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The relationship between capital structure and R&D strategy of firms

A literature review

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Abstract

Through a literature review, this thesis focuses on the relationship between the capital structure of a firm and its R&D strategy. This is relevant because one can cause or surely influence the other. However, until now no universal theory on causality of the relationship has emerged from research. Does the relationship runs from finance to R&D or is it exactly the other way around?
Research has considered innovation as a tool to survive and thrive in today's highly global competitive environment. Firms can increase performance by investing in research in development (R&D). They can decide to conduct R&D either internally (in-house) or externally (outsourcing). Firms investing in R&D have to decide how much to invest in R&D and how to finance it. In line with the pecking order theory (Myers and Majluf, 1984) firms can finance investments with internal funds, debt or external equity. As R&D projects are highly uncertain, financing constraints can occur because capital providers demand more favourable terms, thus increasing the cost of external financing for these projects. This issue is related to and will affect the capital structure of a firm.
Although the missing of a universal theory on causality of the relationship between capital structure and R&D strategy, some patterns can be found in literature. More innovative firms will become more dependent on external financing, but this source of finance is difficult to obtain for investment in R&D. Banks require collateral and investors want a higher return due to uncertainty of R&D projects. Furthermore, in-house R&D seems to positively influence the decision to opt for internal financing. The relationship between outsourcing R&D and external financing appears to be positive in both ways.

1. Introduction

1.1 Background information

Schumpeter (1932) already found out that processes that are associated with innovation and technological change were perceived as being important. Organizations need to change and adapt themselves to the demands of internal and external environment to survive and thrive in a competitive environment (Popper and Lipshitz, 2000). Innovation is recognized to play a central role in creating value and sustained competitive advantage (Baregheh et al., 2009; Raj and Srivastava, 2013). Although no universal definition of innovation exists in literature, Baregheh et al. (2009) argue that innovation can be considered as a multi-stage process for organizations which transforms ideas into new/improved products, services or processes with the aim to successfully advance, compete and differentiate.

According to Love and Roper (2002), firms engaged in innovation have to face two important decisions. First, how much to invest in R&D, and second, how to make that investment. In the past there was general consensus among researchers that inventions were generated by a company's own researchers (Gassmann, 2006). The firm's own engineering department realized the transition of ideas to commercial products and the diffusion and exploitation of innovation was driven by the innovating firm itself. However, due to technological changes, firms are no longer able to develop everything in-house and must source technology beyond their boundaries in order to provide the demanded products and services (Chesbrough and Crowther, 2006; Gassmann, 2006). Firms need to combine both internal and external R&D to achieve better results (Cassiman and Veugelers, 2006).

However, returns on R&D projects are highly uncertain (Jordan et al., 1998) and the projects themselves often have a high probability of failure (Müller and Zimmermann, 2008). Combining that with a lack of collateral value (Vicente-Lorente, 2001) and asymmetric information problems, financing constraints can occur causing firms to conduct R&D activities at a sub-optimal level (Charnitzki and Hottenrott, 2011; Brown et al., 2015). As more innovative firms have more attractive investment opportunities, they will become more dependent on external finance (Casson et al., 2008). Those firms however will experience problems, because uncertainty and asymmetric information increases with R&D intensity (Müller and Zimmermann, 2008). Therefore the costs of external financing will be relatively higher for R&D than ordinary investment, as creditors will ask for more favourable terms (Titman and Wessels, 1988). This implies that the capital structure choice is also of significant importance for firms. Although early research of Modigliani and Miller (1958) has shown that capital structure decisions are irrelevant to firm value and to the cost of or accessibility to capital, Jensen (1986) found that firms have an optimal debt-equity ratio in which firm value is maximized. Vernimmen et al. (2015) consider the capital structure as a firm-specific policy that changes over time.

Little research has been conducted on the relationship between capital structure and innovation and even less on how the capital structure relates to specific R&D strategies. Considering R&D strategies, in this thesis a distinction will be made between internal/in-house R&D and external R&D/outsourcing. In the literature the decision to organize R&D either internal or external is also referred to as the make-or-buy decision. While previous research of Bartoloni (2013) suggests that the type of finance determines how firms innovate, Vicente-Lorente (2001) mentions that the capital structure is partially determined by 'make or buy' decisions. The aim of this thesis is therefore to help filling the current knowledge gap in literature regarding the relationship between capital structure of firms and

their R&D strategies. In order to do so, both literature on the capital structure and R&D strategies will be extensively studied. Furthermore, available research on the linkage between both components will be consulted.
Although this thesis is a literature study, meaning no quantitative data will be provided, the outcomes of this research can still be useful for different interest groups. Businesses can use it to assess which R&D strategy to pursue and how to finance it. Also governments can take it into account to improve policies. Finally, hopefully it will serve as an incentive for further research on this interesting topic.

1.2 Research objective & research questions

In today's highly competitive global environment firms need to differentiate themselves from competitors. Firms can do this in different ways, participating in R&D is one of them. Also firms need to carefully assess whether to finance investments in R&D with either debt or equity to establish a capital structure that suits their goals best. A lot of research has been conducted on the concepts of both R&D strategy and capital structure, but still a knowledge gap exists in terms of possible correlation between both concepts. No quantitative analysis will be used to verify this correlation, but by means of a literature review this thesis intends to check if a causal relationship does exist. The main research question of this thesis will thus be:

Does the capital structure of a firm determine what R&D strategy it pursues or is the R&D strategy the driver of a firms capital structure?

To investigate the exact nature of this relationship the research will be constructed based on a number of sub-research questions. The formulation of these questions is as follows:

1) What are the determinants of the capital structure for firms?
2) What does the literature say about R&D strategies?
3) What is the relationship between the capital structure and R&D?
4) What evidence can be found in literature about the relationship between capital structure and R&D strategy, in terms of in-house and outsourcing?

2. Method

As mentioned before, an extensive literature study will be the method in this thesis to elaborate on how R&D strategy and capital structure relate to each other. Especially because relatively little research has been conducted on investigating this relationship, it can be a particularly interesting subject for the future. It may be necessary to accumulate information from a wide range of areas in literature, such as theories on general economics, innovation in general, R&D strategies, financial management and even sociology with regard to relationships. A lot of research is available on these concepts. This thesis will primarily focus on manufacturing firms.

First of all emphasis in this thesis will be put on the capital structure, followed by R&D strategy and eventually, after enough literature has been collected, the connection between both components will be intensively studied. The pecking order theory (Myers and Majluf, 1984) will serve as a guideline in investigating this particular connection. This thesis will primarily use the databases of Scopus, Web of Science and Google Scholar, using keywords that closely relate to the variety of areas mentioned before needing further investigation. Keywords can be capital, structure, equity, debt, financing, innovation, R&D, internal/in-house/make, external/outsourcing/buy, decision, strategy or equivalent terms.

3. Literature study

First, in this literature study, the capital structure of firms will be studied. Both internal (firm-specific) as well as external determinants will be considered.
Second, R&D strategies and their drivers will be discussed. A distinction will be made between internal R&D (in-house) and external R&D (outsourcing). For both forms of R&D, different advantages and disadvantages are being considered. Also recent literature will be used to elaborate on trends in R&D. This part will thus mainly be an analysis of the general R&D topic.
Third, because the aim of this thesis is to investigate whether or not a causal relationship between capital structure and R&D strategy exists and if so what the direction of that relationship is, knowledge will be provided on the relationship between capital structure and R&D strategy. With the pecking order theory as a guideline, the relevance and limitations of using internal and external (both debt and equity) funds in relation to R&D will be discussed. The literature used in this section will thus elaborate on how firms can fund R&D best according to the relationship with capital structure. This will be explained in an attempt to cover the gap in literature.
Fourth and final, a distinction between internal R&D and external R&D will be made in relation to capital structure. Research has indicated that one has to differentiate between different types of R&D strategies, as total R&D may not reflect accurately the nature of the problems responsible for credit constraint (Piga and Atzeni, 2007). In this final session this thesis intends to investigate whether the capital structure will have different implications for in-house R&D and outsourcing R&D. The possible relationship may also be the other way around, which will imply that internal R&D has a different impact on the capital structure than external R&D does.

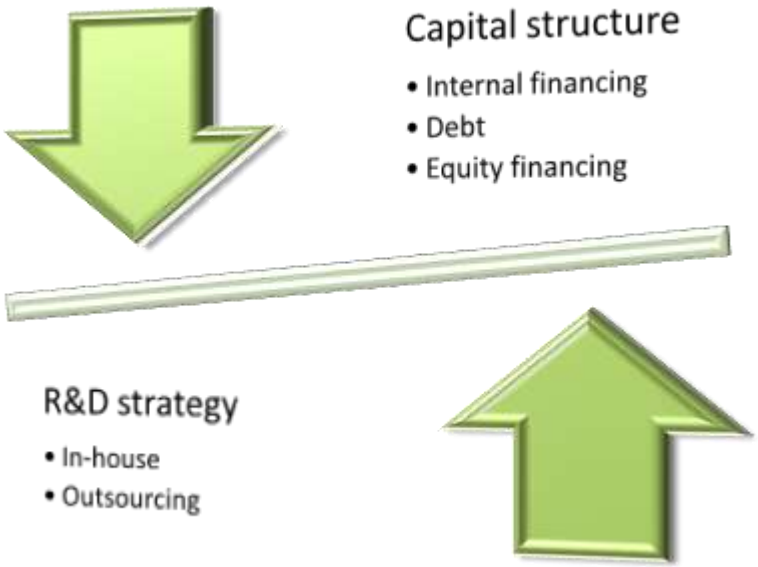

Figure 1: The potential relationships between capital structure and R&D strategy

3.1 Capital structure of a firm

First in this section it will be discussed what the literature says about the capital structure. The study of the capital structure attempts to explain the mix of securities and financing resources used by corporations to finance real investments (Myers, 2001). According to Myers (2001), research on capital structure has primarily focussed on the proportions of debt vs. equity on the balance sheet. Nevertheless, there is no universal theory about the debt-equity choice. Modigliani and Miller (1958) even claim that the type of instrument used to finance an investment is irrelevant to the question whether or not the investment is worthwhile. An investment is worthwhile if and only if the rate of return on it is as large or larger than the cost of capital. The view that no common optimal capital structure exists is supported by Vernimmen et al. (2015).
This does not imply that individual firms cannot establish a capital structure that is optimal for themselves. The choice between debt or equity will depend on a wide range of considerations (Vernimmen et al., 2015). Macroeconomic conditions such as rapid growth and low interest rate will favour borrowing, whereas a low growth rate and high interest rate will stimulate companies to include less debt in their capital structure.
Research is available on whether companies should finance their investment in general mostly with either debt or equity. Emphasis here is put on a wide range of variables determining which capital structure is most advantageous. In the book of Vernimmen et al. (2015) the capital structure choice is considered as a firm specific policy that changes over time. Over the last decades, this was based primarily on interest rates (late 1990s lowest interest rates in 30 years, debt in favour) or general economic conditions (1950s and 1960s, just after the war, accent was on securing autonomy). According to Titman and Wessels (1988) theories suggest that firms select capital structures depending on attributes that determine the various costs and benefits associated with debt and equity financing. They conducted research on the different attributes that may affect the debt-equity choice of firms of which some of them will be discussed in the current session.
Throughout this section debt-equity ratio, debt/asset ratio and leverage will be used frequently. With the first one, total liabilities divided by stockholders' equity is meant. The second one is defined as the total amount of debt (both short and long term) relative to assets. With leverage the use of borrowed funds is implied.

