Scientific Annals of Economics and Business
70 (SI), 2023, 55-84
DOI: 10.47743/saeb-2023-0014

The Empirical Study of the Impact of Firm- and Country-level Factors on Debt Financing Decisions of ICT Firms

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Abstract: The capital structure has been extensively analysed in the empirical literature. Despite of the great contribution of the technological industry to the global economy, little research has been conducted regarding corporate finance of ICT firms. Moreover, the previous literature barely considers the effect of macroeconomic variables on financial decisions, focusing much more on internal determinants, such as cash flow, firm's size or growth opportunities. The objective of this work is to reduce this gap by disentangling the reasons behind the financial decisions of technological firms. The sample included 1,510 public ICT firms from 23 countries over the period 2004 – 2019 (17,342 observations). The variables used in this study are obtained from S&P Capital IQ, World Development Indicators, Main Science and Technology Indicators from OECD, and FMI dataset. The two-step system generalized method of moments (GMM) was used as methodology. Consistent with the extant literature, more profitable and liquid ICT firms and those with an increased non-debt tax shields are less leveraged. However, the companies which present higher risk, measured as volatility of EBIT, increase their use of debt financing. Contrary to the findings of many other studies, the analysis of a firm's size and tangible assets shows non-conclusive results. Regarding macroeconomic determinants, only economic growth and foreign direct investment inflows were found to generate a positive effect on financial decisions of ICT firms. The findings of this work can be used to design and develop policies, measures, and facilitate mechanisms for optimal management of the financing decisions of ICT firms.

Keywords: financial decisions; capital structure; corporate finance; external and internal determinants; ICT firms.

JEL classification: G30; G32.

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Article history: Received 15 November 2022 | Accepted 13 January 2023 | Published online 21 February 2023

To cite this article: Alexeeva-Alexeev, I. (2023). The Empirical Study of the Impact of Firm- and Country-level Factors on Debt Financing Decisions of ICT Firms. *Scientific Annals of Economics and Business*, 70(SI), 55-84. https://doi.org/10.47743/saeb-2023-0014

1. INTRODUCTION

Financing decisions are those faced by the firm at a given moment and include the best combinations of sources to finance investment and other needs. These decisions require the firm to determine the financial structure in which the optimal ratio of debt to equity must be defined since it influences firm value, future growth and profit generation (Hackbarth & Mauer, 2011). Early approaches to capital structure focused on determining possible relationships between the level of debt linked to the cost of capital and the value of the firm in perfect markets. Later, when considering the reality of imperfect markets, this theoretical proposal gave rise to other models that analyse firm value through the level of debt taking into account the tax effect, distress costs, agency conflict and information asymmetry. There are several theoretical models that have been constructed in response to the search for an explanation of a firm's optimal capital structure decisions to ensure greater value for the firm. The main theories of capital structure comprise the trade-off theory and pecking order theory. In addition, there are a number of models associated with them that relate to other factors by establishing an optimal capital structure for companies.

These bases are applied in the assessment of the financing decision behaviour of companies in different sectors, since there are a number of factors that condition these decisions in one way or another. In this sense, it is interesting to analyse the capital structure of companies belonging to the sector of information and communication technologies, ICT, since it is peculiar in many ways and differs from the rest of the sectors. Firstly, the ICT sector is extremely critical for the personal and professional development of individuals and companies of other sectors enabling all of them to connect, interact, transact in the digitised environment and also use technologies to accelerate the pace of innovative creations in various fields. This gives rise to the emergence of different sub-sectors focused on the creation of technological infrastructure, network components, applications, system components and the Internet (Sekmen & Gokirmak, 2018), as well as Big Data and the Internet of Things that enable the effective collection, management and analysis of large volumes of data received from multiple sensors (Ahmed *et al.*, 2017).

