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Capital Structure Decisions in the Biopharmaceutical Industry

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Abstract

In this paper we deal with the capital structure problem in the pharmaceutical industry that has recently changed its business model because of the biotechnology advent. We propose a set of hypotheses that explains the drivers of capital structure decision in this industry and then we test their validity over a sample of 50 biopharmaceutical firms. The obtained results show that pecking order theory is suitable to explain intra industry differences in capital structure while growth opportunities are the most explicative variable.

Keywords

Capital structure, biopharmaceutical industry, pecking order theory, agency theory, resource-based view

1. Introduction

Capital is a critical resource for all firms, the availability of which is a crucial condition to succeed in pursuing firm's strategies. Debt and equity are the two major sources of financial resources and they are provided by the two most important classes of stakeholders: bondholders and shareholders respectively. Each of these financial liabilities has different characteristics and is associated with different levels of benefits and control rights. The choice between debt and equity financing determines the distribution of the economic rents generated by the firm among the suppliers of finance and the control that they can exert over its valuable assets. The study of capital structure has inspired an enormous amount of research during the last fifty years. Despite a lot of theoretical and empirical work has been carried out, much is still unknown about the overall implications of choosing a particular capital structure; moreover which are the drivers of financing decisions still remains a controversial and unresolved issue.

Early work on this subject guided by Modigliani and Millers's famous "Propositions I and II" stated that, under certain conditions, the choice between debt and equity does not affect firm value, and hence, the decision is 'irrelevant'. Those conditions included assumptions such as the absence of taxes, the irrelevance of transaction costs in capital markets and no information asymmetry between contractual parties [1]. Subsequent works tried to relax these assumptions, searching for more realistic and acceptable hypotheses for the capital structure decision. Under more realistic hypotheses, financial researchers argued that an optimal capital structure does exist and that it depends on the trade-off between the benefits and costs of debt [2, 3], even if in this sense the empirical evidence has been scarce.

Due to the lack of satisfying empirical results, other theorists argued that the optimal capital structure doesn't exist. Adopting a very different perspective some researchers presented a new approach called 'pecking order model', according to which the existence of information asymmetry between insiders and outsiders of the firm increases the cost of external capital. As a result, firms always prefer internally generated funds to finance new investments, and when they are not sufficient, they first issue less risky and costly liabilities (such as debt or obligations), and finally, as the last preferred choice, equity [4].

The controversial empirical evidence obtained by traditional financing theories extended the debate on capital structure outside the field of finance. According to many researchers, the traditional financial perspective failed to yield consensus on the real determinants of financing decision, and thus they suggested to explore whether a strategic perspective might fill in the gaps of previous literature. The most important contribution in this new research strand came from Barney's 'resource-based view of the firm' [5] and Williamson's application of the transaction costs framework to the capital structure puzzle [6-9], together they provided the link between strategy and financing decisions.

According to Barney the success of the firm strongly depends on the strategic resources under its control. While there is a general consensus on the characteristic that an asset should have to be considered strategic (valuable, rare,

inimitable and non substitutable) [5], there is no agreement on the real sources of competitive advantage. Recent studies suggest that the capabilities that are present in functional areas are also important in extracting the value contained in idiosyncratic assets [10]. From this perspective strategic resources stock can be considered a necessary but not sufficient condition to realize the full value of a firm. In case of two firms possessing identical resources, but different financial management capabilities, this approach predicts different performances, since if a firm undertakes poor capital structure decisions, it will suffer a loss in the value extracted from its resources [10]. Considering that firms must pursue different strategies to serve different business segments, it is reasonable to think that different capital structures best serve the needs of different competitive strategies [11]. Williamson's application of the transactional costs framework to the choice between debt and equity financing can help in explaining the impact of capital structure decisions on the ability of firms to pursue a given strategy [6-9].

