proxies, Various Measures of Volatility and Subsample Tests

As a first robustness check, I examine whether the results are sensitive to the way I construct the sample of proxy projects. If there are multiple proxy projects for a single project, I create multiple observations of volatility differences between the sponsor and the project. Since

this measure could overstate the number of observations for sponsor and project pairs, I define other measures. First, I take the average cash flow volatility of all matches and use it as a single observation. Second, if there are multiple matches, I keep the proxy project whose size is the closest to project cost (the indicator for project size). I repeat the tests with redefined proxies and the results are quantitatively similar to those from Table 6 to Table 10.

Second, I explore whether the results might be due to the way I calculate volatility difference for non-sponsors. In the main tests, I include both single and multi-segment non-sponsors. By construction, the volatility of the segment of a single-segment firm is its own volatility and therefore, volatility difference between the non-sponsor and its segment is understated. Alternatively, I use industry adjusted median cash flow volatility at three-digit SIC level to proxy for the volatility of the segment for a single segment non-sponsor firm. The results are qualitatively similar. I also repeat the multivariate analysis on the subsample of multi segment non-sponsor firms to mitigate the sample construction issue discussed here. The results are reported in Table 11: Panel A. The basic results remain qualitatively unchanged.

Then, I explore the cases where multiple sponsors invest in a single project. To illustrate the issue, suppose, a petro chemical project has two sponsors – a petrochemical company and a bank. The cash flow/ sales volatility difference between the bank and the project is likely to be higher than that between the petrochemical firm and the project. However, it is not clear whether the inclusion of projects with multiple sponsors strengthens or weakens the result. I exclude the projects with multiple sponsors and repeat the test on the subsamples of US and non-US firms. The results are presented in Table 11: Panel B and are consistent with the hypothesis that for any given correlation, the cash flow volatility difference between the sponsor and the project increases the likelihood of project finance.

In the main test, I exclude sponsors who trade in foreign stock exchanges for two reasons. First, firms that cross list differ in their ex ante characteristics and ex post behaviors compared to the firms that are traded only on a single exchange. Second, firms also differ depending on where they cross-list. For example, Pagano, et. al. (2002) finds that European firms that are cross listed in the US are larger, have recently become public, use equity as a means to rapid expansion and expand their foreign sales after listing and are usually from the technology sector. On the other hand, firms that are listed in more than one European exchanges increase their leverage right after listing, however, they do not expand rapidly. Rapid expansion may affect the sales volatility of the cross listed firms and generate some bias due to the lack of appropriate match between sponsor and non-sponsor firms. However, as robustness, I include the firms that are traded in foreign stock exchange and the repeat the tests for US and non-US subsamples in Table 11: Panel C. The results are not qualitatively different from that of Table 7.

Findings from industry level analysis in Table 10 suggest that industries with high capital intensity have higher probabilities of project finance. Similarly one may argue that firms that undertake project finance are systematically different in capital intensity or other firm characteristics from the firms that do corporate finance. In other words, there might be some unobserved heterogeneity at the firm level. To investigate this, I construct a sample of sponsor and non-sponsor firms matched on tangibility (net PPE) within each industry. Projects and their proxies are also matched on the same variable. Then I repeat the tests on the US subsample with projects within the US. The results are presented in Table 11: Panel D and are qualitatively similar to those in Table 6, 7 and 8.

To address the concerns related to off-balance sheet accounting, in 2003 the Financial Accounting Standards Board (FASB) issued FIN 46, which requires firms to consolidate special

purpose entities if they are primary beneficiaries of these entities. Zhang (2009) finds that S&P 500 firms that previously used special purpose entities to meet certain financial reporting objectives responded to FIN 46 by reducing book leverage or investment in special purpose entities. It implies that FIN 46 is also likely to reduce investment in project finance and book leverage of the sponsors. The impact of FIN 46 can only weaken my result due to a smaller sample of sponsor firms if firms decrease their investments in project finance after 2003. The consolidation of leverage also does not bias my result since I have used sponsor-project weighted leverage for the entire sample period from 1999 to 2008 for all my tests. As additional robustness, I repeat the tests on the sample of US sponsors from 1999 to 2003 and the results are quantitatively similar to Table 7. I also obtain information from the footnote of 10K filings about US sponsors that have consolidated the projects in their balance sheet and repeat the tests by excluding those firms. The results are reported in Table 11: Panel E and indicate that the difference of cash flow/sale volatility between the firm and the project is positively related to the likelihood of project finance.

Finally, I repeat the tests on the identical number of observations of cash flow and sales volatility, presented in Table 11: Panel F and find evidence supporting the hypothesis that the probability of project finance increases in the volatility difference between the firm and project cash flows.

6.2 Alternative Econometric Specification: Firm Level Analysis

In this section, I investigate whether the positive relations between the difference in cash flow/sale volatility and the choice of project finance are robust to different econometric specification. First, I repeat the tests in Table 6, 7, 9 and 10 using linear probability models. Next, I run a firm level random effects logistic regression on a pooled panel using the sample as

in Table 7. The dependent variable equals one if the firm is a sponsor, i.e., invests in project finance.

I use linear probability model because it explicitly models firm and industry fixed effects which are integrated out in the conditional logistics model. Moreover, the interpretation of interaction variables used in Table 9 and 10 are straight forward in a linear probability model. Though using a linear probability speciation on non-linear model is not desirable because the predicted values fall outside the zero/one range, here I am primarily interested in the sign and significance level of the coefficients. To correct for the heteroscedasticity in the error terms, I follow two-stage linear probability model, as suggested by Goldberger (1964). The results are presented in table 12. The findings are statistically significant and qualitatively similar to those in Tables 6, 7, 9 and 10.

Next, I repeat the tests on US and non-US subsamples and the entire sample using random effect model for the following two reasons. First reason is similar to the one discussed in section 5.2.2. Second, fixed-effects models typically produce biased estimates of the fixed effects when the time period is relatively short, T <10 (Heckman, 1981). Though my sample period extends over a period of 18 years, some of the firms have fewer than 10 observations because they are merged with other firms or did not survive or firm data are not available.

The nature of the project finance data is such that there could be unobserved heterogeneity at the country, industry and firm level and as such requires three- level random effect estimation, even without modeling time dimension (Gibbons and Hedeker, 1997). I model industry and firm effects as random effects and use year and country fixed effects.[26] Table 13 reports the estimation results of the regressors on the probability of project finance. Overall findings

[26] This approximate solution has little advantage over the traditional logistic regression (Gibbons and Hedeker, 1997), therefore, I use this model only as a robustness check.

suggest that the probability of project finance is higher when there is a high volatility between firm and project cash flows, as predicted in Hypothesis one. The comparison among column one and two also suggests that the effect of cash flow volatility difference is stronger for US subsample (coefficient = 0.949) than for non-US subsample (coefficient =0.583). It implies that for a 10 percent increase in cash flow volatility difference, odds of project finance increases by 9.95 percent for US and 6.00 percent for non-US sample, respectively. The coefficient on correlation of cash flow is positive and significant for both subsamples. The results are significant and qualitatively similar for the full sample and also for sales volatility difference measure.

6.3 Panel Data Selection Model: Firm Level Analysis

Industry level analysis shows that industry characteristics affect the probability of project finance. The industry which usually finances through project finance, institutional arrangements and the experience to set up a project is already available to the firms in that industry. Therefore, firms operating in these industries may not be randomly selected. For example, a firm in oil drilling or pipeline industry might self-select to engage in project finance because it is easier (lower transaction cost) to finance new activities this way compared to a firm in an industry with a low probability of project finance. This type of endogeneity arising from self selection creates a bias to the estimate.[27] Hence I run a random effect selection model on pooled panel data. Section 5.2.2 describes the reasons for using a random effect model. Though simulation is the natural candidate to integrate out the random effect from a selection model, Wooldridge (1995) proposes a two stage procedure. In the first stage, I run cross-sectional probit models separately for each year and generate inverse mills ratio and other coefficient estimates.

[27] Conditional logistic model used in the main test is the only parametric approach that overcomes the bias if the appropriate matching is used (Heckman, 1998).