Officially, according to the definition reached by OECD member countries in 1998 and revised in 2006 (OECD, 2009), the ICT sector aims to carry out and enable the processing and communication of information by electronic means as well as to transmit and present it visually. Within the ICT sector, two main groups can be distinguished: manufacturing and services (Psychoyios & Dotsis, 2018). Products in the manufacturing subsector fulfil the function of information processing and communication including transmission and display, such as, for example, the manufacture of office machinery, computer and telecommunication equipment, computers, electronic products, electronic components, semiconductors and cables (Holm & Østergaard, 2015). As for the services subsector, this includes services around IT equipment, computers and components such as their sale, installation, maintenance and repair as well as the design, development and licensing of software, online applications, hosting and internet services, data analysis, processing and storage, telecommunication and consulting services, or auditing, among others (Ciesielska, 2017).

Secondly, we should recall that we are currently immersed in the fourth industrial revolution, called Industry 4.0, which is about the increased use of modern technologies and wider access to advanced knowledge and active cooperation that serves to drive industrial development (Nahtigal, 2014). Nowadays, the influence of new technologies on the economy at large is undeniable. In essence, they have radically transformed the way in which data is generated, processed and used in all domains and have created digital technologies with new functionalities that have led to the redesign of traditional business strategies and processes (Bharadwaj *et al.*, 2013). It is the harnessing of these technologies together with innovation that enables successful digital transformation, i.e., generating new digital capabilities and creating new ways of managing resources and business (Condea *et al.*, 2017). As stated by one of the latest reports of OECD (2017) on digital economy, "the ICT sector remains a key driver of innovation, accounting for the largest share of OECD business expenditure on research and development" (2017, p. 1).

The relevance of technologies is currently reflected in the impact generated by digital initiatives from various sectors for companies expressed in cumulative values from 2016 to 2025 and also for the society. In this regard, it is worth noting that in some sectors, such as consumption, automotive, logistics, electricity and aviation, the cumulative value is much higher for society than for the industry itself. In other sectors, e.g., telecommunications, oil and gas, media, mining and chemicals, the contribution is more relevant for business. In addition, increased support for technologies helps to reduce harmful gas emissions significantly. Such is the example of the electricity, oil and gas and logistics sectors. In terms of jobs, the impact of technologies is not always positive, only in some sectors, such as telecommunications, electricity and logistics (see Table no. 1).

Table no. 1 – Potential impact of digital initiatives per sector

Sector	Accumulated value 2016-2015, in billions of USD		Reduction of CO2 emissions, in million tons	Jobs, in thousands
	for society	for firms		
Consumption	5,439	4,877	223	3,249
Automotive	3,414	667	540	Not available
Logistics	2,393	1,546	9,878	2,217
Electricity	1,741	1,360	15,849	3,158
Telecommunications	873	1,280	289	1,100
Aviation	705	405	250	**-780**
Oil and gas	637	945	1,284	**-57**
Media	274	1,037	**-151**	Not available
Mining	106	321	608	**-330**
Chemical	2	308	60	**-670**

Sources: own elaboration based on WEF report Digital Transformation of Industries

Thirdly, considering the multiple applications of technologies in economic fields, new sectors of the digital economy are emerging, such as e-business, e-commerce, digital manufacturing, precision agriculture, algorithmic economy, sharing economy, collaborative economy, fintech, tourismtech and insurtech, among others. Fourthly, the speed at which technologies develop is another prominent feature of the ICT sector, leading to the continuous improvement of technologies and rapid creation of new ones. For example, as reflected in the 2019 Digital Economy Report of the United Nations (UNCTAD, 2019), global Internet Protocol traffic has increased from 2002 to 2017 from 100 to 46,600 gigabytes per second and the forecast for 2022 puts it at 150,700 gigabytes per second. In 2018 there were more objects connected to the internet than people: 8.6 billion versus 5.7 billion broadband subscriptions. And by 2022, Internet of Things connections are expected to exceed 22 billion, driven mainly from the United States and China. Another example is 5G, a new fifth-generation mobile technology network, capable of processing huge volumes of data much more effectively and connecting many more devices than current networks. Already by 2025, it is estimated that 5G will account for almost half of all mobile technologies in North America and a third in Europe. Finally, traffic generated by cloud technologies, which solve the problem of data storage and transform current business models, grew by 116% in just three years, reaching 13 zettabytes of total volume in 2019, and is expected to grow to almost 20 zettabytes by 2022.

