Seventeenth International Working Seminar on Production Economics

PRE-PRINTS VOLUME 2

Papers scheduled for
Wednesday, February 22, 2012
8.00 am to 21.15 pm

Edited by
Jan W. Grubbström and Hans H. Hinterhuber

CONGRESS INNSBRUCK
INNSBRUCK
AUSTRIA

February 20-24, 2012

Gassmann, O.,2006. Opening up innovation process: towards an agenda. *R&D Management*.Vol. 36,(223-228).
Gilsing, V., Nooteboom, B., 2006. Exploration and Explotation in innovation systems: the case of pharmaceutihcal biotecnology. *Research Policy* .Vol. 35, (1-23).
Hartmann, M. and Hassan, A., 2006. Application of real options analysis for pharmaceutical R&D project valuation-Empirical results from a survey. *Research Policy* Vol. 35, (343-354).
Huizingh, E., 2010; Open innovation: State of the art and future perspectives. *Technovation*, 1-8.
Kuchta, 2001. A fuzzy mode for R&D project selection with benefit: outcome and resource. *The Engineering Economist*, 46 3 (164–180).
Lazzarotti, V., Manzini F., Mari L., 2011. A model for R&D performance measurement. *Int. J. Production Economics* 134(212-223).
Licthnthaler, 2011. Open Innovation: Past Research, Current Debates and Future Directions, Academy of Management Perspective, , 75-93.
Lo Nigro G., Perrone G., S. Chiapparrone, 2011. Governance forms drivers in bio-pharmaceutical inter-firm relationships. *International Journal of Production Economics*, doi:10.1016/j.ijpe.2011.09.003.
Nicholson, S., Danzon, P. M., Mccolough, J., 2005. Biotech-Pharmaceutical Alliances as a Signal of Asset and Firm Quality. *Journal of Business*, Vol. 78, no. 4.
Powell, W. W., Koput, K. and Smith-Doerr, L.; 1996. Interorganizational Collaboration and the Locus of Innovation: Networks of Learning in Biotechnology. *Administrative Science Quarterly* 41 (1): 116–45.
Rogers, M. J. and Maranas, C. D. 2005. Valuation and design of pharmaceutical R&D licensing deals. *AIChE Journal January* Vol. 51, No. 1(198-209).
Rogers, M. J., Gupta, Maranas, C. D., 2002. Real options based analysis of optimal pharmaceutical research and development portfolios. *Ind. Eng. Chem. Res.* 41, (6607 6620).
Vanhaverbeke, W., Van de Vrand,e V., Chesbrough, H.,2008. Understanding the Advantages of Open Innovation Practices in Corporate Venturing in Terms of Real Options. . Vol. 17, (251-258).
Wang, J. and Hwang, W.L.; 2007. A fuzzy set approach for R&D portfolio selection using a real options valuation model. *Omega*, Vol. 35, Issue 3 (247-257).

The Importance of Relation-specific Investments in Capital Structure Decisions: the Case of the Biopharmaceutical Industry

Giovanna Lo Nigro and Fabio Zambuto
Department of Chemical, Management, Mechanical Engineering and Computer Science, University of Palermo, 90128, Palermo, Italy
giovanna.lonigro@unipa.it, fabio.zambuto@unipa.it.

Abstract
According to capital structure literature, bilateral relationships with key customers and suppliers have a strong impact on financing decisions, since they involve relation-specific (R-S) investments. Firm-specific assets lose most of their value in case of liquidation; thus, by adjusting their capital structure firms can reduce liquidation probability and incentive specialized investments from customers and suppliers.
In this paper we provide empirical support for these predictions by analyzing the specific influence of R&D-based strategic alliances in the biotechnology industry, where bilateral relationships are formed to advance the commercialization of innovation and asset-specificity is a primary issue. We analyze a sample of 173 independent biotech firms and we test whether they take R&D alliances into consideration when setting optimal debt level.
Our results have interesting managerial implication since they suggest that the influence of R-S investments on corporate financing policies is contingent upon partners' relative bargaining power. Biotech firms dealing with powerful incumbents restrict debt levels in order to limit transaction costs, prevent potential hold-ups and to incentive R-S investments from their partners. On the contrary, when dealing with smaller firms at a bargain advantage, leverage is less important to gain competitive advantage. Finally, we find that R&D alliances have both and immediate and a long-term effect on financing policies, at least in the biotechnology sector.

Keywords: capital structure, R-S investments, bargaining power, biotechnology industry

1. Introduction and Research Motivation

Since the seminal work of Titman (1984), a growing literature has focused on how *bilateral* relationships with customers and suppliers influence a firm's corporate financing decisions, such as capital structure. Bilateral relationships are of particular interest in capital structure literature because they usually involve relation-specific (R-S) investments from both partners and the product sold is likely to be unique. R-S investments are less redeployable than general-purpose assets and they lose most of their value in case of liquidation of one of the partnering firms. As a result, in the event of bankruptcy both contractual parties would be damaged and each firm may have concerns about the counterpart's financial health (Banerjee et al., 2008). The importance of R-S investments from customers and suppliers in capital structure determination has been extensively investigated through theoretical models (Bronars and Deere, 1991; Dasgupta and Sengupta, 1993). However, despite this issue is not new in capital structure literature, related empirical evidence is still scarce and the reason lies in the difficulty of operationalizing these concepts, since they require information that is not contained on a firm's balance sheet (Franck et al., 2010).
In this paper we contribute to these lines of research by empirically exploring the relationship between capital structure and strategic alliances (SAs) and joint-ventures (JVs) (hereafter "SAs"). Firms usually turn to SAs when the resources involved in the transaction are specific and complete contracts cannot be written. Empirical evidence suggests that firms establishing SAs may reduce leverage in order to reduce ex-ante liquidation risks and to incentive specific investments from partners (Kale and Sharur, 2007). We take this argument a step further by analyzing the specific importance of certain characteristics of SAs with respect to their influence on capital structure. We claim that this issue is still under-explored in capital structure literature and deserves more attention. The few works discussing the importance of SAs analyze them too broadly, by concentrating on multi-industry studies and without discriminating neither the types of alliance, nor their specific purposes and features. We argue