Second stage is a fixed effect liner regression as $y_{it} = a_i + X_{it}^{'}\beta + \rho\,\hat{\lambda}_{it} + v_{it}$ and forms the basis for estimation of β and ρ.

The selection model in the first stage analyzes how industries self-select into project finance (PF) industries. The dependent variable in the selection equation is PF *Industry Dummy* that equals 1 if at least one firm in the three-digit SIC industry has invested in project finance, and zero otherwise. The independent variables are *median* values for industry minus firm characteristics variables. I estimate the second stage using OLS regressions only on the sub-samples of industries that have selected themselves to be in PF industries. The dependent variable is *PF Firm Dummy* that takes a value of one if a firm invests in project finance. The independent variables are difference in cash flow volatility, correlation of cash flows and other firm characteristics. The findings are reported in Table 14. The coefficient on *difference in cash flow volatility* is positive (1.123) and significant for US sample in column two and in other subsamples (column four and five) after controlling for selection bias.

7. Conclusion

This research adds to the growing body of literature that examines the determinants of optimal organizational structure. The existing literature examines how operational and financial synergies determine the scope of the firm. This paper contributes to the recent trend of studies that tries to explain the existence of various innovative financial contracts, such as project finance, in light of traditional theories.

The unique feature of this analysis is that I am able to circumvent two major difficulties of the empirical research on project finance, namely the inability to observe project cash flows and the unobservability of the projects of the non-sponsors. My findings provide strong evidence that the higher the difference in the cash flow (sales) volatility of the firm and the project, the

higher is the likelihood of project finance and is consistent with Leland (2007). The probability of project finance increases in correlation between the firm and project cash flows when the cash flow (sales) volatility of the project is *low* and *similar* to that of the firm. Furthermore, the likelihood of project finance is the highest when the correlation between sponsor and project cash flows is *high* and the risk of the project is *different* from the risk of the sponsor. In addition to that, industry characteristics influence the choice between project finance and corporate finance. The findings are robust to different definitions of project cash flows and volatility measures. The results are also robust to alternate econometric specification of the model and potential self section bias.

References:

Ai, C., and Edward C. Norton, 2003, Interaction Terms in Logit and Probit Models, *Economic Letters* 80, 123-129.

Berkovitch, E., and E. Han Kim, 1990, Financial Contracting and Leveraged Induced over- and under-Investment Incentives, *Journal of Finance* 65, 765–794.

Byoun, S., J. Kim, and S. S. Yoo, 2010, Leverage and Risk: Evidence from Project-Specific Capital Structure, *Working Paper*, Baylor University, San Diego State University and Belmont University.

Campa, J. M., and S. Kedia, 2002, Explaining the Diversification Discount, *Journal of Finance* 57, 1731–1762.

Chemmanur, T. J., and K. John, 1996, Optimal Incorporation, Structure of Debt Contracts, and Limited-Recourse Project Financing, *Journal of Financial Intermediation* 5, 372-408.

Corielli, F., S. Gatti, and A. Steffanoni , 2008, Risk Shifting through Nonfinancial Contracts, Effects on Loan Spreads and Capital Structure of Project Finance Deals, *Working Paper*, Bocconi University.

Goldberger, A.S., 1964, Econometric Theory, *John Wiley and Sons*, New York, NY.

Eckbo, B. E., and K. S. Thorburn, 2008, Corporate Restructuring: Breakups and LBOs, *Working Paper*, Dartmouth College.

Edmans, A., D Garciá, and Ø., Norli, 2010, Sports Sentiment and Stock Returns, Forthcoming at *Journal of Finance*.

Esty, B. C., 2004, Why Study Large Projects? An Introduction to Research on Project Finance, *European Financial Management* 10, 213-224.

Esty, B. C., 2003, The Economic Motivations for Using Project Finance, *Working Paper*, Harvard University.

Esty, B. C., and Aldo Sesia, Jr., 2007, An Overview of Project Finance and Infrastructure Finance - 2006 update, *Harvard Business School Teaching Note*.

Esty, B.C., and W. L. Megginson, 2003, Creditor Rights, Enforcement, and Debt Ownership Structure: Evidence from the Global Syndicated Loan Market, *Journal of Financial and Quantitative Analysis* 38, 37-59.

Faure-Grimaud, A., and R. Inderst, 2004, Conglomerate Entrenchment under Optimal Financial Contracting, *American Economic Review* 95, 850–861.

Finnerty, J. D., 1996, Project Financing: Asset-Based Financial Engineering, *John Wiley and Sons*, New York, NY.

Flannery, Mark, Joel Houston, and S. Venkataraman, 1993, Financing Multiple Investment Projects, *Financial Management* 22, 161–172.

Galai, D., and R. W. Masulis, 1976, The Option Pricing Model and the Risk Factor of Stock, *Journal of Financial Economics* 3, 53-81.

Gatti, S., S. Kleimeier, W. L. Megginson and A. Steffanoni, 2008, Arranger Certification in Project Finance, *Working Paper*, University of Oklahoma.

Gibbons R. D., and D. Hedeker, 1997, Random Effects Probit and Logistic Regression Models for Three-Level Data, *Biometrics*, Vol. 53, 1927-1537.

Heckman, J. J., 1981, The Incidental Parameters Problem and the Problem of Initial Conditions in Estimating a Discrete Time-discrete Data Stochastic Process, in C. F. Manski and D. McFadden, (eds), *Structural Analysis of Discrete Data with Econometric Applications*, MIT Press, Cambridge, MA.

Inderst, R., and H. Müller, 2003, Internal vs. External Financing: An Optimal Contracting Approach, *Journal of Finance* 58, 1033–1062.

Jensen M., and W. Meckling, 1976, Theory of the Firm: Managerial Behavior, Agency costs and Ownership Structure, *Journal of Financial Economics* 3, 305-360.

John, T. A., 1993, Optimality of Spinoffs and Allocation of Debt, *Journal of Financial and Quantitative Analysis* 28, 139–160.

John, T. A., and K. John, 1991, Optimality of Project Financing: Theory and Empirical Implications in Finance and Accounting, *Review of Quantitative Finance and Accounting* 1, 51-74.

Judge G. G., W. E. Griffiths, R. C. Hill, and T.C. Lee, 1985, The Theory and Practice of Econometrics, (2nd ed.), John Wiley & Sons, New York, NY.

Kensinger, J. W. and J. D. Martin, 1988, Project Finance: Raising money the Old-Fashioned Way, *Journal of Applied Corporate Finance* 1, 69-81.

Kleimeier, S., and R. Versteeg, 2010, Project Finance as a Driver of Economic Growth in Low-income Countries, *Review of Financial Economics* 19, 49-59.

Kleimeier, S., and W. L. Megginson, 2001, An Empirical Analysis of Limited Recourse Project Finance, *Working Paper*.

Krishnaswami, S., and V. Subramaniam, 1999, Information Asymmetry, Valuation, and the Corporate Spin–off, *Journal of Financial Economics* 53, 73–112.

Lehn, K., and A. Poulsen, 1989, Free Cash Flow and Stockholder Gains in Going Private Transactions, *Journal of Finance* 44, 771-789.

Leland, H. E., 2007, Financial Synergies and the Optimal Scope of the Firm: Implications for Mergers, Spin-Offs and Structured Finance, *Journal of Finance* 62, 765-807.

Lewellen, W., 1971, A Pure Financial Rationale for the Conglomerate Merger, *Journal of Finance* 26, 521-537.

Manski, C., and McFadden, D., 1981, Alternative Estimators and Sample designs for Discrete Choice Analysis, in C. Manski and D. McFadden, (eds.), *Structural Analysis of Discrete data with Econometric Applications*, MIT Press, Cambridge, MA.

Pagano, M., A. Roell, and J. Zechner, 2002, The Geography of Equity Listing: Why do Companies List Abroad?, *Journal of Finance* 6, 2651- 2694.

Powers, W., 2002, Report of Investigation by the Special Investigative Committee of the Board of Directors of Enron Corp., retrieved from
http://www.enron.com/corp/por/pdfs/PowersReport.pdf.

Rajan, R., H. Servaes, and L. Zingales, 2000, The Cost of Diversity: The Diversification Discount and Inefficient Investment, *Journal of Finance* 55, 35–80.