As for real transactions, debt and equity can be seen as two alternative governance structures that can be used to reduce the overall governance costs associated with the transactions between the firm and the suppliers of finance. The two types of contracts differ in terms of benefits and control rights. These characteristics make debt much more similar to the market mechanism of exchange. Instead, in case of equity financing the situation is reversed. Equity has weaker property rights, since stockholders are residual claimants. Moreover, their contract runs for the entire life of the firm and their investment is protected by the boards of directors, whose task is to continuously monitor manager's actions. Thus the instrument of equity is characterized by strong behavior control, indicating that it is more similar to the hierarchical system. As for real transaction, the choice between the two governance structures turns on the nature of the assets involved in the transaction, namely asset specificity. Strategies which requires highly specific investments, such as product differentiation or innovation, should be associated with low financial leverage, whilst strategies such as cost leadership should be associated with a higher level of debt [7-10].

The main objective of this paper is to investigate whether and how differences in firm level characteristics may affect capital structure decisions; in particular, in order to answer to our research question we focus on the pharmaceutical industry. Previous empirical work in capital structure literature has showed controversial results, indicating that some theories better explain differences in financial behavior of firms competing in different industries, while others find strong evidence when used in intra-industry investigations. From the literature analysis on the financial theories exposed above we formulated some hypotheses; then, in order to test their validity, we carried out an empirical analysis over a sample of 50 biopharmaceutical companies. The results show strong statistical support for the agency theory, the pecking order theory and the linkage between strategy and capital structure.

The paper is structured as follows: the problem statement is presented in Section 2, the hypotheses formulation is explained in section 3 along with the literature analysis, the experimental analysis is reported in section 4 and results and conclusions are drawn in section 5.

2. Problem Statement

In this paper we use the state of the art in the theory of optimal capital structure to explain which factors drive management's financing decision in the biopharmaceutical industry. Since we carry out an intra-industry investigation, along the most prominent theories, we stress the importance of strategy and firm-level variables as drivers of capital structure. The pharmaceutical industry currently faces hard challenges [12]. Biotechnology firms advent, patents expiring, mid-stage R&D pipelines gaps, the shift towards personalized drugs and other market pressures are weakening the traditional business model based on blockbusters, which is no longer able to create value. Incumbents must reconsider some of their R&D investments and redirect them towards commercial activities, leaving part of the early-stage and preclinical research to biotech companies [13]. Relying on their commercial capabilities Big Pharmas can reinvent pharmaceutical innovation and define a new, collaborative business model based on the aggressive use of partnerships. By specializing in the set of activities that most benefit from their size, both incumbents and new entrants (biotech firms) can be better off, exploiting highly complementary assets through new collaboration patterns. For example, post-clinical activities, as well as marketing and sales, benefits from size due to the existence of economies of scale and scope. On the other hand, preclinical research and early-stage development are best supported by small and medium-sized biotech companies, which are used to operate in a dynamic and flexible environment and to adopt rapidly changing technologies [13]. For firms trying to shift to the new business paradigm the availability of financial resources (i.e. capital structure) is a critical enabling factor to succeed in adopting the new approach to innovation. For big industry players, the need to acquire new knowledge and the aggressive use of partnerships stress the importance of financial funds, in order to make deals and agreements in a timely fashion.

Our main focus is on how firm-level characteristics, such as a competitive strategy based on the new innovation paradigm, will impact the capital structure decision. Despite the controversial empirical results in intra-industry

investigations, along with variables related to firm's heterogeneity, we also test variables related to 'traditional' financial theories in order to see whether they are able to explain differences in capital structure decisions between Big Pharmas and biotech companies.

3. Literature review and hypotheses development

We distinguish between traditional financial models and those about the linkage between capital structure and strategy.