3.1.1 Internal determinants

In the following section, several, frequently mentioned in research, firm–specific attributes with regard to the capital structure will be extensively discussed. Firms need to take into account these important internal factors (Harris and Raviv, 1991; Korajczyk and Levy, 2003).

Size

Smith (1978) found that for small firms it is more costly to issue new equity than it is for large firms. The results in his study show that in 90% of the cases underwriters are used to issue new equity. An underwriter is an entity that buys securities from the issuer and subsequently sells them to investors. They act as an intermediary between firms and investors. Smith (1978) indicates that costs for issuing new equity like this are higher than if the firms would just provide existing shareholders the opportunity to buy additional shares directly from the company. Underwriting increases the number of shares outstanding and

will thus reduce the value of existing shares. For large firms however this effect will be smaller, simply because they have more already existing shares.

Considering the cost of issuing long-term debts, small firms appeared to pay just somewhat more to issue long-term debt (Smith, 1978). According to Marsh's (1984), larger firms may be able to reduce transaction costs associated with long-term debt issuance and may also have a better chance of attracting a debt analyst to provide information to the public about the issue. A study of Marsh's (1984) already concluded that large firms more often choose long-term debt while small firms choose short-term debt. Also Korajczyk and Levy (2003) and Frank and Goyal (2009) found that large firms tend to have higher leverage.
Despite the preference for debt of small firms, Vernimmen et al. (2015) found that for bigger companies (in maturity phase) it is easier to attract capital and therefore they have higher leverage ratios. Large firms tend to be more diversified and less prone to bankruptcy (Titman and Wessels, 1988). This is because those companies have all the characteristics a creditor is looking for, like a credit history. The longer the firm's history of repaying its debt, the better its reputation and the lower its borrowing cost (Harris and Raviv, 1991). Small firms, on the other hand, are mainly equity financed, because they have no credit history or cannot provide collateral to take away risk for lenders (Vernimmen et al., 2015). Those small firms face more problems with raising long-term debt through a variety of reasons, such as the fixed transaction costs of securing long-term debt, and thus make more use of short-term debt when they need external funding.

Growth of the firm
Growth of a firm is another important determinant with regards to the proportion of debt and equity a firm decides to employ. The agency costs (Jensen and Meckling, 1976) are likely to be higher for firms in growing industries, which have more flexibility in their choice of future investments (Titman and Wessels, 1988). The same relationship between growth and agency cost was also found in more recent research of Vernimmen et al. (2015). Further on in this session we will elaborate on the theory of agency cost.
According to Wald (1999) firms with high growth should use less debt financing. However, this only holds for long-term debt (Myers, 2001). For short-term debt, cost due to conflict of interest (agency cost) are mitigated because managers are forced to periodically generate information for investors to evaluate return and risk of major operating decisions (Vernimmen et al., 2015). Hall et al. (2004) claim that increased cost of long-term debt as a result of agency problem can be mitigated by increased use of short-term debt. The increased costs are a result of the fear of banks that a provided long-term debt will not be recovered. Harris and Raviv (1991) mention that a mitigation of the conflicts indeed constitutes the benefit of debt financing.

Non-debt tax shield
Another factor that may affect the choice to finance investments with debt or equity and thus influence the capital structure of firms are non-debt tax shields (Titman and Wessels, 1988). A decrease in allowable investment related tax shields (e.g. depreciation or investment tax credits), will increase the amount of debt that firms employ (DeAngelo and Masulis, 1980). On the other hand, firms that are able to use these investment related tax shields, instead of using interest from debts for tax deductions, will create a non-debt related tax shield and will lead to less debt included in the capital structure. Research of

Wald (1999) and Korajczyk and Levy (2003) again found that non-debt tax shield are negatively correlated to debt/asset ratio. The view of Modigliani and Miller (1958) that the optimal capital structure is the one that includes the maximum amount of debt, due to tax advantages, no longer holds. The higher the company's debt, the higher the probability of bankruptcy (Vernimmen et al. 2015).

Profitability

According to Titman and Wessels (1988) the past profitability of a firm, hence the amount of earnings available to be retained, should be an important determinant of its capital structure. According to the pecking order theory, which will be further elaborated on in this session, this is important because firms have a preference for internal sources of finance. Research of Friend and Lang (1988), Wald (1999) and Frank and Goyal (2009) found a negative relationship between profitability and debt/asset ratios. In line with the findings of Titman and Wessels (1988) and the pecking order theory, firms with higher profitability will thus include less debt in their capital structure. The study of Wald (1999) found evidence that an increase in profitability is correlated with a decrease in long term debt/asset ratios. Results in later research of Hall et al. (2004) confirmed the idea that profitability is negatively related to both long term debt and short term debt, although it is only significant for long term debt.

Also Bartoloni (2013) found that more profitable firms use internal finance more. It reduces the need for external finance regardless of size, although large firms are less sensitive to this. Still, if internal resources are not sufficient to cover large (innovative) projects, debt financing is required (Bartoloni, 2013). Although research of Danis et al. (2014) still supports the view that leverage is negatively correlated with profitability, there exists an exemption for firms that are close to their optimal level of leverage.

Collateral value of assets

According to Titman and Wessels (1988), a borrower is restricted to use funds for a specified project if a debt can be collateralized. However, for projects that cannot be collateralized such guarantee cannot be given which leads to creditors asking for more favourable terms. (ibid.). This means a low collateral value of assets will force firms to use equity financing rather than debt financing. According to Myers (1977), outstanding debt can cause underinvestment in future opportunities. However, if the firms has its capital anchored in physical plant, which can serve as collateral, the potential for underinvestment or excessive risk taking by management is reduced (Wald, 1999). This means that the presence of collateral increases the debt/asset ratio, a view that is supported by Harris and Raviv (1991). Their model predicts that firms with more tangible assets will have more debt. According to Korajczyk and Levy (2003) and Frank and Goyal (2009), firms with more tangible assets tend to have higher leverage, whereas firms with unique assets tend to have lower leverage. Vernimmen et al. (2015) also mention that using collateral definitely reduces the cost of the loan, making debt more likely for firms with collateral.

According to Scott (1977), issuing a secured debt can increase the value of the firm, which means that issuing as much secured debt as possible is the optimal policy. A secured debt is a debt secured by collateral, like a mortgage in which the house serves as collateral. If the firms defaults on the loan, the asset (house) can be sold as collateral. The reason for the increase in value of the firm is a result of one of the characteristics of a secured debt.

Because of the issuance of secured debt, the firms has less money available to pay for legal damages (to customers, suppliers, etc.) in case the firms goes bankrupt and the probability that these costs will be paid will thus be reduced (Scott, 1977). Secured creditors namely have the first claim on the assets in the event of bankruptcy.
Another reason to sell secured debts is the fact that in case managers have superior information and stock is issued to finance investments, stock price will fall (Myers and Majluf, 1984). Harris and Raviv (1991) even regarded this asymmetric information as a determinant of the capital structure.

To summarize, table 1 will show the correlation found in literature between internal determinants of the capital structure and the debt to asset ratio.

Table 1: Correlation internal determinants and debt/asset ratio

Internal determinant	Debt/asset ratio
Size	+
Growth of the firm	-
Non-debt tax shields	-
Profitability	-
Collateral value of assets	+

3.1.2 External determinants

In the next section, this thesis will investigate which external factors are relevant for firms when they have to decide on whether to use debt or equity as a source of finance.

Asymmetric information and pecking order theory

Firm managers or insiders are assumed to possess private information about the characteristics of the firm's return stream or investment opportunities that investors lack (Harris and Raviv, 1991). The smaller the information asymmetry, the lower the return investors will accept from a company (Vernimmen et al., 2015). This is because the risk of investing in that company is smaller, which reduces the cost of capital. As information asymmetry grows, it will become more difficult for companies to raise funds outside, especially for young firms in the start-up phases. In addition Hall et al. (2004) found that the better the relationship between banks and borrower, the lower the information asymmetry. If both parties however act more independently and a tradition of hiding information exists, information asymmetry will be higher.

Relating to information asymmetry, Myers and Majluf (1984) found that managers will favour debt over equity financing if external capital is required. In more recent research this principle is frequently referred to in research as the pecking order theory, which tells us that there exists a hierarchy of preferences for finance in companies. Firms have a tendency to rely on internal sources of funds and if external financing is required they prefer debt over equity (Myers & Majluf, 1984). According to Frank and Goyal (2009) the pecking order theory is almost always framed in terms of asymmetric information. The main reason for the preference for retained earnings is that it avoids the problem of adverse selection (ibid.). Equity on the other hand has serious adverse selection issues (Frank and Goyal, 2009), because managers may know more about the value of the firm than investors do(Myers and Majluf, 1984).

Agency cost

According to Jensen and Meckling (1976), in an agency relationship, the principal(s) engage another person (the agent) to perform some service on his/her behalf which involves delegating some decision making authority to the agent. According to the Authors, agency cost occur because:

- the principal tries (apart from monitoring and observing) to 'control' the behaviour of the agent
- the agent sometimes does not take certain actions at cost of the principal
- there is a divergence between the agent's decisions and the decisions that would maximise the welfare of the principal.

Harris and Raviv (1991) established a model in which the agency costs, or cost due to conflict of interest, are the decisive determinant in the capital structure. Jensen and Meckling (1976) make a distinction between two types of conflicts, namely conflicts between shareholders and managers, and conflicts between debtholders and equity holders. An example of the former conflict has just been described with the issuance of shares.

Jensen and Meckling (1976) imply that a conflict between debtholders and equity holders arises because a debt contract gives equity holders an incentive to invest sub optimally. It means that in case of an investment that yields large returns, far above the value of the debt, equity holders capture most of the gain. On the other hand, in case of a failed investment, debtholders bear the consequences. Harris and Raviv (1991) state that equity holders may benefit from investing in risky projects because of this. The loss of the value from the poor investment can be easily offset by the gain in equity at the expense of debtholders (in case of a good investment).

To protect against this risk-shifting problem, bondholders usually demand protective covenants and monitoring mechanisms to safeguard themselves from risk-shifting (Jiraporn et al., 2013). Enforcing such contracts can be costly and as the agency cost of debt rises, bondholders demand a higher rate of return (ibid.). This of course will result in higher cost of debt financing.

Industry classification

According to MacKay and Phillips (2005) the own-firm capital structure depends on changes made by industry peers, which shows the importance of industry interdependence. Also Vernimmen et al. (2015) say that there is good evidence that the average capital structure of the sector is an important benchmark for management when setting capital structure policies. According to Titman and Wessels (1988) firms that manufacture machines and equipment should be financed with relatively less debt. In concentrated industries, where a few large firms dominate, profitability and size are substantially higher (MacKay and Philips, 2005). In line with the findings about size and profitability, in these industries higher leverage levels are found. In competitive industries, with higher risks, on the other hand leverage levels are lower (MacKay and Philips, 2005).

According to De Jong, Kabir and Nguyen (2007), also country-specific factors influence the decisions of companies regarding their capital structure. They do this both in a direct and an indirect way. Although a lot of literature is available on country-specific factors, this thesis will not further elaborate on this because of time constraints. However, it can be an interesting topic for future research.

