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Carbon Risk and Corporate Capital Structure: The State of the Art

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Abstract

In this paper the relationship between carbon risk and corporate capital structure is examined. Recent literature highlights that heavy carbon-emitting firms need to adjust their level of indebtedness to reach their optimal financial leverage. Specifically, the amount of debt raised by high carbon-emitting businesses is lower than that of their low carbon-emitting counterparts. This can be explained by using the trade-off theory, according to which heavy carbon-emitting firms undergo both increasing financial distress costs and decreasing tax benefits of debt, causing them to employ a lower level of financial leverage relative to light carbon-emitting firms.

Keywords: carbon risk, corporate capital structure, financial distress risk, tax shield benefits, trade-off theory

1. Introduction

Since the Paris Agreement, which was signed by 195 countries in December 2015 to limit global warming to below 2 ℃ above pre-industrial levels (UNFCCC, 2016), carbon risk has increased the business risk all over the world for heavy carbon-emitting firms. In fact, owing to the implementation of this agreement, carbon regulation policies have been introduced and these have generated significant costs and/or abandoning of billions of carbon assets that are the main sources of carbon dioxide for enterprises (Shu et al., 2023). Heavy carbon-emitting firms - such as those belonging to the industries of oil, gas, and consumable fuels; electric utilities; gas utilities; independent power producers and energy traders; multi-utilities; chemicals; construction materials; metals and mining; and paper and forest products (CDP 2012) – have thus faced carbon risk.

So far, according to the recent literature review of Wang et al. (2022), the analysis of carbon risk in corporate finance has started covering the following main topics: carbon risk and cost of equity capital (Oestreich & Tsiakas, 2015; Bolton & Kacperczyk, 2021; Bernardini et al., 2021; Ggrgen et al., 2020); carbon risk and cost of debt (Delis et al., 2019; Ehlers et al., 2022; Kleimeier & Viehs, 2023; Chen & Silva, 2012; Jung et al., 2018); carbon risk and financial performance and firm value (Busch & Lewandowski, 2018; Nguyen, 2018; Griffin et al., 2017; Matsumara et al., 2014; Clarkson et al., 2015).

More lately, the debate concerning carbon risk has begun to deal with its implications for firms' financial decisions, with the first study, identifying a direct relationship between carbon risk and the capital structure of firms, by Nguyen and Phan (2020). Therefore, the aim of this work is to examine recent studies related to the effects of carbon risk on the capital structure of businesses. In doing so, pertinent articles published in elite financial journals, such as *The Journal of Finance*, *Journal of Banking and Finance*, *Journal of Corporate Finance*, *Finance Research Letters* and *International Review of Financial Analysis*, will be cited.

The contribution of this work is to highlight and discuss the state of the art of a growing field of corporate finance research by using the lens of the trade-off theory on capital structure (Nguyen & Phan, 2020; Ginglinger & Moreau, 2022), and call for a development of the analysis of further dimensions concerning, for example, the impact of carbon risk on corporate debt maturity structure and corporate governance issues.

The rest of the work is developed as follows. Section 2 discusses the dimensions of carbon risk. Section 3 reviews the capital structure decisions under the trade-off theory. Section 4 applies the trade-off approach in the context of carbon risk. Section 5 concludes.

2. Dimensions of Carbon Risk

Several definitions of carbon risk have been conceived by academicians (Tang & Li, 2022). According to Lash and Wellington (2007), there are six sources of carbon risk: physical; regulatory; supply chain; technology and product; litigation; and reputation risk. Physical risk is the risk of natural disasters, such as drought, heat waves, floods, and cold spells, and related expenses that might be amplified by climate change. Regulatory risk derives from changes in international, national, and local policies or regulations to decrease carbon emissions. Supply chain risk refers to the vulnerability of a firm's suppliers as new regulations impose changes in their products and processes and associated consequences for their customers. Technology and product risk concerns changes and developments that can enhance the availability of alternative low-carbon technologies, and the increase in individual awareness of the negative effects of climate change that can be reflected in modifications in consumer demand for climate-oriented products and services. Litigation risk is borne by carbon emitters which can be sued, similarly to what can happen for tobacco and pharmaceutical industries. Finally, reputational risk derives from the judgement of the public opinion, when companies are deemed to employ products, processes and practices negatively affecting the climate.