that different collaboration patterns (i.e. strategic alliances with different characteristics) may have different financial implications and that their influence could be industry-specific. Our approach suggests that, by considering alliances heterogeneity, empirical research can find additional sources of variation to study the impact of bilateral relationships on capital structure.

As an extension of previous works on customer-supplier relationships, we explore the specific influence of R&D-based SAs on capital structure decisions and we test whether firms takes these strategic drivers into consideration when setting their optimal financial policy. Capital structure literature considers R&D expenditures as a proxy for the presence of specific investments (Vicente-Lorente, 2000). Similarly, for firms engaging in R&D-based SAs with important customers and suppliers, R-S investment are extremely important and such assets may face severe losses in case of liquidation of one of the allying firms. As a result, we argue that R&D-based alliances are likely to exert a significant influence on capital structure decisions. Furthermore, we investigate whether this effect is associated with specific characteristics of the alliance - specifically the relative bargaining power between partners - in order to clarify the role of R-S investments in capital structure determination. Thus, our work also contributes to lines of research arguing for an interaction between the importance of R-S investments and firm's bargaining power vis-à-vis its customers and suppliers in capital structure determination.

We claim that SAs may possess characteristics, which might differ from one industry to another, and that their influence on capital structure could be industry-specific. In particular, we test the impact of R&D-based SAs in the context of the biotechnology industry. SAs are very popular in the biotechnology industry and they possess distinct features that have been extensively studied in alliance literature.

As in many other R&D-intensive industries experiencing important technological breakthrough, the biotechnology industry has been characterized by an increasing recourse to inter-firm relationships (IFRs) between new biotechnology ventures and established partners in the pharmaceutical and agricultural biotechnology industry. The explanation of this phenomenon is related to the extent of several complementary factors between the assets of the two types of firms. As a result, the biotechnology industry is at the core of a complex network of inter-firm relationships involving a broad range of partners and entailing disparate purposes and goals.

The rapidly changing environment and the growing number of strategic alliances has made the biopharmaceutical industry an ideal research setting to test theories of strategic management, industrial organizational and organizational economics. Alliances' and strategic partners' characteristics have been largely investigated with respect to their influence on alliances formation rates (Walker, 1997), governance forms (Lo Nigro et al. 2011) and firm-level innovative performance (Shan et al., 1994). Because these alliances are usually formed to advance the commercialization of innovation, they tend to face severe transactional inefficiencies due to the presence of R-S investments, differences in bargaining power among partners and uncertainty about governance outcomes (Bosse et al., 2010). In our view, these features make the biopharmaceutical industry an ideal setting to analyze the impact of different types of SAs on capital structure decisions.

We test our predictions on a sample of 173 publicly traded biotechnology companies. We build a unique database by combining financial data from Orbis Database with information on R&D alliances from the Securities Data Company Platinum database (SDC Platinum). Our final dataset consists of an unbalanced panel of 899 firm-year observations. We find a statistically significant relationship between R&D-based SAs and financial leverage, but this relation does depend on the typology of partners involved and on their relative bargaining power. Collaborations with established biopharmaceutical incumbents and other powerful downstream partners exert a significant negative influence on the level of debt, while

alliances with purely biotech companies or other upstream partners (such as universities and no-profit research organizations) lacking bargaining power do not seem to play a significant impact.

These findings are interesting because they suggest that bilateral relationships with customers and suppliers can be important determinants of financing decisions even for firms producing non-durable products, such as drugs or just R&D services. Consolidated empirical evidence finds such effect only for firms producing durable goods and only when dealing with customers and suppliers from durable goods industries [Banerjee, 2007]. On the contrary, our results confirm that the importance of alliances in capital structure determination can be industry-specific, and that predictions for corporate financing policy should be revisited in particular research settings, such as R&D-intensive sectors.

Finally, although our analysis is confined to the biotechnology sector and we examine specific characteristics of the industry while formulating our predictions, we believe that the arguments developed in this paper could be easily extended to other R&D-intensive industries, where radical technological breakthroughs led to an increasing recourse to strategic alliances and other inter-firm relationships.

The paper is structured as follows: section 2 develops three hypotheses formulated basing on the available literature that allow to answer to our research question; section 3 discusses the sample employed to test our hypotheses along with the dependent variable and the independent variables; section 4 describes the statistical model and section 5 concludes highlighting the main findings of our research.

2. Literature Analysis and Hypotheses Development

Ever since Modigliani and Miller (1958) formulated their famous leverage-irrelevance propositions, researchers in finance literature searched for possible determinants of capital structure decisions within the boundaries of the firms. These lines of research extensively explore the importance of taxes, bankruptcy, information asymmetry and agency costs. However, despite a lot of theoretical and empirical work has been carried out, results are far from been conclusive.