Rhodes-Kropf, M., and D. Robinson, 2004, The Market for Mergers and the Boundaries of the Firm, *Working Paper*, Columbia University.

Sarig, O. H., 1985, On Mergers, Divestments and Options: A Note, *Journal of Financial and Quantitative Analysis* 20, 385-389.

Sawant, R. J., 2009, The Economics of Large Scale Infrastructure Project Finance: An Empirical Examination, *Journal of International Business Studies* 41, 1036-1055.

Schaefer, S., and I. Strebulaev, 2004, Structural Models of Credit Risk are Useful: Evidence from Hedge Ratios on Corporate Bonds, *Working Paper*, London Business School.

Scott, James H., Jr., 1977, On the Theory of Conglomerate Mergers, *Journal of Finance* 32, 1235-1250.

Shah, S., and Thakor, A. V., 1987, Optimal Capital Structure and Project Financing, *Journal of Economic Theory* 42, 207-243.

Scharfstein , D. S., and J. C. Stein, 2000, The Dark Side of Internal Capital Markets: Divisional Rent-Seeking and Inefficient Investment, *Journal of Finance* 55, 2537-2564.

Subramanian, K, F. Tung, and X. Wang, 2009, Law and Project Finance, *Working Paper*, Emory University.

Wooldridge, J., 1995, Selection Corrections for Panel Data Models under Conditional Mean Independence Assumptions, *Journal of Econometrics* 68, 115-132.

Zhang, J. L., 2008, Economic Consequences of Recognizing Off-balance Sheet Activities, *Working Paper*, University of Washington, Seattle, WA.

Appendix A1

Distribution of Projects with Multiple Sponsors

	Projects	
# of Sponsors	US	Non-US
1	245	213
2	46	41
More than 2	14	18
Total	**305**	**272**

Distribution of Sponsors with Multiple Projects

	# of Sponsor firms	
# of Projects	US	Non-US
21	0	1
18	1	0
17	0	1
15	1	1
14	0	1
10	0	2
9	0	4
8	0	2
7	1	3
6	0	5
5	0	2
4	10	12
3	21	24
2	67	45
1	139	97
Total	**240**	**200**

Appendix A2

Sample Construction Steps for Sponsor Firms and Projects

	US sample		Non-US sample	
	# Sponsors	# Projects	# Sponsors	# Projects
Initial sample of sponsor firms and projects from GPF database (1990-2008)	1,014	988	5,536	4,134
Less:				
Private sponsors and sponsors traded in foreign exchanges	198	147	1,538	857
Cancelled/conventionally financed, rumored/pipeline, defaulted projects	52	79	834	640
Recently announced but non operational projects and projects not having limited/non-recourse feature as described in project synopses	78	73	462	594
Project with data inconsistencies	53	63	186	209
Total sponsor firms and projects from GPF database	633	626	2,516	1,834
Less:				
Sponsor- project pair without proxy projects	221	209	967	1,015
Sponsor- project pair without firm characteristics data	53	28	629	244
Sponsor – project pair without a non-sponsor -segment pair (with firm characteristics data)	119	84	720	303
Final sample of sponsor firms and projects	**240**	**305**	**200**	**272**

Segment Distribution of Sponsors and non-Sponsor Firms

	Sponsor		Non-Sponsor	
	US	Non-US	US	Non-US
Single Segment	84	71	869	1,235
Multi-Segment	156	129	998	914
Total	**240**	**200**	**1,867**	**2,149**

Table 1: Top 25 Project Sponsors by Country and Industry

Table 1 provides the sample distribution top 25 of 440 US and Non –US public sponsors by their countries and industries. Last column presents the number of projects in the sample undertaken by them. There are total 577 projects during the sample period from 1990 to 2008.

	Project Sponsor(s)	Country of the Sponsor	Industry of the Sponsor	# of Projects
1	Petroleo Brasileiro SA	Brazil	Power	21
2	AES Corp	USA	Power	18
3	Marubeni Corp	Japan	Power	17
4	Calpine Corp	USA	Power	15
5	Mitsui & Co Ltd	Japan	Petrochemicals	15
6	Mitsubishi Corp	Japan	Power	14
7	Babcock & Brown Ltd	Australia	Leisure & Property	10
8	Acciona SA	Spain	Power	10
9	Sumitomo Corp	Japan	Power	9
10	Fomento de Construcciones	Spain	Leisure & Property	9
11	Tenaga Nasional Bhd	Malaysia	Power	9
12	Vinci SA	France	Leisure & Property	9
13	SABIC	Saudi Arabia	Petrochemicals	8
14	Empresas ICA SAB de CV	Mexico	Water & Sewerage	8
15	OAO Gazprom	Russian Fed	Oil & Gas	7
16	Bouygues SA	France	Leisure & Property	7
17	Jarvis PLC	UK	Leisure & Property	7
18	Enron Corp	USA	Oil & Gas	7
19	ITOCHU Corp	Japan	Industry	6
20	Cia Vale do Rio Doce SA	Brazil	Industry	6
21	Obrascon Huarte Lain SA	Spain	Transportation	6
22	Bilfinger Berger AG	Germany	Transportation	6
23	Dragados y Construcciones SA	Spain	Transportation	6
24	Sacyr Vallehermoso SA	Spain	Transportation	5
25	Total SA	France	Oil & Gas	5

Table 2: Distribution of Projects by Industry and by Year

Table 2 provides the distribution of projects by two-digit SIC code industries over the range of the sample period from 1990 to 2008. The sample comprises 577 projects undertaken by 440 US and non-US sponsors. Percentage column is the percentage of all projects that belongs to a two-digit industry classification.

2-Digit SIC	Industry	1990-1995	1996-2000	2001-2005	2006	2007-2008	Total	Percentage
49	Electric, Gas, and Sanitary Services	39	93	124	19	11	286	49.57%
29	Petroleum Refining	11	23	26	6	1	67	11.61%
13	Oil and Gas Extraction	0	14	23	3	4	44	7.63%
48	Telecommunication	13	16	2	0	0	31	5.37%
28	Chemicals and Allied Products	3	8	8	2	4	25	4.33%
36	Electronic and Other Electrical Equipment	10	10	1	0	1	22	3.81%
51	Wholesale Trade-non-durable Goods	7	10	2	0	0	19	3.29%
10	Metal Mining	0	2	8	1	2	13	2.25%
33	Primary Metal Industries	0	1	7	1	1	10	1.73%
12	Coal Mining	0	0	8	0	0	8	1.39%
35	Industrial and Commercial Machinery	4	3	1	0	0	8	1.39%
63	Insurance Carriers	2	0	3	0	0	5	0.87%
40	Railroad transportation	0	0	0	4	0	4	0.69%
45	Transportation by Air	1	2	0	0	1	4	0.69%
73	Business Services	0	1	3	0	0	4	0.69%
99	Nonclassifiable Establishments	0	0	4	0	0	4	0.69%
16	Heavy Construction other than Building	0	0	2	0	1	3	0.52%
20	Food and Kindred Products	1	2	0	0	0	3	0.52%
38	Search and Navigation Equipment	3	0	0	0	0	3	0.52%
79	Amusement and Recreation Services	0	2	1	0	0	3	0.52%
87	Engineering Services	0	0	3	0	0	3	0.52%
37	Transportation Equipment	0	2	0	0	0	2	0.35%
42	Motor Freight Transportation	0	0	2	0	0	2	0.35%
46	Pipelines, Except Natural Gas	0	1	1	0	0	2	0.35%
50	Wholesale Trade - Durable Goods	0	0	1	0	1	2	0.35%
	Total	94	190	230	36	27	577	100.00%

Table 3: Descriptive Statistics on Projects during 1990 -2008

The sample consists of 577 US and non-US project deals during the sample period from 1990 to 2008. Panel A provides summery statistics on project characteristics. Variable definitions are taken from SDC database. Project Cost is the overall cost of a project. Equity Ratio is the percentage of total capitalization that is equity. Debt ratio is the percentage of debt in total capitalization. A Sponsor is a firm who has a direct interest in the project such as a contractor, supplier, purchaser or user of the project's output or facilities or has an indirect interest. Panel B describes the financing structure of the project deals in the sample. Sponsor Equity is the total amount of project funding, obtained through equity contributed by the sponsor(s). Subordinated Equity is the total amount of funding obtained through an equity subordinated loan to finance the project. Standby Equity is the total amount of project funding obtained through a standby equity facility. Syndicated Loan is the total amount of project funding obtained through a syndicated loan -a credit facility made available by a group of banks (syndicate) in pre-defined proportions under the same facility. Subordinated Debt is the total amount of funding raised through a subordinated loan to finance the project. Subordinated Bond is the total amount of project funding obtained through a subordinated bond/note issue. A subordinated bond is junior in claim on assets to other debt. Supplier Credit is the total amount of project funding through a supplier credit. A supplier credit is a financing agreement between buyer and supplier under which the latter agrees to accept deferred payment terms from the buyer and funds itself by discounting or selling the buyer's bills or promissory notes with a bank in its own country. Percentage of the sample is the percentage of different types of financing observed in the sample of 577 projects.