To summarize, table 2 shows the correlation found in literature between external determinants of the capital structure and the debt to asset ratio.

Table 2: Correlation external determinants and debt/asset ratio

External determinant	Debt/asset ratio
Asymmetric information	-
Agency cost	-
Industry classification	+/-

3.1.3 Variety of financial instruments

Firms do not solely depend on a single type of instrument to raise capital. They can choose, if free access to various types of debt is ensured (which will be discussed later on), the financing method that suits them best. Further on in this thesis, a distinction will be made based on an article of Wang and Thornhill (2010) between:

- Common equity (common shareholders)
- Convertible securities (convertible debt and preferred stock)
- Relational debt (bank loans and commercial loans)
- Transactional debt (corporate bonds)

According to Faulkender and Petersen (2006), both firms that are opaque (or difficult to investigate) and firms that have more discretion in their investment opportunities have lower leverage if they need to borrow from financial intermediaries such as banks. This is because the costs of monitoring and imperfect financial contracting will raise the costs of debt capital for these firms and thereby lower their desired leverage (ibid.). However, companies with a good debt rating, will favour debt as a source of finance (Vernimmen et al., 2015). A good debt rating implies a higher degree of financial flexibility. It is easier for those firms to issue corporate bonds and thus transactional debt.

3.2 R&D strategies: in-house and outsourcing

Investment in research and development (R&D) represents one way for firms to search for innovations that may strengthen existing product-market positions and/or provide opportunities to enter new product-market domains (Alessandri and Pattit, 2014). By doing so, firms can increase performance. Although using different performance indicators, such as sales growth (Garcia-Manjon and Romero-Merino, 2012), productivity (Wakelin, 2001) or profit (Leonard, 1971) a lot of empirical studies have confirmed a positive relationship between R&D and performance (Lome et al., 2016).
Griffith et al. (2004) found empirical evidence that R&D activity has two roles. R&D activity both stimulates innovation and facilitates the imitation of others' discoveries. By actively engaging in R&D, a firm acquires tacit knowledge which makes it more easily to understand and assimilate the discoveries of others (ibid.). With tacit knowledge it is meant that knowledge is difficult to transfer. One cannot simply write it down or verbalize it.

According to Den Hertog and Thurik (1993), innovating firms have to decide whether to start off R&D project either internally or externally. Internal R&D is R&D that is run in-house, so in the firm itself. External R&D on the other hand means that R&D is contracted out to external research organizations (ibid.). This can be either achieved through R&D alliances or by means of R&D acquisitions (Hagedoorn and Wang, 2012). In the literature outsourcing is often used as the equivalent of external R&D, like in research of Piachaud (2002) and Huang et al. (2009). Finally, in other papers the decision is referred to as the make or buy decision. According to Leiblein et al. (2002), the decision to outsource or vertically integrate a value-chain activity represents one of the more complex choices faced by managers. Make or buy decisions determine the firm's level of vertical integration, since each decision specifies which operations the firm will engage in and which it will contract out to a supplier (Walker and Weber, 1984). Cruz-Cazares et al. (2013) define the make strategy as internal development of R&D activities, whereas the buy strategy reflects the firm's decision to externalise R&D activities to other firms.
For successful R&D sourcing it is essential to select an appropriate R&D strategy (Huang et al., 2009). Firms should therefore carefully assess and measure the level of their technological determinants, which are both technological codification and technological competence, before selecting an R&D sourcing strategy. Whereas the former one refers to the cost of acquiring technology, the latter one refers to the products and services a firm can provide and what competitive advantage a firm can achieve. The level of those determinants can and should be identified based on a detailed examination of these issues (ibid.) However, rather than to look at the absolute R&D intensity of firms, the relative R&D intensity should be considered as the determinant of how important innovativeness is for a firm (O'Brien, 2003). Absolute R&D intensity is measured by firm-level expenditures in R&D divided by sales. Relative R&D intensity refers to the R&D intensity of a firm relative to other firms in the same industry.

3.2.1 Which type of firms would decide to pursue an in-house R&D strategy?

Especially large firms in concentrated markets appear to have a preference for internal R&D instead of external R&D, due to both financial and technical reasons (Den Hertog and Thurik, 1993). Considering the financial reasons, large firms have more financial resources and can spread the fixed costs of internal R&D over a larger sales volume. This is important because

internal R&D projects are more expensive than external R&D projects (ibid.). Research of Narula (2001) already established evidence that a smaller firm size and consequent limited resources are a constraint to the amount of money these firms are able to invest in R&D.
With regards to technical reasons (Den Hertog and Thurik, 1993), Mowery (1983) found out that as firms grow in size, they will have more complex, risky research projects as the core of their in-house activities. Knowledge for such projects may be highly specific to a firm and therefore requires the organization to be engaged in both production and research. This is because production and acquisition of detailed technical knowledge are frequently joint activities (ibid.). Therefore, complex, risky projects cannot be easily outsourced. As larger firms are more engaged in such projects, this explains the preference of large firms for in-house R&D. Also, the tacit nature of innovation and the risks associated with loss of technological competitiveness encourage a high level of in-house R&D activity (Narula, 2001), confirming the view that large firms are more likely to engage in internal R&D activities. Materia et al. (2015) found once again that size appears to be the key determinant of in-house innovation activities: firms with a larger volume of sales tend to innovate in-house.

Market concentration also provides stronger incentives to engage in internal R&D (Den Hertog and Thurik, 1993). This may be again because of insufficient control over external research and internal R&D may be the best way to delay imitation until the products are marketed or new processes are in commercial use (ibid.). In later research of Love and Roper (2010) evidence was found again that firms with a relatively high market share operating in concentrated industrial sectors are more likely to maintain an internal R&D capacity, especially if rivalry is expected to be intense. Those firms want to prevent or delay imitation by rivals. However, a remark must be made for capital-intensive industries, in which external R&D is preferred. This might be because capital-intensive industries often need external experts to solve their problems (Den Hertog and Thurik, 1993). According to Belcourt (2006) specialists know the legislation better than anyone and can assure the user organization that all their practices comply with legislation. The use of experts thus reduces risks and liabilities for firms.

3.2.2 Advantages and disadvantages of in-house R&D

Firms can, as mentioned before, opt to execute their R&D activities in-house. Above it has already been discussed that especially large firms in concentrated markets have a preference for in-house R&D. Large firms are more likely to possess relevant specialized assets within their boundaries at the time of new product introduction (Teece, 1986). They can therefore better use their technology to maximum advantage. According to Robertson and Gattignon (1998), the more important a product category is to the firm, the more likely it will be to engage in internal technology development. An advantage of the make strategy of R&D, closely related to in-house R&D, is that it gives rise to a unique source of knowledge and enables innovative responses to the firm's real needs (West, 2002). Also it is suggested by Mol (2005) that costs of transacting are substantially lower with in-house R&D. This is because organizations can internally develop a specific dialect for exchanging unstructured and tacit knowledge, which makes them much more efficient in transferring such knowledge. According to Hertog and Thurik (1993) complementarities between internal R&D and other activities can be used to improve productivity. They also argue that firms may face

less danger of an outflow of important information to rival firms which prevents the innovating firm from reaping the rewards or even from recovering the costs of R&D.

This last argument however is rather questionable due to mobility of contemporary workforce. esearch of Hall and Lerner (2010) claimed that in practice more than 50% of R&D expenditure consists of wages and salaries of highly educated scientist and engineers. The problem with this is that the knowledge employees gain is embedded in their human capital and therefore leaves the firm in case an employee decides to leave the firm. This implies that an outflow of important information is unavoidable. Hertog and Thurik (1993) already found evidence that internal R&D is related to higher expenses in R&D. As R&D expenditures are extensive and risky sunk (Veugelers, 1997) it thus implies that sunk cost are higher for in-house R&D. The make strategy of R&D is a high cost approach whose results cannot be clearly foreseen (West, 2002). Another disadvantage suggested by Theese (1986) comes from the fact that imitators can often outperform innovators if they are better positioned with respect to critical complementary assets. If the innovation can be easily replicated, the innovator is disadvantaged. This disadvantage is of course bigger for firms having in-house R&D facilities, mainly because more resources are spend on R&D.

Table 3: Advantages and disadvantages of in-house R&D

Author	In-house R&D
	Advantages
West (2002)	Unique source of knowledge
Mol (2005)	Lower costs of transacting (develop internal specific dialect)
Hertog and Thurik (1993)	Improves productivity (if complemented with other activities)
	Disadvantages
Hall and Lerner (2010)	Human capital leaving the firm (due to increased mobility)
Hertog and Thurik (1993)	Both higher expenses and sunk cost
Teece (1986)	Risk of replication

3.2.3 So why would firms outsource R&D?

The motivation to outsource R&D activities has been examined from different perspectives in research. According to Mclvor et al. (2009) diverse theoretical perspectives during different periods of time seem to have dominated the view of how outsourcing should be tackled. Nevertheless, two influential theories that keep coming back in the study of outsourcing have been transaction cost economics (TCE) and the resource-based view (Mclvor, 2008). While also dealing with in-house R&D, most papers used in this thesis relate both theories primarily to outsourcing. According to Mclvor (2008), although TCE and RBV are focusing on two different issues, firms have to deal with both important issues when making outsourcing decisions. Also Freytag et al. (2012) agrees that it is valuable to combine different theoretical perspectives to give a comprehensive picture of the pros and cons of outsourcing.

According to the transaction cost theory, a company will decide to outsource R&D activities in order to reduce production (such as labour, infrastructure) and transaction (such as monitoring performance, selecting suppliers, negotiating prices) costs (ibid.). According to Vining and Globerman (1999) the aim of the firm is to minimise production and transaction costs. However the choice of external partners (for outsourcing) can be made rather freely,

asset specificity may make it difficult for firms to leave a relationship with a specific supplier of R&D (Freytag et al., 2012). A switch to another supplier would mean an unwanted write off of those asset specific investment, which could lead to opportunistic suppliers exploiting this locked-in situation (Caniëls and Roeleveld, 2009). The potential for opportunism increases if investments have to be made which are specific to a particular relationship. Therefore firms should employ a governance structure that uses less specialized investments in order to reduce the potential for opportunism (Mclvor, 2008). Also Sampson (2004) argues that aligning transactions with governance structure leads to more efficient outcomes. Transaction cost economies implies that the more technology can be codified, or described in blueprints or rules, the easier it is to be contracted out (Narula, 2001). The more tacit the knowledge, the more preferable in-house R&D is on the other hand.

The other prominent theory, the resource based view (RBV), sees the firm as a bundle of assets and resources that if employed in distinctive ways can create competitive advantage (Barney, 1991). The focus is on protecting and developing competences to maintain a competitive advantage in the long term (ibid.). A firm should identify suppliers capable of providing specialised services that might enhance its competitive edge (Freytag et al., 2012). According to Espino-Rodriguez and Padron-Robaina (2006), core activities should stay in-house, while non-core activities should be outsourced. Organizations can access complementary capabilities from external providers where they gain no advantage from performing such processes internally (Mclvor 2008). Also Howells (1999) found evidence that utilizing external expertise may cover technology that firms do not possess or areas in which their technology is inadequate.