The ICT sector is therefore characterised as disruptive and innovative on a global scale because new technologies offer innovative solutions to other sectors with a value proposition. For example, Legner *et al.* (2017) argue that the increased use of digital technologies increases business opportunities at all levels. Ferreira *et al.* (2019) suggest that higher performance and, consequently, higher competitiveness is achieved by companies that actively rely on digital processes. Stanley *et al.* (2015) explain that technologies contribute to a country's productive and economic growth, as well as to the creation of new employment opportunities on a permanent rather than sporadic basis. Pradhan *et al.* (2015) and Nureev and Valerievich (2018) add that, thanks to technologies, significant cost reductions are achieved, generating new forms of wealth in other sectors. All of this reshapes traditional business models, contributing to the creation of a new, more dynamic, changing and demanding environment that affects other sectors and markets (Seo, 2017).

Given the specific characteristics of the ICT sector described above, it is possible to think that technological companies need to manage financing issues in a different way than the rest in order to cope with the particular needs of product development. So, it is likely that decision making on financing issues is influenced by other factors, less known or even unknown. Therefore, the main objective of this study is to deepen the analysis of the impact generated by the firm-level as well as macroeconomic variables on the debt financing of ICT firms, trying to find and assess eventual differences of this impact between debt measured at book and market values.

The rest of the paper is structured as follows: Section 2 contains the literature review on the antecedents of capital structure theories and proposals and their application to the ICT sector; Section 3 explains the details of the sample composition, database used and the methodology applies and also presents the econometric model; Section 4 includes the highlights of the empirical results; Section 5 offers discussion on the obtained results and main conclusions of the study suggesting the future research lines.

2. LITERATURE REVIEW AND HYPOTHESIS

2.1 Classical theories of financing decisions

Trade-off theory, suggested by S. Myers (1984), is one of the most important theories of capital structure. It is derived from Modigliani and Miller (1958) theorem which postulates that, in perfect markets, the value of the firm does not depend on the capital structure or financing decisions. It is assumed that firms have wide access to debt and equity and that the market in which they operate is perfect. Therefore, any combination of debt or equity is good. This theory suggests that the optimal capital structure is achieved when there is a trade-off between the marginal value of the benefits associated with debt and the costs associated with debt issuance (Cekrezi, 2013).

Trade-off theory has two major advantages regarding the use of debt: (1) tax savings through expenses which are deductible; and (2) reduction of agency conflict arising from control between shareholders (principals) and directors, or managers (agents) who have different interests and objectives (Jensen & Meckling, 1976; Jensen, 1986). On the one hand, profitable firms, in general, take on more debt because their expected profits are usually high (Fama & French, 2002; Benito, 2003; Heider & Ljungqvist, 2015). On the other hand, managers do not always act in accordance with shareholders' interests, but try to satisfy their own ones (Boshkoska, 2015). Managers tend to use free cash flow to make suboptimal investments, but debt limits it because it forces the firm to pay excess cash flow through interest. In this regard, some works has found that more profitable firms tend to use more debt in order to monitor managers' use of cash flow and reduce agency costs (Castro *et al.*, 2016; Zeitun *et al.*, 2017).

However, it should be noted that a large debt level increases the likelihood of financial distress, the most serious of which is bankruptcy (Mueller, 2012). Therefore, debt is one of the financial factors that increase the risk level of the firm (Ughetto, 2008; Ozdagli, 2012; Sun *et al.*, 2016). In this regard, some papers have found that large and profitable firms tend to have high levels of debt because they are less likely to default, so their financial imbalance costs are expected to be low (Rajan & Zingales, 1995; Benito, 2003).

In addition to the version of the trade-off explained so far, called static, there is another one, called dynamic. The dynamic trade-off takes into account the fact that firms need to be able to adjust their level of indebtedness according to their internal characteristics, such as cash flow volatility, return on assets, interest and bankruptcy cost (Fischer *et al.*, 1989; Yinusa, 2017). This means that firms will make adjustments to the capital structure when these limits are altered (Goldstein *et al.*, 2001; Strebulaev, 2007). In summary, the basis of the trade-off theory is the optimal debt ratio (static model) and the necessary adjustments within optimal limits which are not fixed to reach this target (dynamic model).