Panel A: Project Characteristics for the Overall Sample

	Mean	Median	Std. Dev	Min	Max	Sample Size
Project Cost (Million $)	998.49	395.00	2,204.89	1.50	26,000.00	577
Equity Ratio (%)	20.24	20.00	18.39	0.00	74.00	577
Debt Ratio (%)	79.76	80.00	19.00	0.40	100.00	577
# of Sponsors	1.11	1.00	0.40	1.00	5.00	577

Panel B: Project Financing for the Overall Sample

(Million $)	Mean	Median	Std. Dev	Min	Max	% of the sample
Sponsors' Equity	259.84	132.53	1,319.47	0.00	26,000.00	72.44%
Standby Equity	69.71	30.00	81.88	4.84	200.00	0.87%
Subordinated Equity	161.50	161.50	115.26	80.00	243.00	0.35%
Syndicated Loan	644.45	200.00	1,653.91	0.00	20,000.00	81.46%
Subordinated Debt	122.92	101.31	126.05	6.60	399.63	1.39%
Subordinated Bond	508.48	316.96	541.62	100.00	1,300.00	0.69%
Supplier Credit	161.25	152.50	107.11	40.00	300.00	0.69%

Table 4: Distribution of Volatility and Correlation Measures

This table reports the distribution of volatility difference and correlation of cash flows between the sponsor and the proxy project and the non-sponsor and the segment from 1990 to 2008. The sample consists of 631 firm year observations for sponsor & proxy project pair and 13,406 firm year observations for multi segment non-sponsor & segment pair. Cash flow (sales) volatility difference is the absolute value of the difference in the standard deviation of cash flows (sales) between the sponsor (non-sponsor) and proxy project (segment). Correlation is a dummy which takes a value of 1/0 (high/low) if the sponsor and the project or the non-sponsor and the segment are from the same (different) industry. Cash flow volatility difference is divided in quartiles as 1 being the lowest and 4 being the highest volatility quartile, respectively. Similar Volatility takes a value of 1 if the volatility difference falls in quartile 2 or 3 and Different Volatility takes a value of 1 if the volatility difference falls in quartile 1 or 4. Panel A reports the frequency and percentage of observations where volatility of the sponsor (non-sponsor) is higher than that of the project (segment). Panel B reports the frequencies and percentage of high and low correlations of cash flows between the sponsor (non-sponsor) and the proxy project (segment). Panel C shows the distribution of interaction between volatility difference and correlation of cash flows.

Panel A: Distribution of Volatility Difference

	Cash flow Volatility		Sales Volatility	
Volatility Difference	Total obs.	% of sample	Total obs.	% of sample
Sponsor > Project	631	210 33.28%	545	545 100%
Non-sponsor > Segment	13,406	4,268 31.84%	12,356	16,448 100.00%

Panel B: Distribution of Correlation of Cash Flows

	Correlation	Total obs.	% of sample
Sponsor & Project	High	631	152 24.09%
	Low		479 75.91%
Non-sponsor & Segment	High	13,406	1,034 7.71%
	Low		12,372 92.29%

Panel C: Distribution of Cash Flow Volatility Difference × Correlation

	Low Correlation × Similar Volatility		High Correlation × Different Volatility	
	Total obs.	% of sample	Total obs.	% of sample
Sponsor & Project	479	187 39.04%	152	88 57.89%
Non-sponsor & Segment	12,372	7,483 60.48%	1,034	928 89.75%

Table 5: Differences in Sponsor and Non-sponsor Characteristics

The sample consists of 631 firm-year observations for sponsors and 19,797 firm-year observations for non- sponsors within and outside the US during the period from 1990 to 2008. The sample includes both single and multi segment firms. Cash flow (sales) volatility difference is the absolute value of the difference in the standard deviation of cash flows (sales) between the sponsor and the proxy project and the non-sponsor and its segment. Correlation of cash flows between sponsor and proxy-project and non-sponsor and segment pairs is calculated using cash flows for five years preceding the project initiation year. Firm Size is the natural log of the book value of the total assets of sponsors and non-sponsors. Project Size is the natural log of project's initial cost for a sponsor and the natural log of the book value of the segment's assets for a non-sponsor, respectively. Leverage equals to the book value of long-term debt plus debt in current liabilities divided by the book value of debt and market value of common equity. Leverage of a sponsor is calculated as the sum of the average debt of the sponsor and the project weighted by their total assets. Free Cash Flow is calculated by subtracting interest expense, taxes, preferred and common dividends from operating income before depreciation scaled by total assets. Diversified is a binary variable that takes the value of 1 if the firm operates in more than one business segments. Intangibility is one minus property, plant, equipment (PPE) plus inventory scaled by total asset. Market to Book is the book value of debt plus market value of common equity divided by total assets. All variables in Panel B are winsorized at the 2nd and 98th percentiles. ***, **, and * indicate significance in the difference in means and medians between sponsors and non-sponsors at 1, 5, and 10 percent levels, respectively.

Panel A: Differences in Volatilities and Correlation

	Sponsor & Project					Non-sponsor & Segment				
	Obs. % of sample	Mean	Median	Min	Max	Obs. % of sample	Mean	Median	Min	Max
Difference in cash flow volatility	631 3.09%	0.54 ***	0.09***	0.15	1.80	19,797 96.91%	0.12	0.02	0.00	1.13
Difference in sales volatility	545 3.21%	0.16***	0.11***	0.06	1.33	16,448 96.79%	0.06	0.05	0.00	1.07
Correlation of cash flows	631 3.09%	0.34***	0.25***	0.12	0.78	19,797 96.91%	0.22	0.18	0.07	0.65

Panel B: Differences in Other Firm Characteristics

	Sponsor		US Sample	Non-Sponsor			Sponsor		Non-US Sample	Non-Sponsor		
	Obs.	Mean	Median	Obs.	Mean	Median	Obs.	Mean	Median	Obs.	Mean	Median
CF Volatility	380	0.07 **	0.03***	12,139	0.14	0.06	251	0.22***	0.12***	7,658	0.26	0.15
Sales Volatility	338	0.20***	0.13 **	9,303	0.16	0.15	207	0.15 *	0.13 *	7,145	0.16	0.14
Firm Size	380	7.66***	7.61***	12,139	5.45	5.30	251	8.05***	7.02***	7,658	4.16	4.09
Project Size	380	6.90***	5.98***	12,139	4.60	4.38	251	6.89***	6.55***	7,658	3.79	3.73
Leverage	380	0.42***	0.40***	12,139	0.18	0.14	251	0.39***	0.35***	7,658	0.18	0.15
Free Cash Flow	380	0.12 **	0.08 **	12,139	0.04	0.02	251	0.15***	0.10 **	7,658	0.11	0.08
R & D	374	0.01***	0.00	12,125	0.02	0.00	242	0.01	0.00	7,646	0.01	0.00
Intangibility	376	0.07***	0.05***	12,131	0.10	0.08	245	0.04 *	0.02	7,650	0.02	0.02
Market to Book	380	1.50 **	1.32***	12,139	1.56	1.45	248	1.32***	1.40***	7,649	1.76	1.45
Diversified	388	2.65***	2.00***	12,135	1.81	1.00	239	1.90***	1.00	7,645	1.35	1.00

Table 6: Conditional Logistic Regression Modeling the Likelihood of Project Finance by US Sponsors