3.1 Capital structure and strategy

Recent empirical works have focused on extending the range of strategies linked with leverage and have considered firm-level strategy variables determinants of capital structure. Some researchers [14] applied Porter's strategic framework to the capital structure puzzle and fund statistical evidence that strategies that imply investments in highly specific assets (such as innovation or product differentiation) were associated with lower financial leverage, relative to less specific strategies (such as cost leadership). In case of bankruptcy, highly specific investments, such as R&D activities, will face a greater loss in value, since they create intangible assets that suffer from market failure. These resources are less redeployable, and thus they cannot be effectively used as collaterals. Consequently, the more a firm's strategy emphasizes the use of these assets, the less it will be financed through debt, which is associated with low control rights [7-10].

Recently O'Brien [11] made another step forward pointing out that the appropriate proxy for the strategic importance of innovation to the firm is not the absolute R&D intensity, but rather the firm's relative R&D intensity (relative to its industry rivals). To examine how a strategy based on innovation might impact capital structure decisions O'Brien refers to the concept of 'financial slack'; he defined it as a situation in which, even if a firm has access to cash and debt financing, it simply doesn't want to borrow so much. The reason is that 'the difference between the payments required to maintain the organization and the resources obtained from the environment (i.e. financial slack) provides a source of funds for innovation' [16]. Thus, if financial slack generates innovation and it is associated with a relatively low leverage ratio, then firms actually trying to be industry innovators may show even lower financial leverage relative to their rivals [11].

The contribution of our work to the existing literature is to consider how financial slack may impact firms' ability to pursue a strategy of innovation in the biopharmaceutical industry. Indeed, as mentioned in the previous section, biopharmaceutical companies must adopt a new business model in order to keep on competing on the basis of innovation and to continue to bring new and valuable products to the market. This new approach requires an extensive use of partnerships and superior deal-making and alliance capabilities in order to select the most promising technologies and molecules available in the market-for-know-how. Once an incumbent has selected some good projects, the next step is to set up collaborative arrangements to define how the contractual parties will share the efforts needed, as well as the benefits and risks of the projects. As far as payment methods are concerned, risk-sharing agreements can be structured in several forms, but they always include some up-front fees, milestones payments and eventually royalties on future sales. Thus, setting up a virtual network of innovative partners to conduct R&D activities requires huge amount of funds and financial slack can help incumbents and established biotech companies undertaking the right deals at the right moment. From the above discussion we formulate the following hypothesis:

Hypothesis 1: The more a firm's innovation strategy emphasizes the use of collaboration patterns, the lower its financial leverage.

A slightly different point of view is focused on the business risks associated with the new innovation paradigm. Indeed, by externalizing and carrying out preclinical R&D activities through a set of collaborative arrangements incumbents and new entrants can improve the risk profile of their investments. Furthermore, through these agreements, although they give up some of the benefits associated with their project, they can share some of the risks too. Thus risk-sharing agreements may reduce the uncertainty of transactions with lenders, resulting in lower transaction costs. This argumentation leads us to the following hypothesis:

Hypothesis 2: The more a firm's innovation strategy emphasizes the use of collaboration patterns, the higher the use of debt to finance its investments.

3.2 Traditional models

Trade-off theorists aim to find an optimal capital structure by balancing the benefits and costs associated with debt financing. A key issue is the extent to which firms can actually benefit from tax shields generated by interest

payments deductions. If profitability is low, firm's income may be not sufficient to cover interest payment and there would be no tax benefit from the use of debt. Hence the following hypothesis has been developed:

Hypothesis 3: The more a firm's profitability, the higher the level of sustainable debt, resulting in a higher leverage ratio.

On the other hand, Myers and Majluf's pecking order model predicts that there is no optimal level of debt and that capital structure is strongly influenced by asymmetric information, which increases the cost of external funds. According to this perspective, firms usually prefer internally generated cash flows to fund new projects and if they're not sufficient, they turn to the use of external funds, considering equity as the last preferred choice. Thus, when profitability is low, leverage should increase, since the firm borrows from lenders to fund new projects; conversely when profitability is high firms use retained earnings to fund investments and pay down debt. There will be a negative interaction between profitability and leverage, since when internal funds are high, firm uses them to fund new projects and eventually pay down debt. These argumentations lead us to an opposite formulation for the previous hypothesis:

Hypothesis 4: The more a firm's profitability, the lower the level of sustainable debt, resulting in a lower leverage ratio.