The physical risk, although very often devastating, specifically impacts on agriculture and food industries, rather than on the economy as a whole or heavy carbon emitters. The latter mostly suffer from the other forms of carbon risk. As far as regulatory risk is concerned, rigorous carbon control regulations are likely to generate more carbon related costs (Trinks et al., 2020; Zhang, 2021). In fact, the regulation compliance implies more management costs, such as clean-up costs, and research and development costs (Balachandran & Nguyen, 2018). Besides, a low-carbon supply chain is preferred by climate-friendly consumers and thus expand market demand and sales for firms belonging to low-carbon supply chains and hinder the profitability of heavy carbon-emitting firms. Nonetheless, the costs of the transition to low carbon technologies are considerable, making it difficult for these firms to pursue such a strategy (Luo et al., 2022; de Pee et al., 2018; Gillingham, 2019). Climate change litigation has been increasing rapidly as well as its related costs, even if the impact of these costs needs to be better examined by researchers, as the academic literature on this issue is still very scarce and has a very fragmented focus (Solana, 2020). Allegations or charges that a firm violated environmental regulations are economically significant (Karpoff & Lott, 2005; Balachandran & Nguyen, 2018), as well as its implication in terms of reputational damage.

3. Optimal Capital Structure under the Trade-Off Theory

In a context of perfect markets and perfect competition only investment decisions are important in creating firm value because changes in a firm's capital structure do not influence its value or shareholders' wealth (Modigliani & Miller, 1958). On the contrary, in the real world, taxes and bankruptcy costs do have an impact on a firm's value. Interest payments are deductible from corporate income; thus, firms try to increase their financial leverage to reduce company tax and increase their value (Modigliani & Miller, 1963; Haughen & Senbet, 1986). At the same time, the presence of financial distress costs associated with indebtedness leads firms to employ moderate level of debt, to avoid financial distress and its related costs decreasing firms' wealth. These costs are both direct and indirect (Damodaran & Roggi, 2015; Brealey et al., 2020). The direct costs of financial distress include the costs of paying lawyers, accountants, and consultants to manage the liquidation or bankruptcy process. The indirect costs are associated with the negative perception that stakeholders have towards firms whose probability of default increases. This negative perception generates: Higher interest rates (cost of debt) charged by lenders on the amount of money being borrowed; increasing salaries and compensations a firm must pay to their employees and managers as an incentive for them not to leave the firm; higher prices to their suppliers who are afraid not to collect the money the firm owes them; lowers proceeds and profits, as customers will avoid buying products or services of the firm, as the latter may not be able to deliver them or guarantee post-sale services.

According to the trade-off theory, the optimal leverage is the result of a balance between tax benefits and bankruptcy costs of debt (Kraus & Litzenberger, 1973; Scott Jr, 1976; Bradley et al., 1984; Graham, 2003). As heavy carbon-emitting firms have on the one hand, higher carbon costs increasing their carbon risk and hence financial distress risk and its related costs, and, on the other, they are affected by decreasing financial performance and tax benefits of debt, then high carbon-emitting firms are expected to employ a lower level of financial leverage (Nguyen & Phan, 2020) compared to low carbon-emitting firms, as further argued in the next paragraph.