3.2.4 Advantages and disadvantages of outsourcing R&D

External R&D has become increasingly important over the years as a mean to help maximizing innovation and overall company performance (Howells, 1999; Mata and Woerter, 2013). External sources of technology can be acquired from competing firms, research organizations, government laboratories, industry research associations and universities (Santoro and Chakrabarti, 2002). According to Piachaud (2002) outsourcing can reduce costs of R&D, because resources are better and more economically utilised within the firm. The buy strategy of R&D, closely related to outsourcing, is relatively less expensive, has more predictable results and solves capacity problems (West, 2002). It also enables firms to focus on their core competences (activities), which can help sustaining a competitive advantage over a longer period of time. Lonsdale and Cox (2000) and Barthelemy (2003) also found that outsourcing is a way for firms to cut costs and focus their limited resources on their core business. One has to take into account that outsourcing itself however does not yield a competitive advantage, since what is bought on the market is also available to the firm's competitors (West, 2002).

Another advantage can be minimization of business risk, because the company no longer bears the responsibilities attached to having a project in-house (Piachaud, 2002). Other advantages of outsourcing are hastening product market entry, bringing in resource flexibility and building expertise by exposing the internal development staff to new knowledge, technology and organizational development processes (ibid.). The use of external R&D may also help firms in overcoming the limitations of in-house R&D budgets and in gaining access to the economies of scale and scope available to specialist research organizations (Love and Roper, 2010). Leiblein et al. (2002) mention that outsourcing will

enhance performance by allowing specialized suppliers to benefit from scale economies by pooling demand and from learning economies by focusing on a limited number of well-defined activities. Nevertheless, there is a lot of debate in research whether or not outsourcing increases performance. Compared to Howells (1999) a study of Kessler et al. (2000) found out that more external sourcing is positively related to lower competitive success (during the earlier stages) and slower innovation speed (during the latter stages).

Despite the advantages, in the literature also a lot of disadvantages on external R&D can be found. Due to intellectual property right, appropriability difficulties and lack of appropriate expertise of potential contractors compared to those within a firm's own R&D department outsourcing may be unfavourable (Love and Roper, 2010). Another disadvantage is that the agent, in this case the external R&D facility, is able to exaggerate the costs and commercial potential of their innovation (Ulset, 1996). Other potential areas of concern are dependence on the supplier, monitoring performance, new mind set, lack of shared objectives and loss of control (Piachaud, 2002). Relating to this, the flexibility of adding new features or enhancing or reducing service is reduced with outsourcing (Belcourt, 2006).

Table 4: Advantages and disadvantages of outsourcing R&D

Author	Outsourcing R&D
	Advantages
Lonsdale and Cox (2000), Piachaud (2002), West (2002) and Barthelemy (2003)	Reduces cost
Lonsdale and Cox (2000), West (2002) and Barthelemy (2003)	Solves capacity problems and allows to focus on core competences
Piachaud (2002)	Minimizes business risk (less responsibility)
Leiblein et al. (2002) and Love and Roper (2010)	Gain from economies of scale (of specialized suppliers)
	Disadvantages
Love and Roper (2010)	Lack of appropriate expertise of potential contractors
Ulset (1996)	Principal-agent problem
Belcourt (2006)	Reduced flexibility (to add new features)
Piachaud (2002)	Dependence on supplier, monitoring performance (related to principal-agent), new mind set, lack of shared objectives and loss of control (related to reduced flexibility)

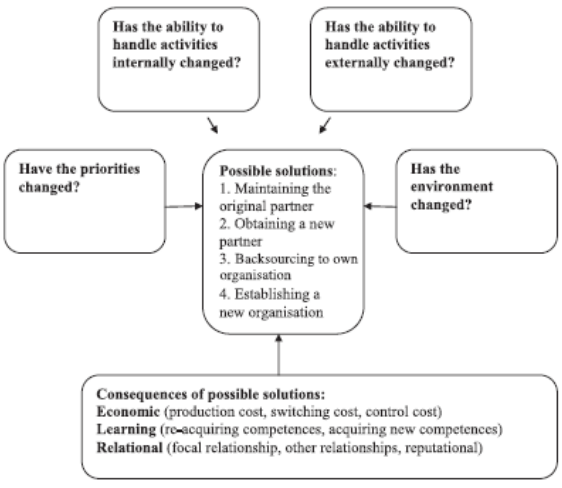

Figure 2: Reconsidering outsourcing solutions, retrieved from Freytag et al. (2012)

According to Freytag et al. (2012), unfulfilled expectations or new opportunities can make alterations to existing sourcing solutions necessary. In figure 2 the issues managers should take into account during the reconsideration process of R&D strategy are summarized.

3.2.5 Open innovation

In the last couple of years there has been a lot of debate in research whether or not the choice between in-house R&D and outsourcing R&D is exclusively. As products become more sophisticated and production relies on an increasing range of specialized technological understanding, firms can hardly develop internally all the capabilities and competences required to bring a product to the market (Cuzmano et al., 2010). Especially as competition is strong and product life cycle short, firms devote internal resources to strengthen their core business, while outsourcing non-core activities. According to Love and Roper (2010), the optimal internal/external decision or combination will vary for different types and sizes of enterprises as the characteristics of a firm influence the relative costs of each type of R&D. Laursen and Salter (2006) claim that the advantages that firms gain from internal R&D expenditure have declined, which is mainly due to increased mobility of knowledge workers.

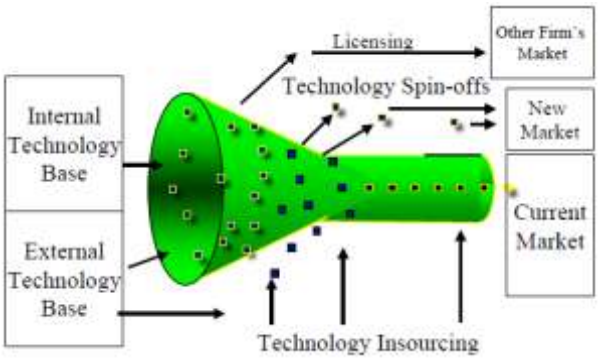

Figure 3: Open innovation, retrieved from Chesbrough et al. (2006)

Nowadays many innovative firms innovate successfully by drawing in knowledge and expertise from a wide range of external sources. More recent research has shown that many firms have shifted to an open innovation model, which can be seen in figure 1. According to Chesbrough et al. (2006) this means that firms can and should use external ideas as well as internal ideas, and internal and external paths to the market, as they look to advance their technology.

3.2.6 Complementarity or substitutability between internal and external R&D?

In recent research a lot of attention has been paid whether there is complementarity or substitutability between internal and external R&D strategies. Mowery (1983) was one of the first to acknowledge that it may be attractive for firms to engage in internal R&D parallel with external R&D. He argued that external R&D functions are complements rather than a substitute for internal R&D. Research of Cassiman and Veugelers (2006) also suggests that internal R&D and external knowledge acquisition are complementary innovation activities, although the degree of complementary is dependent on the firms strategic environment. As a result of that, a tight integration of both internal and external knowledge is required to capture the positive effects of each activity. The make and buy strategies can be regarded as complements rather than alternatives (Cruz-Cazares, 2013). Also according to Cusmano et al. (2010), subcontracting to external specialized providers can complement in-house capabilities, which relates to strengthening core competences.

A study of Hagedoorn and Wang (2012) also found evidence for this complementary innovation strategies, but only at higher levels of in-house R&D. At lower levels of in-house R&D, internal R&D and external R&D turns out to be substitutes. Although firm increasingly rely on external R&D activities, there exists a threshold for optimal external R&D activities (Berchicci, 2013). Above this threshold, innovative performance reduces when increasing external R&D activities. Results of Materia et al. (2014) show that decisions to innovate in-house or to outsource are not interlinked.

3.3 Relationship between capital structure and R&D

3.3.1 Relevance and importance of internal funds related to R&D

Earlier in this thesis the pecking order theory was already discussed. According to this theory, internal funds in general are favoured by firms because they avoid the problem of adverse selection. Relating to this, it is important to introduce the concept of financial slack first. Although in papers relating to the capital structure not much is said about financial slack, it is a concept that frequently comes up in literature in which R&D is discussed. Firms that are competing on the basis of innovation should make financial slack a strategic priority (O'Brien, 2003). Myers and Majluf (1984) refer to financial slack as large holdings of cash or marketable securities, or the ability to issue default-risk-free (or safe) debt to finance investment. Financial slack can be utilized for example when a firm experiences a downturn in sales, revenues or profit. According to Moyer, McGuigan and Kretlow (2001) firms with sufficient financial slack will be able to fund most, if not all, of their investment opportunities internally and will not have to issue debt or equity securities. Also Myers and Majluf (1984) found that high financial slack is associated with a low leverage ratio and it should enhance a firm's ability to be an innovator. According to O'Brien (2003) it ensures:

- Continuous, uninterrupted investments in R&D
- Funds necessary to launch new products available at time needed
- Expansion of knowledge base through acquisition (if beneficial)

Nhoria and Gulati (1996) suggest the relationship between slack and innovation in organizations is inverse U-shaped. Too little slack discourages any kind of experimentation whose success is uncertain. Alike, too much slack breeds complacency and a lack of discipline, with a possibility that more bad projects will be pursued.

3.3.2 But what happens to R&D if there are insufficient internal funds available?

As previously discussed, internal sources of finance are preferred by firms. Nevertheless, great reliance on internal sources of financing for R&D projects may constrain financing of those R&D projects for firms who have limited internal financial resources (Czarnitzki and Hottenrott, 2011). This especially holds for small and young firms, which confirms the earlier research of Müller and Zimmermann (2008). As a result of this, firms that are confronted with financial constraints have to conduct R&D activities at a sub-optimal level (Charnitzki and Hottenrott, 2011). The availability of internal funds is more important for the level of R&D investment than it is for the level of capital investment, such as investment in plants or machinery (ibid.). Capital investment provides more collateral, which lowers the cost of external financing. Therefore companies who invest in capital investments are less dependent on internal funds than companies investing in R&D. Besides, for smaller firms the investment in R&D increases when it is easier for them to get access to external funding. For larger firms however, this does not matter. For those firms, the gap between internal and external costs of capital is lower (Charnitzki and Hottenrott, 2011).
Müller and Zimmermann (2008) found that large companies have a higher probability of pursuing R&D, but lower R&D intensity (R&D expenditures over sales). This makes sense considering the large amount of investment required for R&D.

One can imagine that for some companies R&D investment is crucial and basically their reason for existence. However, in case firms are not able to pursue profitable R&D investment as a result of financial constraint if there is a lack of internal funds, R&D activity

may decline. This will eventually lead to lower levels of innovations and reduce the impact of innovation on the performance of firms (Hall et al., 2015). The study confirms the idea that especially younger and/or smaller firms operating in technology intensive sectors experience financial constraints and will thus benefit most from policies that reduce financing cost. According to Müller and Zimmermann (2008) those younger companies have to rely on their initial investment because they lack (significant) retained earnings and banks are less willing to lend money because they can demand collateral. The lack of collateral limits access to external finance, which may restrict firms in pursuing their favourable R&D level.