Moreover, agency theory suggests that significant agency costs may arise from the conflict of interest between stockholders and bondholders, because of the pay-offs distribution and the different risk propensity. The result is that lenders charge a higher interest rate and thus debt will be less convenient. Myers [4] suggests that this problem is particularly serious for firms investing in assets that grant big growth opportunities. The greater the firm's reliance on such assets, the more serious the agency costs. Thus, we can derive the following prediction:

Hypothesis 5: The more the firm undertakes projects with high growth opportunities, the less the use of debt, resulting in a low leverage ratio.

4. Empirical Analysis

We tested the above hypotheses over a sample of 50 biopharmaceutical firms, among the most important players in the industry. The population primarily encompasses public firms from United States, Europe and Japan, listed in the New York Stock Exchange and the Tokyo Stock Exchange. For firms mainly operating in less relevant stock markets we considered their American Depositary Receipts (ADR), which can be traded like the shares of US-based companies. However, each company has at least a market capitalization of 50 million of US dollars. Pharmaceutical companies were derived from a list of the 50 largest pharmaceutical firms operating all over the world ranked by healthcare revenue of 2008. The list was part of the Global Fortune 500 annual ranking of world's largest corporations. Biotech companies come from a list of the most important biotech companies ranked by market capitalization, published by Bioworld. Bioworld is an online database that contains continuously updated news and information about the biotech industry. Beyond the list of the companies we also took from the database information about Big Pharma-biotech collaborative agreements signed in the last five years as well. Financial data were derived from Google Finance database.

4.1 Variables

In order to investigate which factors influence capital structure decisions we considered *Leverage* as the dependent variable. *Leverage* was computed by dividing the book value of debt by the total market value of the firm. The total market value of the firm was calculated as the book value of debt plus the market value of equity. Considering that this variable is bounded between zero and one, we used a transformation of the dependent variable (*LEVER*) to avoid the problems that may occur if several observations are close to the extreme values of the domain. Following the approach of previous empirical works [15] we used the logistic transformation:

$$LEVER = Log\left(\frac{Leverage}{1-Leverage}\right) \quad (1)$$

The logistic transformation allows us to use linear estimation procedures and maintain the assumption of normally distributed errors.

The primary independent variable of interest in our study is the *Propensity towards Collaboration*, which is our proxy for the emphasis put by the firm on the new innovation paradigm and the use of collaborative (risk-sharing) agreements to conduct R&D activities. First, we counted the number of risk-sharing agreements signed by each firm with biotech partners during the last 5 years and we then divided this value by the number of therapeutic areas served. Thus, by defining this variable as the average number of deals signed for each business segment, we found a

proxy which is independent from firm's size, since we observed a significant positive correlation between the dimension and the therapeutic areas targeted by firms. This metric was used to test hypotheses 1 and 2.
The variable *Profitability* is a proxy for firm's accounting profitability, as measured by return on investment (i.e. operating income divided by the capital invested in the firm's core business). Pecking order model suggests that this variable may be negatively related to leverage, since if profitability is high, firms may use internal fund to pay down debt, whilst trade-off theory predicts an opposite relationship, stressing the importance of tax shields. Thus, this measure is suitable for testing hypotheses 3 and 4.
Agency theory stresses the importance of the agency costs which arise from the conflict of interest between stockholders and bondholders. These costs are especially severe for firms which have the option to undertake big growth opportunities. Firm's growth opportunities are difficult to measure and guidance from previous literature is scarce. Following the approach adopted by other researchers [17] we used the variable *Growth Opportunities*, defined as the market value of equity plus the book value of total debt divided by the sum of the book values of equity and total debt.
Finally, we used a control variable named *Revenue* as a proxy for firm's size, in order to remove the variance explained by this variable from the other predictors. Incumbents and new entrants are very different in terms of size; thus, considering that we tested our hypotheses over a sample of pharmaceutical and biotech companies, it would be better to study the interaction between the independent variables and leverage after removing the influence of firm's size on the others dimensions.
Moreover we used a logarithmic transformation of the variables *Revenue* and *Growth Opportunities* to reduce their variance and to improve model fit.