The pecking order theory, developed by S. Myers (1984) and S. Myers and Majluf (1984), offers a different explanation of the financing decision than the trade-off theory, focusing mainly on the existence of informational asymmetries and costs associated with the source of financing. The pecking order does not consider the existence of the optimal capital structure but rather the costs of adverse selection between the firm and creditors. That is, these costs are what determines financing decisions (Frank & Goyal, 2003; Whited, 2006; Mueller, 2012; Naranjo *et al.*, 2022). The pecking order theory states that the firm first uses internal financing as the cheapest source of financing, then external financing through debt, with a higher cost, and finally equity issuance, which is the most expensive option (Benito, 2003; Zeitun *et al.*, 2017).

Firms choose not to borrow when the interest on debt is high (Hogan & Hutson, 2005; Paul *et al.*, 2007). If internal funds are not sufficient, the firm will resort to debt financing (Castro *et al.*, 2015). The issuance of equity, as the last alternative of financing, involves higher costs than the previous sources of financing. This is due to the high risk it entails for an external investor, so that the demanded return on equity is also high. According to S. Myers and Majluf (1984), a company chooses to issue equity only if it does not have sufficient funds to cover its investments and if these investments are really profitable. Cotei and Farhat (2009) explain that it also happens when firms have exhausted their borrowing capacity and are unable to present more collateral. However, equity issuance, unlike financing through internal funds or debt, implies a loss of control over the firm as it involves active participation by equity investors in important business decisions (Kaplan & Strömberg, 2001). This situation could affect the long-term performance of the firm because it implies the transfer of control from the owners of the firm to new shareholders, whereby the owners will try to avoid loss of control (Cressy & Olofsson, 1997).

2.2 Other theories of capital structure

The classical theories mentioned above have certain limitations. One of them is that they do not provide a general explanation of capital structure behaviour (S. C. Myers, 2001), as they do not consider other factors such as the tangible and intangible nature of assets, growth opportunities, the type of products or services the firms sells, the size, the industry in which it operates, and the volatility of revenues and profitability, among others. Therefore, these theories need some improvement by considering many other factors to provide a more unified framework, as noted by Hennessy and Whited (2005), Sánchez-Vidal and Martín-Ugedo (2005), Leary and Roberts (2007) and Strebulaev (2007). The financing decisions of certain companies are difficult to explain within classical capital structure theories as they are more in line with alternative models, such as the financial growth cycle theory, the market timing model and the managerial entrenchment theory, which are described below.

The financial life cycle theory advocates the idea that a firm, over the course of its life, adopts different capital structures which are optimal according to the stage of the firm's development (A. N. Berger & Udell, 1998; Butzbach & Sarno, 2019). This theory adopts a dynamic perspective on capital structure and considers that life cycles determine a firm's financial need, the selection of a financing source and the cost of capital (La Rocca *et al.*, 2011). Generally, newly created companies in their initial stage of activity resort to internal sources of financing, such as contributions from the founders themselves and their family circles. This type of company is the most opaque in terms of the information it offers to the outside world and the assets it tends to have, which are more intangible, which makes access to external financing more difficult (Huyghebaert, 2001). Despite the difficulties in accessing finance, young firms seem to prefer debt to equity. But what conditions the financing decision is not the firm's preference but the freedom of access to one or another type of financing. As firms grow, they become larger and more experienced and have better access to external sources of finance because they have more assets that can serve as collateral for debt and less informational asymmetries (Mueller, 2012; Hogan *et al.*, 2017).

The market timing model does not assume the existence of an optimal capital structure, but rather that the financial structure depends on the historical financing decisions that were taken depending on the more or less favourable conditions for the company. Market timing analyses the decision of firms to issue equity based on market behaviour, taking into account the variation over time in the cost of capital relative to the cost of other forms of financing in imperfect markets. According to the idea proposed by S. Myers (1984), subsequently studied by other authors such as Lucas and McDonald (1990) or Graham and Harvey (2001), and finally popularised by Baker and Wurgler (2002), companies tend to synchronise with the market and issue shares when they perceive that its behaviour is favourable. This occurs when equity issuance costs are low and the firm's market value is higher than its book value (Alti, 2006; Smulders & Renneboog, 2014).