This table presents estimated coefficient from conditional logistic regressions explaining the probability of project finance for US sponsors and non-sponsors during the period from1990 to 2008. The sample includes both single and multi segment firms. In each matched pair stratum, matched by industry and project announcement year, dependent variable equals 1 if a firm invests in project finance. Cash flow (sales) volatility difference is the absolute value of the difference in the standard deviation of cash flows (sales) between the sponsor and proxy project and the non-sponsor and its segment. Cash flow (sales) volatility of non-US segment is adjusted by the ratio of stock return volatility in the project country and the US. Rank measure is based on volatility difference quartiles where 1(4) is the lowest (highest) volatility quartile. Correlation dummy takes a value of (1/0) if the correlation between cash flows of the sponsor and project or the non-sponsor and its segment is higher (lower) than the median correlation value of the sample. Diversified is the sales-based Herfindahl Index calculated as the sum of the squared market share of each firm in its three -digit SIC code industry. Other variables are as described in Table 5. First four columns report the estimate for sponsors who invested in projects in the US; last four columns report the estimate for sponsors who invested in projects originated outside the US and also include project country dummies. Standard errors accounts for clustering at firm level. ***, **, and * indicate statistical significance at 1, 5, and 10% levels, respectively.

	US Sponsor - US Project				US Sponsor – Non-US Project			
Independent Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Difference in CF Volatility (Rank)	1.120***	0.949***			1.849 **	0.983 **		
Difference in Sales Volatility (Rank)			1.001***	0.843***			1.092 **	0.831 **
Correlation of CF (continuous)	2.947***		2.880***		2.836 **		2.302 **	
Correlation (1/0)		2.417***		2.275***		2.832**		2.234**
Firm Characteristics								
Firm's CF Volatility	0.297	0.402			0.253	0.345		
Firm's Sales Volatility			0.130	0.068			0.134	0.025
Firm Size	0.550***	0.649***	0.608***	0.691***	0.456***	0.457***	0.892***	0.728***
Project Size	1.312***	1.453***	1.337***	1.498***	1.763***	1.738***	1.526***	1.325***
Leverage	0.918***	0.014***	0.929***	0.025***	0.184***	0.045***	0.835***	0.028***
Free Cash Flow	-0.060***	-0.166***	-0.017***	-0.180***	-0.056 **	-0.167 **	-0.053 **	-0.234 **
Diversified	-0.004	-0.165	0.209	0.738	-0.013	-0.125	0.176	0.678
Research & Development	-1.018	-1.405	-0.033	-0.093	-1.089	-1.485	-0.738	-0.056
Intangibility	0.037***	0.226	0.198	0.311	0.019 **	0.223	0.167	0.537
Market to Book	0.000	0.000	0.025	0.001	0.145	0.027	0.045	0.023
Firm Level Clustering		Yes		Yes		Yes		Yes
Country Dummies		No		No		Yes		Yes
# Sponsors' Firm-year Obs.		235		228		145		110
# Firm-year Obs.		8,993		5,345		3,291		3,958
# of Strata		123		101		95		78
χ^2	148.86	149.10	79.79	77.19	148.86	147.98	79.77	78.34
P - Value	<.000	<.000	<.000	<.000	<.000	<.000	<.000	<.000

Table 7: Conditional Logistic Regression Modeling the Likelihood of Project Finance by All Sponsors

This table presents estimated coefficient from conditional logistic regressions explaining the probability of project finance during the period from1990 to 2008. US and non-US denote the two subsamples of firms; all represents the total sample. The sample includes both single and multi segment firms. In each matched pair stratum, matched by industry and project announcement year, dependent variable equals 1 if a firm invests in project finance. Cash flow (sales) volatility difference is the absolute value of the difference in the standard deviation of cash flows (sales) between the sponsor and proxy project and the non-sponsor and its segment. If a project is originated outside the sponsor's country, cash flow (sales) volatility of the non-sponsor's segment is adjusted by the ratio of stock return volatility in the project country and the sponsor country. Rank measure is based on volatility difference quartiles where 1(4) is the lowest (highest) volatility quartile. Correlation of cash flows between sponsor and proxy-project and non-sponsor and segment pairs is calculated using cash flows for five years preceding the project initiation year. Correlation dummy takes a value of (1/0) if the correlation between cash flows of the sponsor and project or the non-sponsor and its segment is higher (lower) than the median correlation value of the sample. Other firm level variables are as described in Table 5. Each regression includes project country dummies. Standard errors accounts for clustering at firm level. ***, **, and * indicate statistical significance at 1, 5, and 10% levels, respectively.

	Cash Flow Volatility			Sales Volatility		
Independent Variables	(1) Non-US	(2) US	(3) All	(4) Non-US	(5) US	(6) All
Volatility Difference (Rank)	0.118 **	1.257***	0.343 **	0.129 **	1.222 ***	1.289 **
Correlation of CF (continuous)	0.112 *	0.314***	0.141 **	0.102 *	0.108 **	0.134 *
Firm Characteristics						
Firm's CF Volatility	0.449	0.499	0.314			
Firm's Sales Volatility				0.111	0.103	0.115
Firm Size	1.107 **	1.103***	1.115 **	1.102***	1.208 **	1.099 **
Project Size	1.002***	1.343***	1.267***	1.004 **	1.093***	1.103***
Leverage	1.014**	1.048***	1.378***	1.011 **	1.783***	1.412***
Free Cash Flow	-0.006	-0.013***	-0.155	-0.004	-0.695***	-0.648
Diversified	-0.039	-0.096	-0.048	-0.043	0.110	0.057
Research & Development	-0.016	-0.021	-0.021	-0.012	-0.105	-0.015
Intangibility	0.003	0.061	0.197	0.002	0.414	0.014
Market to Book	0.154	0.886	0.815	1.161	0.215	0.241
Firm Level Clustering	Yes	Yes	Yes	Yes	Yes	Yes
Country Dummies	Yes	Yes	Yes	Yes	Yes	Yes
# Sponsors' Firm-year Obs.	251	380	631	207	338	545
# Firm-year Obs.	7,658	12,139	19,797	7,145	9,303	16,448
# of Strata	104	119	213	98	112	191
χ^2	243.45	368.86	412.79	219.06	353.45	480.27
P - Value	<.000	<.000	<.000	<.000	<.000	<.000

Table 8: Industry Level Analysis of the Determinants of Project Finance

This table presents estimated coefficient from random effect logistic regressions explaining the probability of project finance during the period from 1990 to 2008. The sample is a pooled time series where industry-year represents the observation and the dependent variable equals 1 if at least one firm in the industry invests in project finance, zero otherwise. US and non-US denote the two subsamples of firms; all represents the total sample. The sample includes only the projects undertaken by the sponsor in its home country. Cash flows (sales) volatility is the median value of the cash flow in the industry. Volatility difference is the absolute value of the difference between the median cash flow/sales volatility of the project finance (non-project finance) industry and the median flow/sales volatility of the proxy projects (segments) in that industry at three-digit SIC codes. Industry size is the natural log of the median book value of the total assets of the industry. Project size is the natural log of median value of the project's initial cost (book value of the segment's assets) in a project finance (non-project finance) industry. Leverage for a project finance industry is calculated as the sum of the median debt of the industry and the project weighted by their median total assets. Leverage for a non- project finance industry is the median value of its debt scaled by total asset. Diversified is the sales-based Herfindahl Index calculated as the sum of the squared market share of each firm in its three-digit SIC code industry. Capital intensity is the median value for firms' capital expenditure scaled by total assets at the three-digit SIC level. Other independent variables are median values for firms in the three-digit SIC Code industry and calculated as described in Table 5. ***, **, and * indicate statistical significance at 1, 5, and 10% levels, respectively.