An important subsequent literature strand develops a more general framework, in which firm boundaries include implicit contracts with non-financial stakeholders (NFSs) as well as explicit contracts with traditional investors, such as shareholders and bondholders. Non-financial stakeholders can be defined as "parties that have either a direct or indirect interest in the firm's long-term viability" (Parsons and Titman, 2007). These works draw from stakeholder theory and analyze the impact of capital structure decisions on its dealings in the input/product markets. Relevant papers discuss the impact of financing strategies on the relationship between the firm and its customers, suppliers, employees and competitors and argue for a stakeholder theory of capital structure (Parsons and Titman, 2007) .

Customers buying unique products may worry about the supplier-firm's financial health, especially when these goods require after-sale services or involve specific investment from the customer. In the event of default of the supplier, these investments may lose most of their value and part of the costs associated with financial distress would be borne by customers. If customers rationally assess the firm's liquidation risk, then they anticipate these costs and require compensation in in the form of discounted prices. Alternatively, they could even reduce their trade with the firm or switch to another supplier. Capital structure is directly related to bankruptcy and it can be used by the firm as a tool to commit itself to a liquidation policy that takes into account the costs imposed on customers. As a result, for firms producing unique goods a conservative financial policy can be a source of competitive advantage (Titman, 1984).

Subsequent empirical works extend this idea by analyzing the importance of *bilateral* relationships with customers and suppliers. Unlike Titman (1984), these lines of research

analyze a setting in which supplier firms concentrate their sales on a few big customers and make investments in "dedicated assets" with the expectation of a considerable amount of trade with such firms (Joskow, 1988). These *bilateral* relationships are of particular interest in capital structure literature, since they usually involve relation-specific investments and unique products. As a consequence, when a supplier firm concentrates its sales on a few *principal* customers, it should remain less levered in order to mitigate potential liquidation costs borne by these important stakeholders and to incentive R-S investments (Banerjee et al., 2008). However, in the event of liquidation of *principal* customers also the supplier firm would face severe losses, since it is *dependent* upon such important stakeholders and its investments are undiversified. The supplier firm may prefer to remain less levered in order to mitigate indirect bankruptcy costs related to *principal* customers liquidation, and not only to incentive R-S investments. In addition, when these costs are high, the supplier firm may prefer the *principal* customer to remain less levered too. Thus, also customer firms relying on *dependent* suppliers (i.e. firms for whom purchases from that particular firm are important) should adopt conservative financing policies to foster relation-specific investments from these partners (Banerjee et al., 2008).

Most empirical works analyzing bilateral relationships and capital structure concentrate on outsourcing contracts with principal customers and dependent suppliers in durable goods industries. Banerjee et al. (2008) find evidence that firms relying on principal customers or dependent suppliers requiring/producing durable-goods tend to use less debt. Kale and Sharur (2007) find that firms tend to reduce leverage when their principal customers and suppliers heavily invest in R&D. Unfortunately, these works pay relatively little attention to the specific influence of SAs. To the best of our knowledge, the only work explicitly addressing issues relating SAs to capital structure determination is Kale and Sharur (2007). These authors consider the existence of SAs between the firm and its NFSs as a proxy for the presence of R-S investments. The empirical evidence provided confirms that firms establishing SAs reduce the level of debt carried in order to incentive R-S investments from these partners. However, the importance of R-S investments could be contingent upon certain characteristics of the alliance, which might reinforce or mitigate the influence of R-S investment on financing policies. In addition, these works overlook to consider that alliances entailing different purposes and activities may differ with respect to the importance of R-S investments and that their influence on capital structure could be industry-specific. We point out that, by considering alliances heterogeneity and by focusing on the distinctive features of SAs in particular industries (such as R&D-intensive ones), empirical research can find additional sources of variation to study the impact of bilateral relationships on capital structure.

Firms turn to SAs when there is a greater need for R-S investments (Fee et al., 2005). Moreover, customer and supplier firms that invest large sums on R&D are expected to undertake higher R-S investments (Kale and Sharur, 2007). Consistently with these results, we consider the intensity of R&D-based SAs as a proxy for the importance of R-S investments and we argue that firms collaborating on R&D projects may reduce leverage in order to reduce potential transaction costs. In particular, we investigate the importance of R&D-based SAs in the context of the biotechnology industry. In general, R&D-based SAs involving biotech firms are formed to foster the commercialization of biotechnology-based innovations and to improve new drugs development processes. As a consequence, they tend to face severe transactional inefficiencies due to the presence of R-S investments, asymmetric information among parties, uncertainty and potential hold-ups. We point out that, due to these transactional inefficiencies, biotech firms collaborating in R&D activities may prefer to adopt conservative financing policies (i) to mitigate the costs they would bear in case such collaborations broke up (bilateral perspective) and (ii) to incentive R-S investments from strategic partners. These consideration lead to our first testable hypothesis:

H1: Biotech firms with high intensities of SAs and JVs involving R&D activities choose lower financial leverage

An interesting but still under-explored line of research relates the importance of NFSs bargaining power to the presence of R-S investments. Franck et al. (2010) suggest that the influence of relation-specific investments from NFSs on capital structure could be stronger when these stakeholders have more bargaining power. Indeed, when suppliers and customers are powerful, they can easily charge the firm potential liquidation costs arising from R-S investments through input and product prices. As a result, a firm will reduce leverage in order to mitigate customers and suppliers liquidation costs especially when it is at a bargaining disadvantage.

We further develop this idea by analyzing the importance of relative bargaining power in R&D alliances formed by biotech firms and by testing its influence on their capital structure decisions. When firms establish R&D alliances, R-S investments are likely to be important. Moreover, biotech firms form strategic alliances with a broad variety of upstream and downstream partners possessing very different characteristics, strategic resources and, thus, bargaining power. We suggest that by discriminating the typology of partners involved in the alliance it is possible to account for the interaction between the importance of R-S investments and NFSs bargaining power, with respect to their influence on corporate financing decisions.