3.3.3 Reduced reliance on debt as R&D intensity increases

As more innovative firms have more attractive investment opportunities, they will become more dependent on external financing, with at first a preference for debt financing because they can keep more control of business (Casson et al., 2008). Bartoloni (2013) found that the need for external finance increases with the innovative effort. Considering the pecking order theory, one would thus expect that R&D intensive firms include more debt in their capital structure. However, this is not the case. Aghion et al. (2004) investigated whether publicly traded U.K. firms with higher R&D intensity made different choices to finance R&D than firms with lower R&D intensity did. They found that there exists a nonlinear relationship between the debt/assets ratio and the firm's R&D profile. Firms with high R&D intensity and firms with zero R&D intensity use less debt financing, meaning a lower debt/assets ratio, than firms with positive but low R&D intensity. The debt/asset ratio decreases with R&D intensity, meaning more R&D intensive firms are likely to be less reliant on debt finance. According to Jordan et al. (1998) this has more to do with the market's reluctance to lend than the reluctance to borrow. Possible explanations for this are the aim to minimize expected bankruptcy costs (Aghion et al., 2004) and information asymmetry (Myers and Majluf, 1984). This matches the view of Jordan et al. (1998) and Vicente-Lorente (2001). Jordan et al. (1998) found that a strategy based on innovation was associated with the lowest levels of debt. This is because innovation strategies have highly uncertain outcomes and collateral values are low because knowledge is often embodied in the firm's personnel. Also Müller and Zimmermann (2008) found that returns on R&D projects are highly uncertain with often a high probability of failure. According to Hall and Lerner (2010), this uncertainty tends to be greatest at the beginning of the research program or project. This means that for an optimal R&D strategy, it may be even worth continuing R&D projects which have a small probability of great success in the future.

Moreover, the more R&D intensity increases, the smaller the portion of total debt comes from banks (Aghion et al., 2004). According to Jordan et al. (1998), banks are more willing to lend when the firm is engaged in known and well understood areas of activity. As monitoring firm specific R&D activities is difficult for banks, they are concerned that borrowers have an incentive to engage in riskier projects (ibid.) and therefore less willing to provide funds for R&D intensive firms. According to Hall and Lerner (2010) banks may not have the necessary skills to evaluate projects with few collateralizable assets and significant uncertainty. Müller and Zimmermann (2008) already found evidence that it is difficult to evaluate the quality of R&D projects as a result of asymmetric information. Uncertainty and asymmetric information increase with R&D intensity (ibid.). This means that both new debt and equity finance will be relatively more expensive for R&D than for ordinary investment, however lack of collateral further reduces the possibility of debt finance (Hall and Lerner, 2010). One

could thus expect that, as the reliance on debt finance decreases with R&D intensity, R&D intensive firms have to look for different ways to finance their R&D investments. In line with this, Aghion et al. (2004) found that an increase in R&D intensity is associated with a higher probability of raising finance from issuing new equity. This will be discussed further on in this session.

3.3.4 Why is debt unsuitable for firms to finance R&D activities?

As previously discussed, it is difficult to obtain money from outside investors and lenders for R&D projects (Müller and Zimmermann, 2008). Besides, a study among large American publicly traded manufacturing firms of Hall (1992) already found evidence for the unsuitability of debt as a source of finance for R&D investment. This is due to the risky nature of R&D. Czarnitzki and Kraft (2009), who did an empirical study on a large sample of German manufacturing firms, found that debt financing has a negative impact on innovativeness. As debt financing creates a commitment, inefficient allocation of firm resources will significantly increase the risk of bankruptcy. In the past, firms with large debt levels have not been R&D intensive firms.

Further research on the relationship between debt and R&D has been conducted by Chiao (2002), using a panel of US firm data in which the assumptions of Hall (1992) serves as a benchmark. Consistent with his findings, current R&D is negatively affected by current debt. However this argument only holds for firms in science-based industries, which proportionally spend more money on R&D investment and have a higher R&D capital stock than nonscience-based industries firms. Because investors tend to finance tangible assets, high R&D capital stock will increase the marginal cost of debt for those firms (Chiao, 2002). In order to resolve this they may want to reduce the marginal cost of debt by reducing the overall debt level, if R&D is essential for them to remain competitive. If current debt is already high, high marginal cost of debt may also discourage R&D investment.
If firms are constrained because debt levels restrict them from full access to sources of debt, overall R&D level will decrease and thus innovation in general. Firms in nonscience-based industries are more likely to finance R&D investment with debt (Chiao, 2002). Again this can be explained because of the proportionally lower amount spent on R&D for those firms combined with the greater availability of tangible assets, which are an important element for investors.

An earlier paper of Long and Ravenscraft (1993) found out that firms that were undergoing a leverage buyout (LBO), or acquisition of another company mainly financed with debt, were typically low-tech firms for which R&D is not critical. This could have something to do with the fact that financial constraint are higher for firms in technology intensive sectors (Hall et al., 2015), which makes them less attractive to acquire. R&D intensity after an LBO declines significantly as a result of the debt incurred, although this effect is smaller for large firms. Performance nevertheless does not drop, which implies that mostly marginal, low productivity R&D gets cut.

3.3.5 The need to distinguish between two types of debt and the effect on R&D

According to David et al. (2008) firms tend to align their debt structure with R&D investments over time, but only after deregulation permits relatively free access to various types of debts. More interesting, they argue that instead of homogeneous, debt is

heterogeneous. In earlier research on the relationship between R&D and capital structure researchers have distinguished between debt and equity, assuming that debt is a relatively simple and homogeneous financial instrument (David et al., 2008). Extending research of Boot (2000), David et al. (2008) found that there are two types of debt with different implications for R&D investment. Taking this into consideration, the choice of debt by managers is no longer irrelevant but will have a huge impact on R&D activity. David et al. (2008) make a distinction between relational debt (loan between firm and financial institution) and transactional debt (public securities, for example bonds).

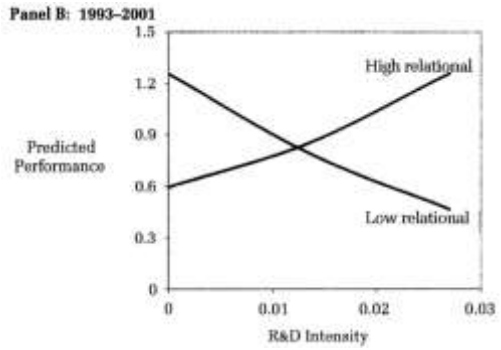

Figure 4: Relationship between R&D intensity and performance, retrieved from David et al. (2008)

R&D intensive firms that rely more on relational debt outperform those that rely more heavily on transactional debt, which is resembled in figure 2. The figure represents a panel of firms with both high relational and low relational debt. With high relational it is meant that a firm almost completely relies on relational debt, whereas low relational debt implies that a firm almost completely relies on transactional debt. With high relational debt performance increases with R&D intensity. This means, if companies can freely choose their debt structure, they should opt for relational debt. Flexibility of banks enables the firm to restructure debt easily if it experiences difficulties, which decreases the costs of financial distress associated with leverage (Kang and Stulz, 2000). Nevertheless, only those firms with a sufficiently high demand for flexibility choose bank lending over bond financing (Bolton and Freixas, 2000). This is because, although more flexible, bank lending is more expensive than bond financing because of intermediation costs. Another reason to opt for relational debt might be that bank loans are monitored, so banks can easily control how their borrowers are performing (Kang and Stulz, 2000).

3.3.6 R&D investment using different financial instruments

As mentioned before, firms investing in R&D do not solely have to rely on debt financing. Especially larger firms can choose among a wide range of financial instruments. Wang and Thornhill (2010) categorized four of them, which can be seen in figure 5, based on the degree of intervention barriers and appropriation discrepancy between capital providers and the firm. The former one refers to the (in)ability of capital providers to monitor and intervene in management as a result of asymmetric information. The latter one refers to what extent the returns of capital providers are separated from the firm's residual value.

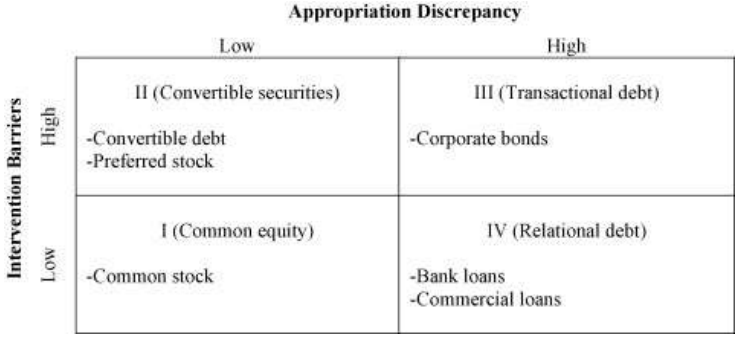

Figure 5, Financial instruments differentiated based on intervention barriers and appropriation discrepancy, retrieved from Wang and Thornhill (2010)

If free access to various types of debt is ensured firms can choose the financing method that suits them best. The table also provides further argument that for R&D intensive firms transactional debt is associated with lower levels of performance (David et al., 2008), both because intervention barriers and appropriation discrepancy are high. Holders of those corporate bonds get fixed interest payments, which are predetermined and isolated from the firm's residual value (Wang & Thornhill, 2010) and do not have access to non – public information. This would imply that more R&D investment is related to less financing through transactional debt. Nevertheless, this appeared not be so.

The main argument for this unexpected result was that R&D investments helps firms to achieve superior performance which can make debt financing cheaper. Superior performance will lead to higher cash flows, which makes it easier for companies to use debt financing. Nevertheless, in general firms with more specific assets will opt less for debt financing (Vicente-Lorente, 2001), in this case transactional debt. Many firm specific assets like R&D are intangible and therefore cannot serve as good collateral for borrowing (Balakrishnan & Fox, 1993).

Wang and Thornhill (2010) also proved that there exists a positive relationship between R&D investment and financing through common equity, linked to both low intervention barriers and low appropriation discrepancy. Nohria & Gulati (1996) and O'Brien (2003), as mentioned earlier in this session, pointed out that financial slack is of major importance for R&D. Because R&D is very resource consuming, firms with a high level of R&D need to reduce other financial obligations (David et al., 2008). Financing with common equity can serve as a buffer for failed R&D projects and reduces risk of bankruptcy.

According to David et al. (2008) performance increased if the fraction of relational debt in comparison to total debt was higher. Nevertheless, Wang & Thornhill (2010) proved that very low or high levels of R&D investment may constrain access to relational debt. Relational debt providers avoid very R&D intensive firms, because it may imply that these firms have opaque knowledge (Vicente-Lorente, 2001). High levels of R&D may also constrain access to relational debt because relational debt is often secured by collateral assets (Wang and Thornhill, 2010) and R&D does, as mentioned before, not serve as good collateral. Low levels on the other hand assume that there is no basis for a sustained competitive advantage for firms (Barney, 1991). Return of relational debt providers depend on continuous lending to successful firms (Boot, 2000) and R&D is positively related to higher performance and thus success (Lome et al., 2016). All this results in an inverted u-shaped relationship between R&D investment and financing through relational debt (Wang & Thornhill, 2010).

The opposite relationship, so u-shaped, exists between R&D investment and financing through convertible securities (Wang and Thornhill, 2010). Because the value of common stock is closely related to R&D investment and holders of convertible securities are able to transform their convertible debt / preferred stock into common stock, the value of convertible securities is high for firms that invest a lot in R&D. This means they are more attractive to providers of these convertible securities, implying a positive relationship when R&D investment is high (ibid.).