	Cash Flow Volatility			Sales Volatility		
Independent Variables	(1) US	(2) Non-US	(3) All	(4) US	(5) Non-US	(6) All
Volatility Difference (continuous)	1.109***	0.638**	1.032 **	1.003***	0.542**	1.759***
Correlation of CF (continuous)	0.946***	0.416***	0.579 **	0.881***	0.265***	0.805***
Industry Characteristics						
Industry's CF Volatility	0.294	0.401	0.478			
Industry's Sales Volatility				0.145	0.067	0.157
Industry Size	0.554 *	0.643 **	0.749 **	0.635 *	0.678**	0.667**
Project Size	1.313***	1.214***	1.674***	1.342***	1.445***	1.648***
Leverage	0.816 **	0.015 **	0.012**	0.924**	0.056**	0.024**
Free Cash Flow	0.063**	0.134*	0.149**	0.012**	0.171*	0.184**
Diversified	0.003	0.168	0.300	0.210	0.734	0.577
Research & Development	-1.014	-1.403	-1.261	-0.031	-0.091	0.247
Capital Intensity	0.039 **	0.296 **	0.412 **	0.191 **	0.310 **	0.524 **
Market to Book	0.000	0.000	0.000	0.056	0.011	0.001
Intercept	6.789***	7.789***	6.930***	6.477***	7.939***	6.783***
Industry Random Effect	Yes	Yes	Yes	Yes	Yes	Yes
Country Fixed Effect	No	Yes	Yes	No	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
#Industry –year Obs.	2,160	990	3,150	2,160	990	3,150
χ^2	350.90	246.90	378.78	346.60	247.67	347.02
P - Value	<.000	<.000	<.000	<.000	<.000	<.000

Table 9: Low and similar Cash Flow/Sales Volatility, Correlation and Choice of Project Finance

This table presents estimated coefficient from conditional logistic regressions explaining the effect of the interaction of volatility difference and correlation on the probability of project finance. US and non-US denote the two subsamples of firms; all represents the total sample. Sample period is from 1990 to 2008. The sample includes both single and multi segment firms. In each matched pair stratum, matched by industry and project announcement year, dependent variable equals 1 if a firm invests in project finance. *Low and similar volatility* is a binary variable that takes a value of one if the rank of the volatility of the sponsor (non-sponsor) and project (segment) pair equals either 1 or 2. Rank measure is based on cash flow/sales volatility quartiles where 1(4) is the lowest (highest) volatility quartile. C*orrelation* measures the correlation of cash flows between sponsor and project and non-sponsor and its segment using cash flows for five years preceding the project initiation year. If a project is originated outside the sponsor's country, the cash flow of non-sponsor's segment is adjusted by the ratio of stock return volatility in the project country and the sponsor country. Other firm level variables are as described in Table 5. Standard errors accounts for clustering at firm level. ***, **, and * indicate statistical significance at 1, 5, and 10% levels, respectively.

	Cash Flow Volatility			Sales Volatility		
Independent Variables	(1) US	(2) Non-US	(3) All	(4) US	(5) Non-US	(6) All
Low and similar Volatility × Correlation	0.673***	0.578 ***	0.683***	0.739***	0.635 ***	0.638***
Correlation of Cash Flows	0.285	0.101	0.293	0.230	0.121	0.284
Firm Characteristics						
Firm's CF Volatility	0.190	0.519	0.317			
Firm's Sales Volatility				1.031	0.928	1.102
Firm Size	0.528***	0.529***	0.522***	0.533***	0.510***	0.511***
Project Size	0.800***	0.629***	1.023***	0.831***	0.645***	0.832***
Leverage	0.609***	1.023 **	1.113***	0.673***	1.190 **	1.256***
Free Cash Flow	-0.067***	-0.006	-0.034**	-0.045***	-0.003	-0.076 **
Diversified	0.836	0.738	0.709	0.812	0.453	0.610
Research & Development	-2.183**	-1.839	-1.312	-2.950	-0.920	-1.178
Intangibility	0.002	0.103	1.235	1.193	1.384	1.102
Market to Book	-0.043	-0.029	0.104	-0.109	-0.074	-0.138
Firm Level Clustering	Yes	Yes	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes	Yes	Yes
# Sponsors' Firm-year Obs.	380	251	631	338	207	545
# Firm-year Obs.	12,139	7,658	19,797	9,303	7,145	16,448
# of Strata	91	98	189	89	95	184
χ^2	365.57	241.34	413.56	351.45	216.56	454.29
P - Value	<.000	<.000	<.000	<.000	<.000	<.000

Table 10: Different Cash Flow/Sales Volatility, High Correlation and Choice of Project Finance

This table presents estimated coefficient from conditional logistic regressions explaining the effect of the interaction of volatility difference and correlation on the probability of project finance. US and non-US denote the two subsamples of firms; all represents the total sample. Sample period is from 1990 to 2008. The sample includes both single and multi segment firms. In each matched pair stratum, matched by industry and project announcement year, dependent variable equals 1 if a firm invests in project finance. *Different volatility* is a binary variable that takes a value of one if the rank of the volatility difference between the sponsor and proxy project or the non-sponsor and its segment equals either 1 or 4. Rank measure is based on cash flow/sales volatility difference quartiles where 1(4) is the lowest (highest) volatility quartile. *High correlation* equals one if the correlation of cash flows between sponsor and proxy project or non-sponsor and its segment is higher than the median correlation value of the sample. If a project is originated outside the sponsor's country, the cash flow of non-sponsor's segment is adjusted by the ratio of stock return volatility in the project country and the sponsor country. Other firm level variables are as described in Table 5. Standard errors accounts for clustering at firm level. ***, **, and * indicate statistical significance at 1, 5, and 10% levels, respectively.

	Cash Flow Volatility			Sales Volatility		
Independent Variables	(1) US	(2) Non-US	(3) All	(4) US	(5) Non-US	(6) All
Different Volatility × High Correlation	0.218 *	0.027	0.213 *	0.206 *	0.082	0.209*
Correlation of Cash Flows (dummy)	0.083	0.034	0.095	0.079	0.058	0.087
Firm Characteristics						
Firm's CF Volatility	0.176	0.167	0.187			
Firm's Sales Volatility				1.518	1.389	1.293
Firm Size	0.563***	0.489 **	0.575***	0.660***	0.438 **	0.387***
Project Size	0.967***	0.849***	0.954***	1.098***	0.830***	1.412***
Leverage	3.021***	2.138 **	3.028***	1.187 **	2.489 **	1.203 **
Free Cash Flow	-0.121 **	-0.001	-0.125 **	-0.605	-0.002	-0.482
Diversified	0.874	0.489	0.812	0.428	0.429	0.422
Research & Development	-4.923 **	-0.529	-4.845 **	0.048	-0.565	0.086
Intangibility	1.043	1.198	1.040	0.001	1.147	0.003
Market to Book	-0.035	-0.002	-0.001	-0.021	-0.000	-0.002
Firm Level Clustering	Yes	Yes	Yes	Yes	Yes	Yes
Country Dummies	Yes	Yes	Yes	Yes	Yes	Yes
# Sponsors' Firm-year Obs.	380	251	631	338	207	545
# Firm-year Obs.	12,139	7,658	19,797	9,303	7,145	16,448
# of Strata	119	104	213	112	98	191
χ^2	347.46	247.38	454.85	329.46	217.11	438.03
P - Value	<.000	<.000	<.000	<.000	<.000	<.000

Table 11: Findings from Selected Robustness Checks

This table presents estimated coefficient from conditional logistic regressions explaining the probability of project finance during the period from 1990 to 2008. Dependent variable equals 1 if a firm invests in project finance, 0 otherwise in all regressions. Panel A consists of the sub-sample of multi-segment firms; Panel B, C, D, E, and F comprise both single and multi segment firms. Again, panel D and E consist of the sub-sample of US firms while Panel A, B, C and F comprise full sample. In each matched pair stratum, dependent variable equals 1 if a firm invests in project finance. Cash flow (sales) volatility difference is the absolute value of the difference in the standard deviation of cash flows (sales) between the sponsor and proxy project and the non-sponsor and its segment. If a project is originated outside the sponsor's country, cash flow (sales) volatility of the non-sponsor's segment is adjusted by the ratio of stock return volatility in the project country and the sponsor country. Rank measure is based on volatility difference quartiles where 1(4) is the lowest (highest) volatility quartile. Correlation of cash flows between sponsor and proxy-project and non-sponsor and segment pairs is calculated using cash flows for five years preceding the project initiation year. Correlation dummy takes a value of (1/0) if the correlation between cash flows of the sponsor and project or the non-sponsor and its segment is higher (lower) than the median correlation value of the sample. In Panel D and E, Model (1), (2), (3) and (4) report the estimate for US sponsors who invested in projects originated in the US; Model (5), (6), (7) and (8) report the estimate for US sponsors who invested in projects originated outside the US. Each regression includes all other explanatory and control variables used in Table 7. (For brevity, estimated coefficients are not reported for these variables). Standard errors accounts for clustering at firm level. ***, **, and * indicate statistical significance at 1, 5, and 10% levels, respectively.