Relative bargaining power between contractual parties is extremely important in bilateral relationships involving biotechnology firms. Empirical evidence demonstrates that bargaining power has a direct effect on governance negotiations outcomes (Bosse et al., 2010), which in turn influence the ability of both partners to achieve their strategic goals in the alliance (Alvarez and Barney, 2001). Biotech firms that have more bargaining power are likely to have their interests met in negotiations, whereas firms at a bargaining disadvantage must accept the conditions dictated by the partner. Alliance literature suggests that relative bargaining power is likely to depend upon the concentration of resources provided by the partner firm relative to resources acquired by the biotech firm from other partners (Bosse et. Al, 2010). In vertical R&D alliances with downstream partners - such as established pharmaceutical, biopharmaceutical, agri-food and chemical firms - the biotech firm usually provides technical knowledge, but most of the financial resources and competencies required to complete the development of innovations are likely to be provided by the larger firm. As a result, when biotechnology firms deal with established downstream partners they negotiate at a bargaining disadvantage and they are at risk of being under compensated for disclosing their valuable knowledge (Deeds and Hill; 1996). On the contrary, as biotech firms grow, they may tend to vertically integrate later phases of the value chain in order to fully develop and commercialize their products. Just like established downstream players, vertically-integrated biotech firms may form explorative alliance with smaller upstream partners (such as universities and smaller biotech firms) in order to in-license new products and to bring them to the marketplace through their own financial resources and competencies. Thus, it is likely that when established biotech firms deal with upstream partners they are in a stronger bargaining position.

As an extension of hypothesis 1, we argue that the impact of R-S investment, as measured by the intensity of R&D-based SAs, will be contingent upon the typology of partner involved – i.e. downstream or upstream partners. We suggest that biotech firms will take into account liquidation costs imposed on R&D partners especially when dealing with established downstream firms with greater bargaining power. Established firms provide the bulk of R-S investments involved in the alliance and would suffer severe losses in case of liquidation of the counterpart. However, due to their strong bargaining position, it is easy for them to transfer these costs to the biotech firm by under-compensating it for revealing its technical knowledge. On the opposite, we would expect NFSs liquidation costs to be less important for

biotech firms dealing with smaller upstream partners with less bargaining power. These considerations lead to the following testable hypotheses:

H2: The influence of R&D-based SAs will be stronger for firms dealing with established downstream partners.

H3: The influence of R&D-based SAs will be weaker for firms dealing with smaller upstream partners.

Finally, we test whether R&D-based SAs and their characteristics have a long lasting effect on capital structure or if their influence is limited to the short term. Thus, we split each of our main hypotheses into two sub-hypotheses (*H1a, H1b, H2a, H2b, H3a, H3b*) in order to test them in the short-term (sub-hypotheses *a*) or in the long term (sub-hypothese *b*), respectively.

3. Sample, Dataset and Variables

All of the financial variables used in this study were derived from Orbis Database, a global extensive database that contains accounting, market and business information covering over 60 million companies. Our initial sample included all publicly traded biotechnology firms listed in the database that could be considered as independent firms. In order to test the latter condition we used the Orbis BvD Independence Indicator and selected only those firms that scored a value of A in such indicator - i.e. companies with known recorded shareholders none of which having more than 25% of direct or total ownership - and finally we excluded firms having a group ultimate owner. These conditions were required in order to prevent the sample from including both parent firms and their subsidiaries. This situation could skew our proxies, since we may consider the same data both at the parent firm level and at the subsidiary firm level. Following these criteria, our starting sample included 221 biotech firms and an unbalanced panel of 1645 firm-year observations spanning from 2000 to 2010. We excluded firms with empty records and firm-year observations with occasionally missing values. The final sample includes 173 firm and 899 firm-year observations.

This data source was combined with data on R&D-based SAs derived from the Securities Data Company (SDC) Platinum database, which is the industry standard for information on strategic alliance, joint-ventures, M&As and private equity investments. For each firm we considered all SAs involving R&D activities from 1997 to 2010, and for each alliance we retrieved data on the characteristics of the partners involved. This second dataset includes information on 221 R&D collaborations, which represent 65% of all SAs formed by the biotech firms included in the final sample during the span of time considered.

3.1 Dependent variable. Our dependent variable is the firm's financial leverage (*Leverage*). *Leverage* is computed by dividing the total book value of debt (long term debt plus bank loans in current liabilities) by the total book value of assets. Other studies in capital structure literature also analyze a market-based formulation of leverage (Vicente-Lorente, 2001), which considers the total market value of the firm and of equity capital. However, this formulation was not used in this study. Along with motivations related to the availability of market-based data, the main reason to consider book leverage is that it is unaffected by potential reverse causality problems with variables related to SAs. As documented by Nicholson et al. (2005), R&D SAs between biotech firms and other established players transfer positive information to financial markets. For publicly traded firms, it is likely that in the short term such events end up increasing the stock prices of the partners involved and, thus, the denominator of the dependent variable. As a result, if biotech firms reduce leverage following the formation of such alliances as predicted by hypothesis 1, the increase in stock prices may skew our inferences, since we would overstate the negative impact of R&D SAs on leverage.