3.3.7 Relevance and importance of external equity related to R&D

In accordance with the pecking order theory, external financing with equity ranks last in the hierarchy of preferences for financing. Nevertheless, Brown et al. (2012) found evidence that access to external equity matters for R&D. As mentioned earlier in this session, debt is an unsuitable source of finance for firms investing in R&D. The riskiest firms may be too risky to

obtain bank loans or issue bonds (Bolton and Freixas, 2000). Because of this, firms may need to resort to other sources of external finance. Aghion et al. (2004) found that firms who invest more heavily in R&D have a higher probability of issuing new equity, which was once again confirmed by the study of Czarnitzki and Hottenrott (2011). Further elaborating on this, Vicente-Lorente (2001) already found evidence that investment in R&D will primarily result in intangible assets, which cannot be easily collateralized. As banks often require collateral, more highly innovative firms will have no choice but to issue outside equity (Aghion et al., 2004). When the project size (or scope) becomes sufficiently large and/or when the assets become sufficiently intangible, R&D intensive firms will thus be more likely to issue new equity (Casson et al., 2008).

According to Magri (2014) equity is a better source of external finance than debt for innovation, even though equity can be affected by issuing costs and adverse selection problems that arise from information asymmetry. The main arguments for this are that it does not require collateral, it does not increase the probability of bankruptcy and it allows investors to reap the entire benefits of the returns of innovative projects. Also, Magri (2014) found evidence that issuing equity increases the probability that the firm has R&D expenditures. According to Dittmar and Thakor (2007), firms that issue equity have more R&D expenses. However, this effect is stronger for small (and young) firms. Those firms may need to conduct more fundamental R&D, which requires more resources and is much more uncertain (Czarnitzki & Hottenrott, 2011). Also Brown and Petersen (2008) found that particularly R&D investment of firms with low cash flows may be heavily dependent on public equity finance.

3.3.8 Difficulty of raising new equity for R&D investment and problem-solving policy

Although according to Magri (2014) equity is a better source of external financing than debt for innovation, it is certainly not easy to get access to new equity. Firms need to find new owners willing to invest in the company, but those investors may be reluctant to take control (Müller and Zimmermann, 2008). They may be only willing to engage in substantial R&D activities if the returns of the R&D project are high enough to make the acquisition of additional equity feasible and worthwhile. Therefore, in some situations the required returns for obtaining new equity from additional owners may be too high, refraining firms to undertake R&D (Müller and Zimmermann, 2008).

The importance of external equity suggests that policies which increase access to external equity finance, like improvement of accounting standards and stronger protection for investors, can increase R&D investment in firms (Brown et al., 2012). According to Müller and Zimmermann (2008), governments could try to improve the access to equity capital or could initiate support programmes that provide cheaper equity capital to support R&D activities. Especially if internal funds are unavailable and taking into account that common equity reduces risk of bankruptcy (David et al. 2008), external equity may be used as an appropriate alternative. If it is easier for companies to issue equity, smooth and continuous investment in R&D can be ensured (O'Brien, 2003) which will reduce adjustment cost related to R&D (Brown et al., 2012).

In this section the relationship between internal financing / debt financing / new equity financing and R&D has been intensively studied. In the table below a summary is provided

on the direction of the relationship between financing (and thus capital structure) and R&D according to the different authors. So, does 1) the source of finance determines the R&D intensity?, 2) the R&D intensity determines the source of finance? or 3) a causal relationship in both ways (underscored) exists between both components?

Table 5: Direction of the relationship between the source of finance and R&D intensity

From / To	R&D	Finance
R&D	—	Jordan et al. (1998), Vicente-Lorente (2001), Aghion et al. (2004), Casson et al. (2008), Müller and Zimmermann (2008) and Wang and Thornhill (2010) Chiao (2002) and O'Brien (2003)
Finance	Myers and Majluf (1984), Nohria and Gulati (1996), David et al. (2008), Czarnitzki and Kraft (2009), Czarnitzki and Hottenrott (2011) and Hall et al. (2015) Chiao (2002) and O'Brien (2003)	—

3.4 Relationship between in-house/outsourcing R&D and capital structure

3.4.1 Relationship between in-house R&D and capital structure

The view that capital structure is partially determined by 'make or buy' decisions, as mentioned before closely related to R&D activities, was established by Vicente-Lorente (2001). The author makes a clear distinction between internal R&D and external R&D. The former one, referred to as the ratio of internal R&D investments to total net sales, appears to be negatively correlated with financial leverage, whereas external R&D intensity does not affect the borrowing decision.

In figure 6, (Vicente-Lorente, 2001) specificity of an asset refers to how specific it is in relation with other assets. This specificity was already mentioned as a key determinant for in-house R&D according to the TCE theory discussed in section 3.2. For firms investing in specific assets, integration of R&D (or internal R&D) is more likely (Robertson and Gatignon, 1998). Opacity on the other hand refers to transparency. An opaque asset is one that is difficult to imitate because information for outsiders is limited. Comparing this to the RBV theory in section 3.2, opacity is also a motive for in-house R&D because the focus of in-house R&D is on protecting core competences to maintain a competitive advantage in the long term (Barney, 1991). Although mentioning specificity and opacity of assets, the figure can still be useful. One can relate it to R&D as the author (Vicente-Lorente, 2001) considers internally made R&D as an example of a specific and opaque resource.

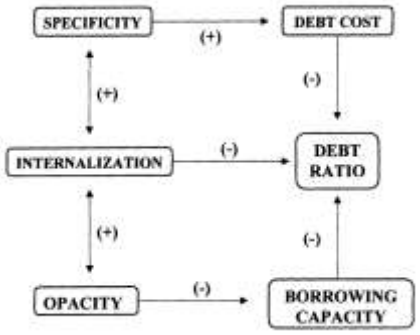

Figure 6: Effect of internalization on debt ratio, retrieved from Vicente-Lorente (2001)

Technological knowledge acquired through internally developed activities (or internal R&D) thus is highly firm specific and opaque (Vicente-Lorente, 2001). Both specificity and opacity have a negative effect on the debt ratio, calculated using total debt / total assets. Specificity increases debt cost, because in case of reorganization or bankruptcy the assets will incur high losses of value. Lenders will therefore charge a risk premium. Opacity on the other hand reduced borrowing capacity. This might be because investment in R&D will primarily result in intangible assets, which cannot be easily collateralized. According to Piga and Atzeni (2007) lenders do not look favourably at large in-house R&D activities on the borrower's side as they entail a greater proportion of intangible assets.

As discussed previously, one has to take into consideration that most R&D expenditures are on staff and materials (Hall and Lerner, 2010), which do not serve as collateral for debt financing. For internal R&D it is necessary to establish a department and hire highly skilled employees, which clearly is a long term project. Internal R&D unit costs increase with both plant size and the scale of the R&D operations / numbers of R&D staff (Love and Roper, 2002). The entire internal organization and management thus needs to be called upon (d'Alfonso and Giannangeli, 2012) and uncertainty is much higher because, as mentioned earlier, human capital is lost if employees leave the firm (Hall and Lerner, 2010). Uncertainty is also higher for in-house R&D because both the objectives and implementation of the projects will be less visible to external financers (d'Alfonso and Giannangeli, 2012). Because of this uncertainty investors require a higher rate of return, which may force firms to have a preference for internal sources of finance (ibid.). As lack of collateral and information

asymmetry thus raise the cost of external funding, financing in-house R&D strongly rests on internal funding sources (Som, 2011). Bradley et al. (1984) already found evidence that R&D expense is negatively related to firm leverage and as internal R&D projects are more expensive than external R&D projects (Den Hertog and Thurik, 1993), in-house R&D will be more dependent on internal sources of finance.

To summarize, the relationship found in literature between in-house R&D and the source of finance is shown in the figure below.

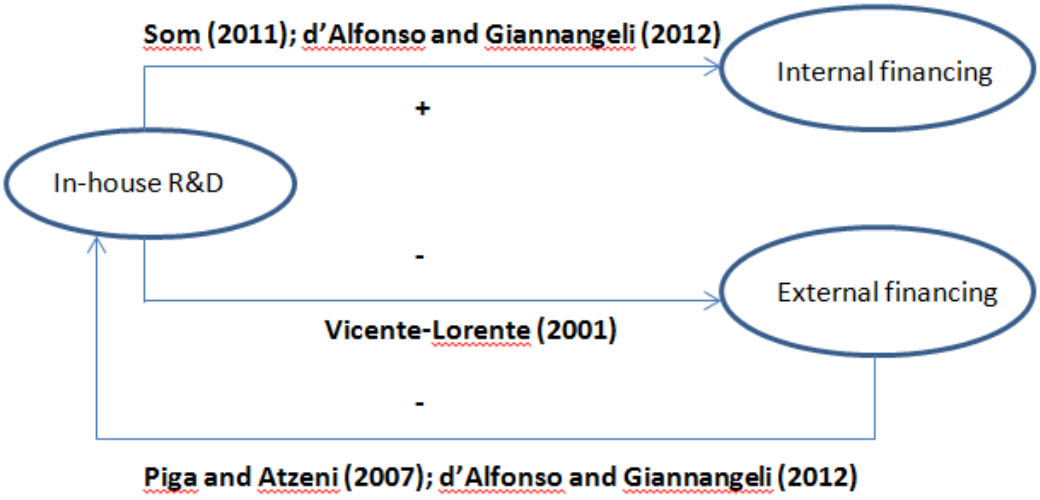

Figure 7: Relationship between in-house R&D and the source of finance

3.4.2 Relationship between outsourcing R&D and capital structure

d'Alfonso and Giannangeli (2012) argued that the use of bank debt for financing R&D increases the probability of outsourcing R&D. When we compare this to research of Vicente-Lorente (2001), in which 'make or buy' decisions with regard to R&D determined the capital structure, here the type of R&D is determined by the capital structure. Research of Bartoloni (2013) also found evidence that the type of finance determines how firms innovate. The paper of d'Alfonso and Giannangeli (2012) proved that in the presence of asymmetric information this hypothesis is indeed valid.

As mentioned earlier in this section, lenders do not look favourably at large in-house R&D activities (Piga and Atzeni, 2007). Besides, those large in-house activities provide a stronger incentive for the borrower to reduce the flow of information to the lender. This increases information asymmetry and according to d'Alfonso and Giannangeli (2012), in the presence of information asymmetry, the use of bank debt increases the probability of outsourcing R&D. This could have something to do with the fact that, as mentioned earlier in this thesis, banks are more willing to lend when the firm is engaged in known and well understood areas of activity (Jordan et al, 1998). If banks provide a loan, they will demand more standard and less firm-specific assets because such assets will offer them clear advantages in terms of evaluation and redeploy ability (Tirole, 2006). As in-house R&D activities are highly specific to the firm and monitoring firm-specific R&D activities is difficult for banks (Jordan et al., 1998), receiving a loan increases the probability of outsourcing R&D. Outsourcing is likely to involve generic, non-firm specific, already-sufficient standard knowledge (d'Alfonso and Giannangeli, 2012). This takes away the problem for lenders of insufficient physical collateral, because as discussed before specificity increases the cost of debt and therefore

reduces the borrowing capacity (Vicente-Lorente, 2001). Relating to the problem of insufficient physical collateral, Materia et al. (2015), using cross-section data on 1,393 agri-food firms in seven EU countries, found that a higher level of asset tangibility positively affects both in-house R&D and outsourcing R&D. The effect however was larger for outsourcing R&D.