Panel A: Sub-sample of Multi-segment Sponsors and Non-Sponsors

	Cash Flow Volatility			Sales Volatility		
Independent Variables	(1) US	(2) Non-US	(3) All	(4) US	(5) Non-US	(6) All
Volatility Difference (Rank)	0.737**	0.738**	0.746**	0.489*	0.374*	0.637*
Correlation of CF (continuous)	1.478**	1.305*	1.586**	1.458*	1.395*	1.684*
# Firm-year Obs.	7,637	3,789	11,426	6,478	2,257	8,735
χ^2	235.37	169.37	392.73	210.79	145.78	398.39
P-value	<.000	<.000	<.000	<.000	<.000	<.000

Panel B: Excluding Projects with Multiple Sponsors

	(1)	(2)	(3)	(4)	(5)	(6)
Volatility Difference (Rank)	1.123***	0.948***	1.357***	1.056***	0.937***	1.378***
Correlation of CF (continuous)	1.950***	1.469***	1.527***	1.948***	1.357***	1.738***
# Firm-year Obs.	11,467	6,937	18,404	8,457	6,279	14,736
χ^2	375.48	264.43	428.48	326.89	220.39	418.30
P-value	<.000	<.000	<.000	<.000	<.000	<.000

Continued

Panel C: Including the Sponsors Traded in the Foreign Exchange

Independent Variables	Cash Flow Volatility (1) US	(2) Non-US	(3) All	Sales Volatility (4) US	(5) Non-US	(6) All
Volatility Difference (Rank)	1.257***	0.936**	1.289***	1.136***	0.992 **	1.297***
Correlation of CF (continuous)	1.326***	1.251**	1.428**	1.289***	1.041 **	1.420 **
# Firm-year Obs.	11,517	7,457	18,974	11,517	7,457	18,974
χ^2	378.82	324.82	389.18	379.12	327.38	389.21
P-value	<.000	<.000	<.000	<.000	<.000	<.000

Panel D: US Sponsor (Non-Sponsor) matched by Industry, Asset Tangibility and Project Year

	US Sponsor - US Project (1)	(2)	(3)	(4)	US Sponsor – Non-US Project (5)	(6)	(7)	(8)
Difference in CF Volatility (Rank)	1.123**	0.948**			1.378 **	0.920**		
Difference in Sales Volatility (Rank)			1.056 *	0.937 *			1.389 **	0.739 **
Correlation of CF (continuous)	1.950**		1.948**		1.390 **		1.378 **	
Correlation (1/0)		1.469**		1.357**		1.749**		1.357**
# Firm-year Obs.	8,357	8,357	5,358	5,358	7, 738	7, 738	4,578	4,578
χ^2	150.67	151.83	81.37	81.34	148.45	147.46	101.35	100.38
P-value	<.000	<.000	<.000	<.000	<.000	<.000	<.000	<.000

Panel E: Excluding US Sponsor that implemented FASB FIN46

	US Sponsor - US Project (1)	(2)	(3)	(4)	US Sponsor – Non-US Project (5)	(6)	(7)	(8)
Difference in CF Volatility (Rank)	1.062***	0.829***			1.030***	0.829***		
Difference in Sales Volatility (Rank)			1.002 ***	0.918***			1.218***	0.927***
Correlation of CF (continuous)	1.038**		1.026**		1.190 **		1.083 **	
Correlation (1/0)		1.183**		1.145**		1.262**		1.142**
# Firm-year Obs.	8,301	8,301	6,832	6,832	7, 695	7, 695	5,839	5,839
χ^2	184.48	182.39	180.37	180.23	181.20	181.69	176.29	174.79
P-value	<.000	<.000	<.000	<.000	<.000	<.000	<.000	<.000

Continued

Panel F: Using Identical Sample of Cash flow and Sales Volatility

	Cash Flow Volatility			Sales Volatility		
	(1) US	(2) Non-US	(3) All	(4) US	(5) Non-US	(6) All
Volatility Difference (Rank)	1.253***	0.219 **	1.256***	1.222 ***	0.129 **	1.289 ***
Correlation of CF (continuous)	0.117***	0.131 *	0.154 **	0.108 **	0.102 *	0.134 *
# Firm-year Obs.	9,303	7,145	16,448	9,303	7,145	16,448
χ^2	220.78	352.98	481.38	219.06	353.45	480.27
P-value	<.000	<.000	<.000	<.000	<.000	<.000

Table 12: Linear Probability Modeling the Likelihood of Project Finance

This table presents estimated coefficient from linear probability model explaining the probability of project finance during the period from 1990 to 2008. Panel A consists of the sub-sample of US firms. Panel B, C and D comprise full sample. Dependent variable equals 1 if a firm invests in project finance, 0 otherwise in all regressions. Cash flow (sales) volatility difference is the absolute value of the difference in the standard deviation of cash flows (sales) between the sponsor and proxy project and the non-sponsor and its segment. If a project is originated outside the sponsor's country, cash flow (sales) volatility of the non-sponsor's segment is adjusted by the ratio of stock return volatility in the project country and the sponsor country. Rank measure is based on volatility difference quartiles where 1(4) is the lowest (highest) volatility quartile. Correlation of cash flows between sponsor and proxy-project and non-sponsor and segment pairs is calculated using cash flows for five years preceding the project initiation year. Correlation dummy takes a value of (1/0) if the correlation between cash flows of the sponsor and project or the non-sponsor and its segment is higher (lower) than the median correlation value of the sample. *Low and similar Volatility × Correlation* is a binary variable in Panel C as described in Table 9. *Different Volatility × High Correlation* is described in Table 10. Each regression includes all other explanatory and control variables used in Table 7. (For brevity, estimated coefficients are not reported for these variables). All regression except first four columns in Panel A include country dummy. All regressions also include firm, industry, and year dummies. Standard errors accounts for clustering at firm level. ***, **, and * indicate statistical significance at 1, 5, and 10% levels, respectively.

Panel A: Modeling the Likelihood of Project Finance by US Sponsors

Independent Variables	US Sponsor - US Project				US Sponsor – Non-US Project			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Difference in CF Volatility (Rank)	0.589***	0..638***			0.739 ***	0.639***		
Difference in Sales Volatility (Rank)			0.125 **	0.173 **			0.153 **	0.163 **
Correlation of CF (continuous)	0.539**		0.362**		0.457 **		0.372 **	
Correlation (1/0)		0.352**		0.332**		0.267**		0.372**
# Firm-year Obs.	8,993	8,993	5,345	5,345	3,291	3,291	3,958	3,958
R^2	0.14	0.14	0.13	0.13	0.11	0.11	0.11	0.11
F-value	256.86	256.90	256.13	255.88	251.37	251.48	251.39	257.32

Panel B: Modeling the Likelihood of Project Finance by All Sponsors

Independent Variables	Cash Flow Volatility			Sales Volatility		
	(1) US	(2) Non-US	(3) All	(4) US	(5) Non-US	(6) All
Volatility Difference (Rank)	0.565***	0.384***	0.475***	0.520***	0.329***	0.472***
Correlation of CF (continuous)	0.739**	0.630**	0.683**	0.720**	0.516**	0.528**
# Firm-year Obs.	12,139	7,658	19,797	9,303	7,145	16,448
R^2	0.12	0.10	0.13	0.12	0.11	0.13
F-value	261.37	263.72	267.19	258.39	251.58	260.38

Continued

Panel C: Low and similar Cash Flow/Sales Volatility, Correlation and Choice of Project Finance