3.2 Independent variables. In order to test hypothesis 1 we measure the intensity of R&D-based strategic alliances as the number of SAs involving research and development activities

formed by the biotech firm in a given period of time. The variable *RD_SAs* measures the number of alliances formed during the last year and it allows us to estimate the short-term impact of R&D-based SAs on leverage. Since this variable is our proxy for the importance of R-S investments, the underlying assumption is that firms establishing more alliances will undertake higher levels of R-S investments in conjunction with their partners. However, it is unlikely that the impact of SAs is confined to the short run. Most R&D alliances in the biotechnology industry are formed to foster the development of novel drugs and this process can require several years to be completed. R-S investments from both partners are not limited to the year of alliance formation and they are generally contingent upon the achievement of certain development milestones, such as the approval of the new compound by regulatory agencies. Moreover, some alliances may brake up after several years and R-S investments could be interrupted. As a consequence, the financing policy of a biotech firm in a given year may be influenced also by older R&D alliances. The variable *RD_SAs4* is computed as the number of R&D based strategic alliances formed during the last four years and it allows us to test whether the importance of SAs is not limited to the short term. Clearly, the choice of the correct span of time to account for the long-term impact of SAs is highly subjective. We decided to consider the number of alliances formed during the previous four years because the average expected duration of R&D alliances involving biotechnology firms is of about four years (Robinson et al., 2007).

In order to test hypotheses 2 and 3 and to operationalize the interaction between the importance of R-S investments and NFSs bargaining power we analyze the characteristics of the partners involved in the alliance. Firstly, we divide partner firms into five categories - *pharmaceutical*, *biotech*, *biopharmaceutical*, *no-profit organization (NPOs) and Other* companies – by considering their 4 digit SIC and NACE codes. *Pharmaceutical* and *biotech* firms are companies that possess only competencies in pharmaceutical preparation or in research and experimental development on biotechnology, respectively. *Biopharmaceutical* firms possess both types of competencies as they report industry codes related to both type of activities. *NPOs* include universities and other research institutions, which do not aim at making profits and that are involved in basic research activities. The category *Others* includes established players operating in the chemical, agricultural, food and beverage and medical equipment industries. Finally, on the basis of these categories we classified partners firms in *downstream* or *upstream* partners in order to distinguish their bargaining power relative to the biotech firm, as discussed in section 2. The variables *Downstream* and *Upstream* are computed as the number of R&D-based SAs signed with downstream and upstream partners respectively, during the last year. In addition, we computed the variables *Downstream4* and *Upstream4* as the number of alliances formed in the last four years with each type of partner. Much of the existing literature on strategic alliance locates biotechnology firms at the upstream pole of other consolidated industries, such as the pharmaceutical or agricultural industries (Stuart et al., 2007). Consistently with these lines of research, we consider as *downstream* partners *pharmaceutical, biopharmaceutical* and firms classified as *Others*. These partners possess consolidated businesses and they have already brought several products to final markets. Moreover, in SAs with biotech firms they usually provide financial and other complementary resources necessary to bring new biotechnologies to the marketplace, and thus, they are expected to undertake the bulk of R-S investments involved in the alliance. On the opposite, we consider purely *biotech* firms and *NPOs* as *upstream* partners. Since our units of analysis are established and publicly traded biotech firms, we expect these firms to be more vertically integrated when dealing with upstream partners. As a result, we argue that in the latter case R-S investments from alliance partners will be less important.

3.3 Control variables. Following similar studies in capital structure literature we include a

number of control variables that previous researches linked to financial leverage (Fama and French 2002; Vicente-Lorente, 2001). We control for the effect of *Size* by including the natural logarithm of total book asset. This variable is a proxy for firm's age and, in the case of the biotechnology industry, for firm's profitability. Our proxy for expected investment opportunities is the variable *Growth Opportunities*, which is computed as the annual growth in total book assets. *Depreciation* is our proxy for non-debt tax shields that may provide firms with alternative ways of reducing the amount of taxes paid and it is computed by dividing total depreciation expenses by the total book value of assets. *Tangibles* is our control for the level of assets that a firm can use as collaterals. It is computed as the ratio of all tangible assets – such as buildings, machinery, equipment, etc. - to total book assets. The variable *R&D Intensity* is the ratio of R&D expenditures to firm's total assets and is a proxy for the intensity of R&D investments and the uniqueness of the firm's products.

4. Hypotheses Test

Since our sample is an unbalanced panel of firm-year observations, our dataset has both cross-sectional and time series dimensions. The application of regression models to panel data is a more complex task than those for simple cross-section datasets. Indeed, the unobserved heterogeneity effect due to unobserved characteristics of firms will in general cause standard OLS to yield inefficient estimates and invalid standard errors. Following other empirical studies in capital structure literature (Degryse et al., 2010; Vicente-Lorente, 2001), we address this issue by adopting a fixed-effects model. In this context this approach was deemed superior to other possible solutions such as random-effect models. Random-effects models are appropriate when the sample can be viewed as a random draw from a given population. Clearly, this is not the case in our study since we analyze all independent and publicly traded firms in the biotech industry. Moreover, random-effects models are likely to be biased when the researcher fails to include in the model all variables that influence the dependent variable. Again, this assumption is not supported in our study because, although we include a set of control variables identified by prior studies, we do not include all potential determinants of capital structure. When the underlying assumptions of random effects model cannot be justified, fixed-effects estimators are most preferable. Thus, the following standard fixed-effects model was estimated:

$$y_{it} = \alpha_i + \beta x_{it} + \mu_{it} \qquad (1)$$

where y_{it} and x_{it} are the dependent variable and independent variables, respectively. The appropriateness of the fixed-effects model was tested with a not reported F-test, which rejected the null hypothesis that the intercept term is constant across firms.