4.3 The Model

Following previous empirical studies we used multiple regression in order to identify the significant determinants of capital structure [11, 15]. The general form of the model is the following:

$$LEVER = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 \quad (2)$$

LEVER is the dependent variable expressed as the logistic transformation of *Leverage* (eq. 1), β_0 is the intercept, while the others β's represent the regression coefficient of the four independent variables, i.e. X_1, X_2, X_3 and X_4 respectively *Propensity towards collaboration*, *Growth opportunities*, Log(*Profitability*) and Log(*Revenue*).
Multiple regression shares the same assumption of simple linear regression: normally distributed errors, independent observations, absence of outliers and homoscedasticity. In order to respect all the assumptions we used the WLS (weighted least squares) regression instead of the OLS (ordinary least squares) model. In particular, homoscedasticity requires that the variance of residuals must be constant for all the values of the independents. If this assumption is violated the regression coefficients will be biased and the power of significance tests will be reduced. Weighted least squares (WLS) regression compensates for violation of the homoscedasticity assumption by weighting cases differentially and giving less weight to the points that show much variance in the error term and to outliers.

5. Results and Conclusions

The results of the WLS regression are reported in Table 1. All the regression coefficients were significant ($p<0.005$), indicating that all the predictors included in the model have relevant influence on the dependent variable.
The negative and significant coefficient on the variable *Propensity towards Collaboration* is consistent with hypothesis 1. Thus, firms that emphasize the use of partnerships in order to adopt the new business paradigm will make financial slack a strategic priority, and hence maintain lower leverage. The negative value of this coefficient is not consistent with hypothesis 2 that predicts an opposite relationship with leverage. It seems that risk-sharing agreements aren't able to reduce the uncertainty of the transactions with lenders.
Hypothesis 4 predicts that when profitability is high firms use retained earnings to fund new projects and pay down debt. The negative and significant sign of the slope for *Profitability* is consistent with this hypothesis, while the trade-off theory (hypothesis 3 that predicted an opposite relationship) fund no statistical support.
The negative and significant coefficient on the variable Log(*Growth Opportunities*) is consistent with Hypothesis 5, indicating that agency theory predictions are also supported. Firms that have the option to undertake big growth opportunities in the future actually bear some agency costs and hence a higher cost of debt. Consequently they won't be able to borrow so much.

Table 1. Regression coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	-.805	.169		-4.764	.000
Profitability	-1.398	.469	-.309	-2.983	.005
Propensity toward Collaboration	-.032	.009	-.350	-3.605	.001
Log(*Revenue*)	.134	.045	.324	2.986	.005
Log(*Growth Opportunities*)	-.665	.144	-.480	-4.605	.000

Finally, the positive and significant value of the slope for *Log*(*Revenue*) indicates that firm's size has a positive influence on leverage. A possible explanation could be that bigger firms have more diversified business, since they usually target several therapeutic areas or operate across different industries. If a firm diversifies its activities, then it can improve the risk profile of its investments and obtain more capital at a lower cost.

These results give an original contribution to the existing literature highlighting the importance, in the capital decision and in this industry, of variables related to the pursued strategy over classical variable like profitability.

Future developments aim at increasing database dimension, in order to overcome the paper limitation, and testing the hypotheses over different R&D based industries to verify the study under an inter-industries perspective.

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