	Cash Flow Volatility			Sales Volatility		
Independent Variables	(1) US	(2) Non-US	(3) All	(4) US	(5) Non-US	(6) All
Low and similar Volatility × Correlation	0.186**	0.029**	0.037**	0.056**	0.041**	0.184**
Correlation of Cash Flows	0.158**	0.133**	0.153**	0.157**	0.126**	0.138**
# Firm-year Obs.	12,139	7,658	19,797	9,303	7,145	16,448
R^2	0.16	0.12	0.15	0.15	0.14	0.16
F-value	183.93	181.27	185.39	180.38	180.67	181.23

Panel D: Different Cash Flow/Sales Volatility, High Correlation and Choice of Project Finance

	(1)	(2)	(3)	(4)	(5)	(6)
Different Volatility × High Correlation	0.583***	0.457***	0.572***	0.519***	0.401***	0.510***
Correlation of Cash Flows (dummy)	0.240***	0.168***	0.193***	0.273***	0.171***	0.203***
# Firm-year Obs.	12,139	7,658	19,797	9,303	7,145	16,448
R^2	0.20	0.19	0.21	0.17	0.16	0.19
F-value	191.63	188.27	193.38	193.42	189.82	190.33

Table 13: Random Effect Logistic Regression Modeling the Likelihood of Project Finance by All Sponsors - Pooled Panel

This table presents estimated coefficient from random effect logistic regressions explaining the probability of project finance during the period from 1990 to 2008. US and non-US denote the two subsamples of firms; all represents the total sample. Sample period is from 1990 to 2008. The sample includes both single and multi segment firms. The sample is a pooled time series where firm-year represents a single observation and the dependent variable equals 1 if a firm invests in project finance, zero otherwise. Cash flow (sales) volatility difference is the absolute value of the difference in the standard deviation of cash flows (sales) between the sponsor and proxy project and the non-sponsor and its segment. If a project is originated outside the sponsor's country, cash flow (sales) volatility of the non-sponsor's segment is adjusted by the ratio of stock return volatility in the project country and the sponsor country. Correlation of cash flows between sponsor and proxy-project and non-sponsor and segment are calculated on a rolling basis by using the cash flows for past five years. Other firm level variables are as described in Table 5. Industry and firm effects are modeled as random effects; the parameters are not reported here. Each regression includes year as well as project country dummies. Standard errors accounts for clustering at firm level. ***, **, and * indicate statistical significance at 1, 5, and 10% levels, respectively.

	Cash Flow Volatility			Sales Volatility		
Independent Variables	(1) US	(2) Non-US	(3) All	(4) US	(5) Non-US	(6) All
Volatility Difference (continuous)	0.949***	0.583 **	1.324 **	0.843***	0.387 **	1.223***
Correlation of CF (continuous)	0.417***	0.213 **	0.384 **	0.275***	0.139 *	0.431***
Firm Characteristics						
Firm's CF Volatility	0.402	0.416	0.467			
Firm's Sales Volatility				0.068	0.023	0.031
Firm Size	0.649***	0.573 **	0.638 **	0.691***	0.528***	0.615***
Project Size	1.237***	1.722***	1.485***	1.478***	1.839 **	1.172***
Leverage	0.014***	0.013 **	0.037***	0.025***	0.025 **	0.025***
Free Cash Flow	-0.166***	-0.014	-0.147***	-0.180***	-0.036	-0.163***
Diversified	-0.165	-0.147	-0.124	-0.738	-0.091	-0.137
Research & Development	-1.405	-1.392	-1.834	-0.093	-1.611	-1.032 **
Intangibility	0.226	0.245	0.863	0.311	0.365	0.899 **
Market to Book	0.000	-0.106	-0.038	-0.001	-0.102	-0.097
Intercept	4.710***	4.549	6.784***	5.793***	4.683	6.686***
Firm Random Effect	Yes	Yes	Yes	Yes	Yes	Yes
Industry Random Effect	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Country Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
# Firm-year Obs.	20,428	9,993	30,421	16,993	10,638	27,631
χ^2	375.29	286.94	492.78	347.76	293.27	438.89
P - Value	<.000	<.000	<.000	<.000	<.000	<.000

Table 14: Firm Level Analysis of the Determinants of Project Finance – Panel Data Selection Model

This table presents estimated coefficient from a firm level selection model on panel data for the period from 1990 to 2008. The selection equation is a cross – sectional probit model estimated for each year separately. The dependent variable is PF Industry Dummy that takes a value of 1 if at least one firm in the industry invests in project finance, zero otherwise. The regression equation is a fixed effect linear regression estimated on a panel data. (see Wooldridge, 1995 for details). The sample for this equation is the firms in project finance industry. The dependent variable is PF Firm Dummy that takes a value of 1 if a firm invests in project finance. Cash flow (sales) volatility difference is the absolute value of the difference in the standard deviation of cash flows (sales) between the sponsor and proxy project and the non-sponsor and its segment. If a project is originated outside the sponsor's country, cash flow (sales) volatility of the non-sponsor's segment is adjusted by the ratio of stock return volatility in the project country and the sponsor country. Correlation of cash flows between sponsor and proxy-project and non-sponsor and segment are calculated on a rolling basis by using the cash flows for past five years. Project size is the natural log of project's initial cost for a sponsor and the natural log of the book value of the segment's assets for a non-sponsor, respectively. Leverage equals the book value of long-term debt plus debt in current liabilities divided by the book value of debt and market value of common equity scaled by total asset of the firm. # of Segments is a binary variable that takes the value of 1 if the firm operates in more than one business segments. Other firm level variables are calculated as described in Table 5. All industry level variables are firm level values subtracted from industry median. Industry size is the natural log of the median book value of the total assets of the industry. Leverage is calculated as the sum of the median debt of the industry weighted by its median total assets. Project size at the industry level is the natural log of median value of the project's initial cost (book value of the segment's assets) in a project finance (non-project finance) industry. Capital intensity is the median value for firms' capital expenditure scaled by total assets at the three-digit SIC level. Diversified is the sales-based Herfindahl Index calculated as the sum of the squared market share of each firm in its three-digit SIC code industry. % of PF firms is the percentage of the firms in the industry that invested in project finance at least once. Other industry level variables are median values for firms in the three-digit SIC Code industry and calculated as described in Table 5. US and non-US denote the two subsamples of industries. Only the projects undertaken in the sponsors' home countries are included in the sample. All represents the total sample. ***, **, and * indicate statistical significance at 1, 5, and 10% levels, respectively.

	US		Non -US		All	
	(1)	(2)	(3)	(4)	(5)	(6)
Independent Variables	PF Industry Dummy (1st)	PF Firm Dummy	PF Industry Dummy (1st)	PF Firm Dummy	PF Industry Dummy (1st)	PF Firm Dummy
Difference in Cash Flow Volatility		1.123**		0.948*		1.056***
Correlation of Cash Flows		1.950**		1.948**		1.471**
Firm Characteristics						
Firm Size		0.856***		0.356***		0.313
Project Size		1.386***		1.867***		1.033
Leverage		0.038		0.864		0.678
Free Cash Flow		-0.189*		-0.478		-0.098*
# of Segments		0.093		0.172		0.220
Research & Development		-0.638		-0.009		-1.040
Intangibility		-0.078		-1.829		-0.286
Market to Book		0.020		0.034		0.044

Continued

Industry Characteristics (Median-Firm)						
CF Volatility	-0.445***	-0.511**	-0.390**	-0.290**	-0.494***	-0.501***
Industry Size	3.587***	3.700***	3.395***	3.484***	3.684***	3.937***
Project/Segment Size	1.358***	1.390***	1.289***	1.314***	0.097***	0.044***
Leverage	0.132	0.196	0.396	0.301	0.971	1.040
Free Cash Flow	0.136***	-0.125***	0.084	-0.149	0.333***	-0.313***
Diversified	-0.046	0.008	0.029	0.068	-0.119	0.098
Research & Development	-0.008	-0.006	-0.018	-0.003	-0.386	-0.408
Capital Intensity	0.469**	0.123	0.467**	0.239	0.200**	0.220
Market to Book	-0.157	0.197	-0.147	0.136	-0.280	0.286
Intercept	3.012*	2.987	2.945 *	2.961	3.010 **	2.590
Firm Fixed Effect		Yes		Yes		Yes
# Firm-year Obs.	20,428	12,139	9,993	7,658	30,421	19,797