Table 1 reports descriptive statistics for the dependent variable and the independent variables, along with Pearson's correlation matrix. The variables related to SAs (*R&D SAs, R&D SAs4, Upstream, Upstream 4, Downstream, Downstream4*) are not highly correlated with the control variables, but they are strongly correlated among them. These high correlations derive from the way the variables were computed, but they do not represent a serious concern in our models, since they were tested separately.

	Min	Max	Mean	Std Dev.	Assets	Int.	Tang.	Depr.	R&D Intens.	Growth	R&D SAs	R&D SAs4	Upst.	Upst.4	Downstr.	Downstr.4
Assets	2,88	5,59	4,28	0,74	1	-,05	-,01	-,29**	-,37**	,11**	,16**	,30**	,07*	,17**	,17**	,32**
Intangibles	0	0,61	0,13	0,18	-	1	-,19**	,18**	-,10**	,02	-,02	-,08**	-,01	-,07*	-,02	-,06
Tangibles	0	0,48	0,11	0,13	-	-	1	,26**	-,03	-,08*	-,03	-,07*	-,02	-,08*	-,03	-,05
Depreciation	0	0,2	0,04	0,05	-	-	-	1	,24**	-,22**	-,07*	-,09**	-,04	-,08*	-,07*	-,08*
R&D Intensity	0	1,37	0,34	0,35	-	-	-	-	1	-,25**	-,01	-,02	,01	,00	-,03	-,03
Profitability	-3	0,12	-0,65	0,79	-	-	-	-	-	,25**	,10**	,15**	,03	,08*	,11**	,17**
Growth	- 0,56	2,3	0,26	0,69	-	-	-	-	-	1	-,00	-,01	-,01	,00	,00	-,02
R&D SAs	0	5	0,10	0,41	-	-	-	-	-	-	1	,61**	,71**	,46**	,83**	,56**
R&D SAs4	0	9	0,50	1,14	-	-	-	-	-	-	-	1	,43**	,77**	,52**	,90**
Upstream	0	3	0,03	0,23	-	-	-	-	-	-	-	-	1	,54**	,22**	,25**
Upstream4	0	5	0,17	0,55	-	-	-	-	-	-	-	-	-	1	,23**	,44**
Downstream	0	2	0,07	0,29	-	-	-	-	-	-	-	-	-	-	1	,59**
Downstream4	0	5	0,32	0,77	-	-	-	-	-	-	-	-	-	-	-	1

*Table 1. Descriptive statistics and correlation matrix for the dependent variable and the independent variables. * Significant at the 10% level, ** significant at the 5% level.*

Time Effect			
Short	Long		
M1 (H1*a*)	M3 (H1*b*)	No	*Partner's bargaining Power*
M2 (H2*a*, H3*a*)	M4 (H2*b*, H3*b*)	Yes	

Table 2. Tested models characteristics and related hypotheses

Four different models were estimated in order (i) to distinguish between the short-term and the long-term impact of R&D SAs on leverage, and (ii) to account for the interaction between the presence of R-S investments and partners bargaining power (Table 2). Model 1 and Model 2 include variables related to the number of R&D SAs formed during the year of observation and they analyze whether these drivers has an immediate impact on corporate financing policies. Model 3 and Model 4 include variables measuring the number of R&D SAs formed during the last four years and they account for the influence of older alliances. Model 1 and Model 3 test the influence of R&D SAs as whole, without discriminating the typology of partners involved and their bargaining power. These specifications allow us to test the relevance of hypothesis 1 in the short-term (H1*a*) and in the long-term (H1*b*), respectively. Model 2 and Model 4 test separately the importance of alliances with downstream and upstream partners. Thus, they test hypotheses 2 and 3 in the short-term (H2*a*, H3*a*) and in the long-term (H2*b*, H3*b*), respectively.
Results from fixed-effect panel regressions are reported in Table 3.

Variables	Model 1	Model 2	Model 3	Model 4
const	0,479**	0,473**	0,486**	0,478**
Assets	-0,091*	-0,090*	-0,090*	-0,089*
Intangibles	0,021	0,021	0,026	0,03
Tangibles	0,271	0,271	0,273	0,277*
Depreciation	0,176	0,174	0,184	0,182
Growth	0	0	-0,002	-0,003
RD Intensity	0,052	0,053	0,05	0,053
RD SAs	-0,016*	-	-	-
Upstream	-	0,003	-	-
Downstream	-	-0,032**	-	-
RD SAs4	-	-	-0,023**	-
Upstream4	-	-	-	0,003
Downstream4	-	-	-	-0,044**
R^2	0,659	0,660	0,661	0,663
R^2-adjusted	0,574	0,574	0,577	0,579

*Table 3. Resulting estimates from the fixed-effect panel regressions. All variables were winsorized at the 5% and 95% percentile in order to mitigate the influence of outliers. Coefficients' standard errors are robust to the presence of heteroskedasticity and autocorrelation, through the use of HAC estimators. Notes: * Significant at the 10% level, ** significant at the 5% level.*