Turning to external, contractually stated R&D may reduce information asymmetry and improve the borrowing capacity (d'Alfonso and Giannangeli, 2012). When R&D is acquired from external suppliers, the final objectives of the project and the monitoring steps are no longer less visible for external financers. They must be clearly stated from the beginning, for example the costs and the time-horizon in which the project must be accomplished (d'Alfonso and Giannangeli, 2012.)
However, as information asymmetry between the bank and the firm diminishes, one can no longer assume that using bank debt increases the probability of outsourcing (d'Alfonso and Giannangeli, 2012). As the relationship with the bank improves, differences in asset specificity between outsourcing and in-house R&D become smaller (ibid.) Relating to this issue research conducted by Materia et al. (2015) found evidence that long-term leverage, calculated by dividing long term liabilities by total assets, is negatively related to R&D outsourcing. R&D activities increase the risk level of the firm and firms with already high levels of debt bear even more risk with regards to investments in R&D.

To summarize, the relationship found in literature between outsourcing R&D and the source of finance is shown in the figure below. The * indicates that this particular relationship only holds in the presence of asymmetric information.

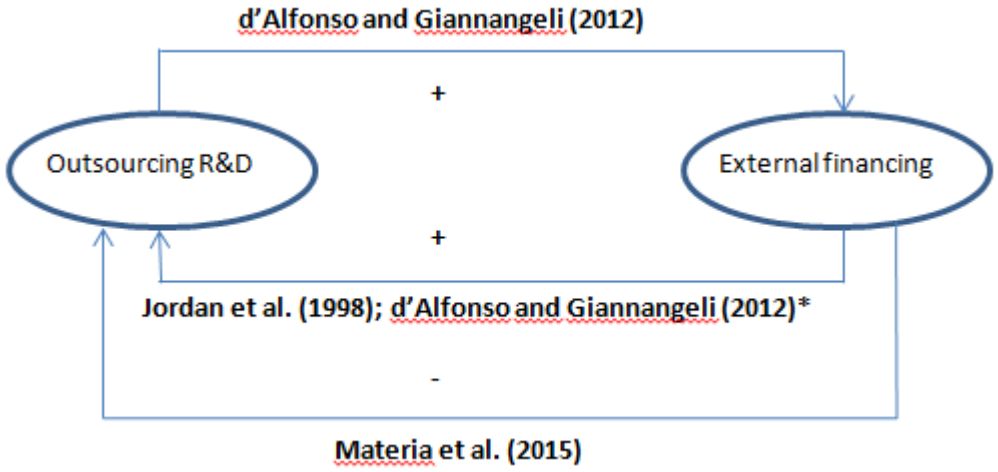

Figure 8: Relationship between outsourcing R&D and the source of finance

4. Discussion

This thesis has examined the relationship between the capital structure of a firm and its R&D strategy. It has tried to discover whether the relationship runs from finance to R&D or the other way around. As there is a lack of sufficient research conducted on this relationship, especially if one differentiates between in-house R&D and outsourcing R&D, this thesis attempts to contribute to reducing the knowledge gap. By means of a literature study this research shows that until now there is no consensus in research whether capital structure or R&D strategy is the determinant of its counterpart. Nevertheless, the findings of this literature study implicate that there is enough evidence to assume the existence of a causal relationship between both components.

This research has shown that there is a need for further research on the relationship between capital structure and R&D strategy. In an ideal situation this would result in a universal theory on the causality of the relationship.
In practice, managers of innovative firms need to take into account that the chosen R&D strategy and/or the source of finance can have huge (alternative) implications. Governments can use the knowledge provided to stimulate R&D investments as a mean to increase performance by playing a facilitating role between firms on the one hand and capital providers on the other hand.

As this thesis is a literature review without executing quantitative research it is subjected to some limitations. Firstly, there is a lack of sufficient scientific research on the relationship between capital structure and R&D strategy. Although many studies have analysed either capital structure or R&D strategy, the relationship between both concepts is relatively underdeveloped. Even less literature is available when making a distinction between in-house R&D and outsourcing R&D. Combining that with the fact that available literature is also mainly focussed on manufacturing firms, it is difficult to generalize the findings of this thesis. Secondly, this research has deduced information from a wide range of scientific articles. Even if this is necessary to conduct a thorough literature review, one has to take into account that all those studies use their own (specifically) chosen indicators. Therefore some associations made in this thesis may not be a good representation of reality, making reliability regarding this issue questionable. Thirdly, since no quantitative research is conducted due to time constraint, it is impossible to test whether or not the main findings of this thesis hold on a dataset of companies. Fourthly, emphasis in the first part of this thesis was put on internal and external determinants of the capital structure as well as features of in-house R&D and outsourcing R&D. Undoubtedly exploration of these concepts is a prerequisite to get a better understanding of the topic in general, but just a small part of those findings seem to come back in literature on the relationship between capital structure and R&D strategy. Finally, a limitation for research on this topic in general, one always has to take into account that firms may not be willing to disclose all information on both their financing choices and the decision what R&D strategy to pursue.

For future research it may be wise to initiate research directly on the relationship and see what findings on both the capital structure and R&D strategy emerge from it. Although still underexplored, especially in the last couple of years the relationship between the source of finance (internal or external) and R&D has been increasingly analysed. Nevertheless, only

few authors make a distinction between in-house R&D and outsourcing R&D. Further research is necessary to gain more knowledge on causality of the relationship between capital structure and R&D strategies. A quantitative dataset could be a next step to find evidence on this causality and to test some of the findings of this thesis. To generalize, it would be interesting not to restrict the quantitative research to manufacturing as has been done in previous research, but to include sectors such as IT, healthcare and, especially interesting from the viewpoint of Wageningen UR, agriculture.

5. Conclusion

The objective of this thesis was to explore the relationship between capital structure and R&D strategy by conducting a literature review. Although not generating new results, extracting scientific literature from a wide range of sources may contribute to give a better understanding of the nature and the direction of this relationship. The most important findings of this research are:

- Size and industry seem to have an impact on both the decision which R&D strategy to pursue and how to finance R&D. Collateral value and asymmetric information will influence the source of finance used for R&D investment. For the other internal and external determinants of the capital structure, no or insufficient evidence was found in literature.
- There is still no universal theory on the causality of the relationship between capital structure and R&D. Some researchers argue that it runs from finance to R&D, while according to others it is exactly the other way around. A few authors claim that the causal relationship goes both ways.
- The pecking order theory explains that firms have a preference for internal financing. Research consulted in this thesis shows that this also holds for investment in R&D. If internal financing is insufficient, according to the pecking order theory one would assume that debt financing is next in line. Although it has become clear that reliance on relational debt for R&D investment increases performance, high levels of R&D investment constrain access to relational debt. External financing with equity can reduce most problems related to debt financing (such as bankruptcy and requirement of collateral), but investors are only willing to invest in R&D intensive firms if returns are substantial.
- In-house R&D appears to positively influence the decision to opt for internal financing. The relationship between in-house R&D and external financing appears to be negative in both ways.
- The relationship between outsourcing R&D and external financing appears to be positive in both ways. For internal financing, no direct literature on the relationship was found.

References

Aghion, P., Bond, S., Klemm, A., & Marinescu, I. (2004). Technology and financial structure: Are innovative firms different? Journal of the European Economic Association, 2(2-3), 277-288.

Alessandri, T.M., & Pattit, J.M. (2014). Drivers of R&D investment: The interaction of behavioural theory and managerial incentives. Journal of Business Research, 67(2), 151-158.

Balakrishan, S., & Fox, I. (1993). Asset specificity, firm heterogeneity and capital structure. Strategic Management Journal, 12(1), 3-16.

Baregheh, A., Rowley, J., & Sambrook, S. (2009). Towards a multidisciplinary definition of innovation. Management Decision, 47(8), 1323-1339.

Barney, J. (1991). Firm resources and sustained competitive advantage. Journal of Management, 17(1), 99-120.

Barthelemy, J. (2003). The seven deadly sins of outsourcing. Academy of Management Executive, 17(2), 87-98.

Bartoloni, E. (2013). Capital structure and innovation: causality and determinants. Empirica, 40, 111-151.

Belcourt, M. (2006). Outsourcing - The benefits and the risks. Human Resource Management Review, 16(2), 269-279.

Berchicci, L. (2013). Towards an open R&D system: Internal R&D investment, external knowledge acquisition and innovative performance. Research Policy, 42(1), 117-127.

Bolton, P., & Freixas, X. (2000). Equity, bonds, and bank debt: Capital structure and financial market equilibrium under asymmetric information. Journal of Political Economy, 108(2), 324-351.

Boot, A.W.A. (2000). Relationship banking: What do we know? Journal of Financial Intermediation, 9(1), 7-25.

Bradley, M., Jarell, G.A., & Kim, E.H. (1984). On the existence of an optimal capital structure: Theory and evidence. The Journal of Finance, 39(3), 857-878.

Brown, J.R., Martinsson, G., & Petersen, B.C. (2012). Do financing constraints matter for R&D? European Economic Review, 56, 1512-1529.

Brown, J., & Petersen, B.C. (2008). Why has the investment-cash flow sensitivity declined so sharply? Rising R&D and equity market developments. Journal of Banking & Finance, 33(5), 971-984.

Caniëls, M.C.J., & Roeleveld, A. (2009). Power and dependence perspectives on outsourcing decisions. European Management Journal, 27(6), 402-417.

Cassiman, B., & Veugelers, R. (2006). In search of complementarity in innovation strategy: Internal R&D and external knowledge acquisition. Management Science, 52(1), 68-82.

Casson, P.D., Martin, R., & Nisar, R.M. (2008). The financing decisions of innovative firms. Research in International Business and Finance, 22(2), 208-221.

Chesbrough, H., Crowther, A.K. (2006). Beyond high tech: early adopters of open innovation in other industries. R&D Management, 36(3), 229-236.

Chesbrough, H., Vanhaverbeke, W., & West, J. (2006). Open innovation: Researching a new paradigm, Oxford University Press.

Chiao, C. (2002). Relationship between debt, R&D and physical investment, evidence from US firm-level data. Applied Financial Economics, 12(2), 105-121.

Cruz-Cazares, C., Bayona-Saez, C., & Garcia-Marco, T. (2013). Make, buy or both? R&D strategy selection. Journal of Engineering and Technology Management, 30(3), 2013.

Cusmano, L., Mancusi, M.L., & Morrison, A. (2010). Globalization of production and innovation: How outsourcing is reshaped an advanced manufacturing area. Regional Studies, 44(3), 235-252.

Czarnitzki, D., & Hottenrott, H. (2011) R&D investment and financing constraints of small and medium-sized firms. Small Business Economics, 36, 65-83.

Czarnitzki, D., & Kraft, K. (2009). Capital control, debt financing and innovative activity. Journal of Economic Behavior & Organization, 71, 372-282.

D'Alfonso, E., & Giannangeli, S. (2012). Outsourcing innovation and the role of bank debt for SMEs. Working Paper Series, 28.