4. Carbon Risk and Capital Structure: The Trade-Off Theory Approach

The transition to a greener economy is expected to generate direct and mostly indirect financial distress costs. Allegations or charges of environmental violations implies costs of litigation and stakeholders who fear

reputational risks from being associated with an environmental scandal are likely to terminate their relationship with the firm (Bauer & Hann, 2010). The stakeholders of heavy carbon-emitting firms, including managers, employees, suppliers and customers prefer to create business relationships with companies with better environmental reputation and prospects or demand higher compensations for their perceived risk associated with the transition to a cleaner economy. This, in turn, generates higher bankruptcy costs. Moreover, banks increase their loan spreads to firms that are significantly exposed to climate policy and transition risk (Delis et al., 2023). The increased credit risk arising from regulatory compliance and litigation makes banks more sensitive to firms' environmental behavior, thus affecting the cost of debt for borrowers (Chava, 2014; Chen et al., 2018). Lenders charge lower interest rates to borrowers that have better corporate environmental performance than to borrowers that have worse environmental performance (Du et al., 2017). Furthermore, bond yields incorporate climate risk exposure (Schneider, 2011; Seltzer et al., 2022) and cause the cost of debt in debt markets to grow (Li & Zhang, 2023). Therefore, heavy carbon emitters incur in higher costs of debt and higher financial constraints relative to low carbon emitters, as banks employ environmental criteria when they finance enterprises (Herbohn et al., 2019; Huang et al., 2021; Nguyen & Shi, 2021). Besides, severe carbon regulation policies can prevent high carbon-emitting firms from obtaining external finance in capital markets, as investors perceive a considerable financial distress risk (Shu et al., 2023), thus decreasing investments in projects creating value.

Additionally, carbon risk affects firms' financial performance, as expressed by Tobin's q or ROE or ROA, through increasing costs borne to reduce environmental damage (Wang et al., 2022) and substitute carbon technologies for cleaner processes (Nguyen & Phan, 2020). Several studies document a negative effect of carbon risk on firm financial performance (Busch & Hoffmann, 2011; Lee et al., 2015; Busch & Lewandowski, 2018; Nguyen, 2018).

On the basis of the previous discussion, the optimal capital structure for high carbon emitters is the result of a trade-off between the financial distress costs and the tax shield benefits of debt (Kraus & Litzenberger, 1973; Scott Jr, 1976; Bradley et al., 1984; Graham, 2003). Specifically, higher costs and lower profitability caused by the transition to a low carbon economy generate carbon risk and thus financial distress risk, its related direct and indirect costs, and lower the financial leverage of heavy carbon-emitting firms. Correspondingly, the transition to a cleaner economy implies lower financial performance, decreases the tax shield benefits of debt, and diminishes the level of indebtedness of higher carbon-emitting businesses.

This balance between the costs of financial distress and the benefits of debt tax shield is further explained by Figure 1. It shows the trend of the firm value of two firms: a low carbon-emitting firm and a high carbon-emitting firm. For the sake of simplicity, the firm value of both businesses is supposed to be the same when they are all equity financed, that is when their debt ratios are equal to zero. When both firms start raising debt, hence their financial leverage is moderate, their firm values increase because the marginal benefit of tax shield of debt is greater than the marginal direct and indirect costs of financial distress. However, very soon the firm value of the high carbon-emitting firm reaches its highest value, because of the combination of increasing marginal direct and indirect insolvency costs and decreasing marginal tax shield benefits of debt, caused by carbon risk as a dimension of the financial distress risk; while the low carbon-emitting firm incurs in considerable financial distress costs, more than offsetting its tax shield benefits, only when its financial leverage is very significant, because it slightly suffers or does not suffer at all from carbon risk. As a result, the optimal debt ratio for the high carbon-emitting firm is lower than that of the low carbon-emitting firm. It is worth noting that for the same level of indebtedness, the heavy carbon-emitting business tends to have a lower firm value because of the higher carbon risk implying higher costs of bankruptcy and lower benefits of debt tax shield, rapidly slowing the increase in firm value, and then reducing it.