Hypothesis 1*a* predicts that biotech firms establishing R&D SAs will reduce leverage in order to reduce transaction costs and to incentive R-S investments. The negative and significant coefficient on the variable *RD_SAs* ($p<0,1$) in Model 1 supports this prediction and shows that R&S SAs have an immediate effect on financing policies. This effect is somewhat clearer if we take into consideration the typology of partners involved in the alliance. The negative and significant coefficient on *Downstream* ($p<0,05$) in Model 2, confirms that biotech firms tend to reduce leverage, especially when dealing with established downstream partners. On the contrary, the coefficient for the variable *Upstream* is close to zero and not statistically significant. Moreover, the coefficient on *Downstream* is greater than the coefficient on *R&D SAs*. These results suggest that most of the impact of R&D SAs comes from the presence of alliances with downstream partners and that the influence of R-S investments on corporate financing policies is strengthened when NFSs have greater bargaining power. On the opposite, when dealing with smaller upstream firms at a bargaining advantage leverage is less important. Thus, hypotheses 2*a* and 3*a* are also confirmed. Results from Model 3 and Model 4

show that the impact of R&D SAs is even stronger when considering older alliances and that relationships with NFS have a long lasting effect on corporate financing policy then also H1*b*, H2*b* and H3*b* *are confirmed* . Indeed, the coefficients on the variables *RD SAs4, Upstream4* and *Downstream4* are greater than the coefficients on their related short-term variables and statistically significant.
As far as our controls are concerned, the coefficient on the variable *Assets* is negative and significant in all four specifications. Firm's size is a proxy for the ease of access to equity markets and the maturity of the firm's business. Moreover, in our sample of biotech firms it is highly correlated with firm's profitability. Thus, this result is in line with the prediction of the famous pecking order model and it suggests that large mature biotech firms with more internal funds tend to be less levered (Myers, 1984).
The coefficient on *Tangibles* is positive but significant only in Model 4. Tangible assets are easy to collateralize and reduce debtholders' concerns about bankruptcy costs. This effect is consistent with the predictions of static trade-off models, although not particularly significant in our sample. The other controls seem not to exert a significant influence.

5. Conclusions

Capital structure literature suggests that bilateral relationships with NFSs have a strong influence on corporate financing decisions. Firms imposing higher liquidation costs on their NFSs may reduce financial leverage to mitigate transaction costs and to incentive important R-S investments. In this paper we provide compelling empirical support for the importance of R-S investments in capital structure determination by analyzing the specific influence of R&D-based SAs in the biotechnology sector.
Available empirical evidence finds that the presence of bilateral relationships with customers and supplier negatively affects leverage, but only for firms operating in durable goods industries and when customers and suppliers from durable goods industries are involved (Banerjee et al., 2008). In contrast, our study demonstrates that bilateral relationships are among the most important determinants of capital structure even for firms producing non-durable products (such as drugs or just R&D services). We also contribute to the limited empirical literature relating the presence of SAs to capital structure decisions. We investigate the role of different types of R&D SAs and demonstrate that, by considering alliances' heterogeneity, empirical research can find additional sources of variation to clarify the impact of SAs on capital structure. Our results show that biotech firms forming R&D alliances tend to reduce leverage, but only when established downstream partners are involved. These partners provide the bulk of R-S investments in the alliance and have great bargaining power. Since they can easily transfer expected liquidation costs arising from the relationship to smaller partners, biotech firms tend to adopt conservative financing policies especially when dealing with these stakeholders. Thus, our study also contributes to recent empirical works arguing for an interaction between the importance of R-S investments and partners bargaining power in capital structure determination (Franck et al., 2010). Finally, we find that R&D alliances have both an immediate and a long-term effect on financing policies, at least in the biotechnology sector. These results confirm that the importance of strategic alliances in capital structure determination can be industry-specific, and that predictions for corporate financing policy should be revisited in particular research settings, such as R&D-intensive sectors.

6. References

Titman, S., 1984. The effect of capital structure on a firm's liquidation decision. *Journal of Financisal economics*, 13, 137-51.
Banerjee, S., Dasgupta, S., Kim, Y., 2008. Buyer-Supplier Relationships and the Stakeholders Theory of Capital Structure. *The Journal of Finance*, 63, 2507-2552.