David, P., O'Brien, J.P., & Yoshikawa, T. (2008). The implications of debt heterogeneity for R&D investment and firm performance. The Academy of Management Journal, 51(1), 165-181.

Danis, A., Rettl, D.A., Whited, T.M. (2014). Refinancing, profitability, and capital structure. Journal of Financial Economics, 114(3), 424-443.

DeAngelo, H., & Masulis, R. (1980). Optimal capital structure under corporate and personal taxation. Journal of Financial Economics, 8, 3-29.

De Jong, A., Kabir, R., & Nguyen, T.T. (2008). Capital structure around the world: The roles of firm- and country-specific determinants. Journal of Banking & Finance, 32, 1954-1969

Den Hertog, R.G.J., & Thurik, A.J. (1993). Determinants of internal and external R&D: Some Dutch evidence. De Economist, 141(2).

Dittmar, A., & Thakor, A. (2007). Why do firm issue equity? The Journal of Finance, 62(1), 1-54.

Espino-Rodriguez, T.F., & Padron-Rabaina, V. (2006) A review of outsourcing from the resource-based view of the firm. International Journal of Management Reviews, 8(1), 49-70.

Faulkender, M., & Petersen, M.A. (2006). Does the source of capital affect capital structure? The Review of Financial Studies, 19(1), 45-79.

Frank, M.Z., & Goyal, V.K. (2009) Capital structure decisions: Which factors are reliably important? Financial Management, 38(1), 1-37.

Friend, I., & Hasbrouck, J. (1988). Determinants of capital structure. Research in Finance, 7(1), 1-19.

Freytag, P.V., Clarke, A.H., & Evald, M.R. (2012) Reconsidering outsourcing solutions. European Management Journal, 30(2), 99-110.

Garcia-Manjon, J.V., & Romero-Merino, M.E. (2012). Research, development, and firm growth. Empirical evidence from European top R&D spending firms. Research Policy, 41, 1084-1092.

Gassmann, O. (2006). Opening up the innovation process: towards an agenda. R&D Management, 36(3), 223-228.

Griffith, R., Redding, S., & Van Reenen, J. (2004). Mapping the two faces of R&D: Productivity growth in a panel of OECD industries. The Review of Economics and Statistics, 86(4), 883-895.

Hagedoorn, J., & Wang, N. (2012). Is there a complementarity or substitutability between internal and external R&D strategies. Research Policy, 41(6), 1072-1083.

Hall, B.H. (1992). Investment and Research and Development at the Firm Level: Does the Source of Financing Matter? Economics Department, University of California at Berkeley and National Bureau of Economic Research. Working Paper, 92-194

Hall, B.H., Castello, P.M-P, Montressor, S., & Vezzani, A. (2015). Financing constraints, R&D investment and innovative performances: new empirical evidence at the firm level of Europe, Economics of Innovation and New Technology, 25(3), 183-196.

Hall, G.C., Hutchinson, P.J., & Michaelas, N.(2004). Determinants of capital structures of European SMEs. Journal of Business Finance & Accounting, 31(5-6), 711-728.

Hall, B.H., & Lerner, J. (2010). The financing of R&D and Innovation. Handbook of Economics of Innovation, Elsevier, 1.

Harris, M., & Raviv, A. (1991). The theory of capital structure. The Journal of Finance, 46(1), 297-355.

Howells, J. (1999). Research and technology outsourcing. Technology Analysis & Strategic Management, 11(1), 17-29.

Huang, Y-A., Chung, H-J., & Lin, C. (2009). R&D sourcing strategies: Determinants and consequences. Technovation, 29(3), 155-169.

Jensen, M.C. (1986). Agency costs of free cash flow, corporate finance, and takeovers. The American Economic Review, 76(2), 323-329.

Jensen, M.C., & Meckling, W.H. (1976). Theory of the firm: Managerial behavior, agency costs and ownership structure. Journal of Financial Economics, 3(4), 305-360.

Jiraporn, P., Chintrakarn, P., Kim, J-C., & Liu, Y. (2013). Exploring the agency costs of debt: Evidence from the ISS governance standards. Journal of Financial Services Research, 44(2), 205-227.

Jordan, J., Lowe, J., & Taylor, P. (1998). Strategy and financial policy in UK small firms. Journal of Business & Accounting, 25(1-2), 705-737.

Kang, J-K., & Stulz, R.M. (2000). Do banking shocks affect borrowing firm performance? An analysis of the Japanese experience. The Journal of business, 73(1), 1-23.

Kessler, E.H., Bierly, P.E., & Gopalakrishnan, S. (2000) Internal vs. external learning in new product development: effects on speed, costs and competitive advantage. R&D Management, 30(3), 2000.

Korajczyk, R.A., & Levy, A. (2003). Capital structure choice: macroeconomic conditions and financial constraint. Journal of Financial Economics, 68(1), 75-109.

Laursen, K., & Salter, A. (2006). Open for innovation: The role of openness in explaining innovation performance among U.K. manufacturing firms, Strategic Management Journal, 27, 131-150.

Leiblein, M.J., Reuer, J.J., & Dalsace, F. (2002). Do make or buy decisions matter? The influence of organizational governance on technological performance. Strategic Management Journal, 23, 817-833.

Leonard, W.N. (1971). Research and development in industrial growth. Journal of Political Economy, 79(2), 232-256.

Lome, O. (2016). The effect of R&D on performance: Do R&D intensive firms handle a financial crisis better? The Journal of High Technology Management Research, 27(1), 65-77.

Long, W.F., & Ravenscraft, D.J. (1993). LBOs, Debt and R&D Intensity. Strategic Management Journal, 14, 119-135.

Love, J., & Roper, S. (2002). Internal versus external R&D: A study of R&D choice within sample selection, International Journal of the Economics of Business, 9(2), 239-255.

MacKay, P., & Philips, G.M. (2005). How does industry affect the firm financial structure? The Review of Financial Studies, 18(4), 1433-1466.

Magri, S. (2014). Does issuing equity help R&D activity? Evidence form unlisted Italian high-tech manufacturing firms. Economics of Innovation and New Technology, 23(8), 825-854.

Marsh, P. (1982). The choice between equity and debt: An empirical study. Journal of Finance, 37, 121-144.

Mata, J., & Woerter, M. (2013). Risky innovation: The impact of internal and external R&D strategies upon the distribution of returns. Research Policy, 42(2), 495-501.

Materia, V.C., Abduraupov, R., Dries, L., & Pascucci, S. (2015). Does the capital structure of firms influence their innovation strategies? Evidence from the European agri-food sector.

Materia, V.C., Pascucci, S., & Dries, L. (2014). Are in-house and outsourcing innovation strategies interlinked? Evidence from European agri-food sector. Compete Working paper, 11.

Mcvlor, R. (2008). What is the right outsourcing strategy for your process? European Management Journal, 26(1), 24-34.

Mclvor, R., Humphreys, P., McKittrick, A., & Wall, T. (2009). Performance management and the outsourcing process: Lessons from a financial services organisation. International Journal of Operations and Production Management, 29(1), 1025-1048.

Modigliani, F., & Miller, M. (1958). The cost of capital corporation finance and the theory of investment. The American Economic Review, 48(3), 261-297.

Mol, M.J. (2005). Does being R&D intensive still discourage outsourcing? Evidence from Dutch manufacturing. Research Policy, 34(4), 2005.

Moyer, R.C., McGuigan, J.R., & Kretlow, W.J. Contemporary Financial Management, 8th edition. South-Western College Publishing, Cincinnati, OH, 2001.

Mowery, D.C. (1983). The relationship between intrafirm and contractual forms of industrial research in American manufacturing. Explorations in Economic History, 20, 351-374

Müller, E., Zimmermann, V. (2008). The importance of equity finance for R&D activity. Small Business Economics, 33, 303-318.

Myers, S.C. (1977). Determinants of corporate borrowing. Journal of Financial Economics, 5, 147-175.

Myers, S. C. (2001). Capital Structure. Journal of Economic Perspectives, 15(2), 81-102.

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.

Narula, R. (2001). Choosing between internal and non-internal R&D activities: Some technological and economic factors. Technology Analysis & Strategic Management, 13(3), 365-387.

Nohria, N., & Gulati, R. (1996). Is slack good or bad for innovation. The Academy of Management Journal, 39(5), 1245-1264.

O'Brien, J.P. (2003). The capital structure implications of pursuing a strategy of innovation. Strategic Management Journal, 24(5), 415-431.

Piachaud, B.S. (2002). Outsourcing in the pharmaceutical manufacturing process: an examination of the CRO experience. Journal Technovation, 22(2), 81-90.

Piga, C.A., & Atzeni, G. (2007). R&D investment, credit rationing and sample selection. Bulletin of Economic Research, 59(2), 149-178.

Popper, M., & Lipshitz, R. O(2000) Organizational learning: Mechanisms, culture and feasibility. Management Learning, 31(2), 181-196.

Raj, R., & Srivastava, K. (2013). The mediating role of organizational learning on the relationship among organizational culture, HRM practices and innovativeness. Management and Labour Studies, 38(3), 201-223.

Robertson, T.S., & Gatignon, H. (1998). Technology development mode: A transaction cost conceptualization. Strategic Management Journal, 19(6), 515-531.

Sampson, R.C. (2004). The cost of misaligned governance in R&D alliances. The Journal of Law, Economics, and Organization, 20(2), 2004.

Santoro, M.D., & Chakrabarti, A.K. (2002). Firm size and technology centrality in industry-university interactions. Research Policy, 31, 1163-1180.

Schumpeter, J.A. (1934). The Theory of Economic Development, Harvard University Press, Cambridge, MA.

Scott, J.H. (1977). Bankruptcy, secured debt, and optimal capital structure. The Journal of Finance, 32(1), 1977.

Smith, C.W. (1977). Alternative methods for raising capital. Journal of Financial Economics, 5, 273-307.

Som, O. (2011). Innovation without R&D, heterogeneous innovation patterns of non-R&D-performing firms in the German manufacturing industry, DOI 10.1007/978-3-8349-3492-5.

Teece, D.J. (1986). Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. Research Policy, 15(6), 285-305.

Titman, S., & Wessels, R. (1988). The determinants of capital structure. The Journal of Finance, 43(1), 1-19.

Ulset, S. (1996). R&D outsourcing and contractual governance: An empirical study of commercial R&D projects. Journal of Economic Behaviour, 30(1), 63-82.

Vernimmen, P., Quiry, P., Dallochio. M, Le Fur, Y., & Salvi, A. (2015). Corporate Finance: theory and Practice. DOI: 10.1002/9781119208372.ch35

Veugelers, R. (2007). Internal R&D expenditures and external technology sourcing. Research Policy, 26, 303-315.

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.

Wakelin, K. (2001). Productivity growth and R&D expenditure in UK manufacturing firms. Research Policy, 30, 1079-1090.

Wald, J.K. (1999). How firm characteristics affect capital structure: An international comparison. The Journal of Financial Research, 12(2), 161-187.

Walker, G., & Weber, D. (1984). A transaction cost approach to make-or-buy decisions. Administrative Science Quarterly, 29(3), 373-391.

Wang, T. & Thornhill, S. (2010). R&D investment and financing choices: A comprehensive perspective. Research Policy Elsevier, 39, 1148-1159.

West, A. (2002). Estrategia de Innovacio ‘n (in Spanish). Clasicos COTEC, Madrid, 342 pp.