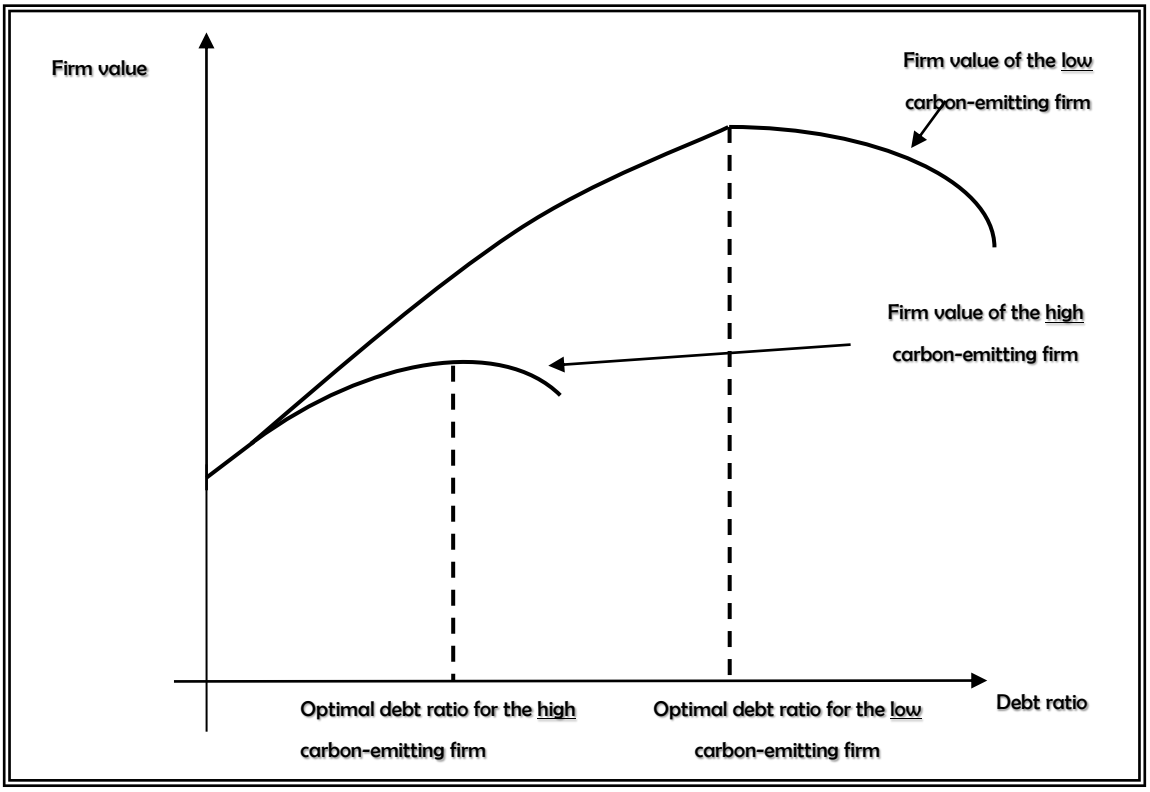
4. Conclusions

The purpose of this study was to discuss the main dimensions of carbon risk impacting on capital structure decisions of high carbon-emitting businesses. For heavy carbon-emitting firms, carbon risk means increasing financial distress risk and lower tax shield benefits, so that the optimal level of indebtedness for heavy carbon emitters can be explained through the trade-off theory. In fact, increasing operating costs and lower performance caused by the transition to a greener economy cause higher carbon risk and hence greater financial distress risk and related costs of insolvency, on the one side, and lower tax shield benefits of debt, on the other. High carbon-emitting businesses, under the trade-off approach, need to adjust their financial leverage by moderately borrowing from banks, bond investors and other lenders.

Even though an operational application of the relationship between carbon risk and corporate capital structure is beyond the purpose of this paper, the absence of an empirical investigation on this relationship represents a

limitation of this work, therefore experimental research could try to fill this gap.

Figure 1. The trade-off between financial distress costs and tax shield benefits of debt



Source: inspired by Brealey, R. A., Myers, S. C., & Allen, F. (2020). Principles of Corporate Finance, McGraw-Hill Education, New York, Figure 18.2, p. 483, and substantially modified by the author.

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