Kale, J.R., Sharur, H., 2007. Corporate Capital Structure and the characteristics of suppliers and customers. *Journal of Financial Economics*, 83, 321-65.
Franck, T., Huyghebaert, N., 2010. Determinants of capital structure in business start-ups: the role of nonfinancial stakeholders relationship costs. *The Journal of Financial Research*, 33 (4), 487-517.
Bronars, S.G., Deere, D.R., 1991. The threat of unionization, the use of debt, and the preservation of shareholder wealth. *Quarterly Journal of Economics*, 106, 231-54.
Dasgupta, S., Sengupta, K., 1993. Sunk investment, bargaining and choice of capital structure. *International Economic Review*, 34, 203-20.
Vicente-Lorente, J.D., 2001. Specificity and Opacity as Resource-Based Determinants of Capital Structure: Evidence for Spanish Manufacturing Firms. *Strategic Management Journal*, 22 (2), 157-177.
Bosse, D.A., Alvarez, S.A., 2010. Bargaining power in alliance governance negotiation: evidence from the biotechnology industry. *Technovation*, 30, 367-375.
Doz, Y.L., 1988. Technology partnerships between lager and smaller firms: Some critical issues. *International Studies of Management and Organization*, 17 (4), 31-57.
Stuart, T.E., Ozdemir, S.Z., Ding, W. W., 2007. Vertical Aliances Networks: The case of university-biotechnology-pharmaceutical alliance chains. *Research Policy*, 36, 477-498.
Walker, G., Kogut, B., Shan, W., 1997. Social capital, structural holes and the formation of an industry network. *Organization Science*, 8 (2), 109-125.
Lo Nigro, G., G. Perrone, S. Chiapparrone, 2011. Governance forms drivers in bio-pharmaceutical inter-firm relationships. *International Journal of Production Economics*, doi:10.1016/j.ijpe.2011.09.003.
Shan, W., Walker, G., Kogut, B., 1994. Interfirm cooperation and startup innovation in the biotechnology industry. *Strategic Management Journal*, 15 (5), 387-394.
Modigliani, F., Miller, M.H., 1958. The cost of capital, Corporate Finance and the Theory of Investment. *American Economic Review*, 48, 261-297.
Parsons, C., Titman, S., 2007. Capital Structure and Corporate Strategy. In: Eckbo, B. E., (Ed). *Handbook of Corporate Finance*, 2, 203-234
Joskow, P.L., 1998. Asset specificity and the structure of vertical relationships: Empirical test of transaction cost analysis. *Journal of Law, Economics and Organization*, 4, 121-139.
Fee, E.C., Hadlock, C.J., Thomas, S., 2005. Corporate equity ownership and the governance of product market relationship. *Journal of Finance*, 61, 1217-1250.
Alvarez, S., Barney, J., 2001. How entrepreneurial firms can benefit from alliances with large partners. Acad. Manage. Exec., 15 (1), 139-148.
Deeds, D.L., Hill, C. W.L., 1996. Strategic alliances and the rate of new product development: An empirical study of entrepreneurial biotechnology firms. *Journal of Business Venturing*, 11, 41-55.
Nicholson, S., Danzon, P.M., Mc Cullough, J., 2005. Biotech-Pharmaceutical Alliances as a Signal of Asset and Firm Quality. *Journal of Business*, 78(4).
Robinson, D.T., Stuart, T.E., 2007. Financial Contracting in Biotech Startegic Alliances. *Journal of Law and Economics*, 50 (3), 559-596.
Fama, E.F., French, K.R., 2002. Testing Trade-off and Pecking Order Predictions about Dividends and Debt, *The Review of Financial Studies*, 15(1), 1-33.
Degryse, H., Goeij, P., Kappert, P., 2010. The impact of firm and industry characteristics on small firms' capital structure. *Small Business Economics*.
Myers, S.C., Majluf, N.S., 1984. Corporate Financing and Investment Decisions When Firms have Information that Investors do not have. *Journal of Financial Economics*, 13, 187-221.

Entering The Nuclear Power Plant Supply Chain: The France Case Study

Locatelli Giorgio[1], Mauro Mancini[2], Cocco Gianluca[3], Ruzzon Valentino[4]

Dipartimento di IngegneriaGestionale, Politecnico di Milano, Via Lambruschini ,20100 Milano, Italy
[1] giorgio.locatelli@polimi.it, [2] mauro.mancini@polimi.it, [3] gianluca1.cocco@mail.polimi.it,
[4] valentino.ruzzon@mail.polimi.it

Abstract

The so called "nuclear renaissance" is creating a huge market for new nuclear reactors. One of the major criticality in this field is the supply chain: few firms have the capabilities to work in this complex and highly demanding market, whereas many other are investigating the option to enter. The international scientific literature provides information regarding the high-level governmental aspects of nuclear power programs in different countries, but the analysis at firm level is almost inexistent. Moreover, the usual business model for the manufacturing industry is not suitable, since the nuclear market is very peculiar. In particular it's unclear how an EPC (Engineering, Procurement and Construction) company can enter in the supply chain (or project delivery chain). In order to answer this research question this paper investigates the France case study. First it investigates the pure history facts and shows how French companies developed the national supply chain with a strong governmental support. Then, the typical pattern used in a French NPP project is described, resulting in only five major companies effectively acting: EDF with its characteristic three-roles of Owner/Architect-Engineer/Utility, VINCI and Bouygues as Constructors, Alstom as TG supplier and Areva as NSSS (Nuclear Steam Supply System) supplier. The results show the importance of governmental support, as a key-factor for the development, and the role-by-role requirements asked for a company, to proficiently work in the nuclear supply chain.

1. Introduction

The nuclear power plants market is dynamic and growing. Even after the Fukushima Daichi accident (causing different reactions in governmental plans for nuclear energy development), several countries declared their renewed support and conviction in nuclear energy. Sweden, France, Finland, Hungary, Romania, Slovakia, Slovenia, Spain and other countries proclaimed intentions not to change nuclear policies. One of the most clear acts of trust in nuclear power technology has been made by Saudi Arabia, with its intention to build 16 new nuclear reactors over the next 20 years, for a $300 billion estimated cost.

Even if the nuclear business is very significant the scientific literature focuses mainly on technical topics like neutronics or thermal-hydraulic issues. Beside these, the scientific literature related to managerial topics often discusses the high-level, governmental issues concerning national nuclear power development. There are very few papers dealing with the main contractors and EPC in the construction of nuclear plants. In particular is completely uncovered how an EPC, working in other businesses, can enter the nuclear market. For this reason, after the preliminary literature review, that offered no information on the topic of entering in the nuclear Project Delivery Chain (PDC), the case study methodology (with an exploratory approach) has been applied, with a national approach, on the French case. The France choice seems really appropriated since it is the European country where Nuclear Energy accounts for 75% of the total.

2. Scientific Literature Review

At the beginning, scientific literature was examined to understand the specific market and to find preliminary evidences of historical paths, for any company.
(Collingridge, D., 1984) writes about the nuclear development in the USA and United Kingdom (UK), highlighting the issues regarding expected NPP performances, serial NPP orders and piecemeal NPP orders. Different papers compare USA scenario with French ones. (Golay, et al., 1977) focuses attention on the NPP siting process in France and United States, comparing them. Some considerations are deducted, regarding the shifting of major design issues in the early stages of the process, and the rigidity of the process itself. (David & Rothwell, 1994) compares the amount of standardization in the United States (US) nuclear industry, compared to the French one. The article