However, it has to be kept in mind that in order to issue equity at a given moment, firms have to assess whether market conditions are attractive, otherwise equity will not be issued (Frank & Goyal, 2009). It is further noted that firms may prefer to issue equity even when they do not really have a need for funds or when they could have used internal funds or even debt, if market conditions are favourable (Fama & French, 2005). This decision affects the capital structure which, according to Baker and Wurgler (2002) and Mahajan and Tartaroglu (2008), is understood as the cumulative outcome of attempts to predict on the past market movements. In contrast to the Modigliani and Miller theorem, the market timing model considers that the costs of debt and equity vary independently, so that firms have the opportunity to switch between one source of financing and another to minimise the associated costs. If the costs of deviation from the optimal capital structure target are low compared to the costs of issuing equity, the variation in past market values can have a long-lasting effect on the capital structure. However, Leary and Roberts (2005) add to the market timing model the adjustment costs that arise when firms are forced to rebalance the capital structure.

The managerial entrenchment theory takes into account the behaviour of managers through their decisions on capital structure. This model considers capital structure as a central element that allows managers to balance the expansion of their empire-building and to maintain control over their empire, i.e. to retain and entrench their position in the face of internal and external control of any kind (Zwiebel, 1996). Managerial entrenchment is based on agency theory which states that managers do not always choose the capital structure with the optimal level of debt. Entrenched managers can hedge against internal and external pressures generated by corporate governance mechanisms. This behaviour causes debt levels to change as a function of the degree of entrenchment: when managers are not under pressure from shareholders or performance rewards, the firm's indebtedness is lower (Morellec *et al.*, 2008). Debt levels, however, increase when managerial entrenchment in the firm is reduced through the introduction of disciplinary measures, such as takeover bids, managerial replacement or board expansion that incorporates controlling shareholders.

In this regard, there are several studies that analyse the consequences of managerial entrenchment on capital structure. For example, Faleye (2007) and Ruan *et al.* (2011) find that the higher degree of entrenchment significantly affects the market value of the firm. P. G. Berger *et al.* (1997), in their analysis of 434 large US industrial firms, find that a high degree of managerial entrenchment in the firm leads to low indebtedness, and vice versa. Brailsford *et al.* (2002), Kayhan (2003) and Morellec *et al.* (2008), through their respective empirical studies, confirm the same result: entrenched managers choose less debt and rebalance the capital structure less frequently than shareholders would like to. P. G. Berger *et al.* (1997) explain that this result is in line with other studies showing that in a firm with a small board of directors managers face more active monitoring and are therefore less entrenched in the firm, leading to an increase in the level of debt.

2.3 Financing decisions in ICT companies

Although there is a considerable literature on the implication of different market imperfections on the financing decision, there is relatively little research on the behaviour of ICT firms in this field. The existing literature points out certain trends concerning the choice of financing sources by technological companies.

In this regard, the first source of financing is internal funds, followed by equity issuance and, finally, debt. The extensive use of internal funds is explained by the need to manage innovation projects, which are more frequent in the ICT sector than in any other one (Magri, 2009; Revest & Sapio, 2012). However, internal funding may be insufficient and may condition the growth and development of companies. The second financing option is equity issuance, considered as the most preferred by innovative companies (Robb & Robinson, 2014). The reasons why equity issuance is more attractive than debt for tech firms, according to Carpenter and Petersen (2002), are the lack of obligation to provide collateral through tangible assets and a lower exposure of firms to financial imbalances. In addition, a possible loss of ownership control, relevant in many sectors, does not seem so critical for tech firms (Hogan *et al.*, 2017). External financing through debt seems to be the least convincing option for ICT firms. In fact, some studies show that these companies have lower debt levels than the firms of other sectors (N. Chen & Kou, 2009; Calcagnini *et al.*, 2011). This behaviour is mainly explained by higher information asymmetry of ICT companies, high levels of uncertainty and volatility and little tangible assets, which makes debt more expensive and difficult for technological firms to access (Coleman & Robb, 2012).

2.4 Main hypothesis of the study

In order to better understand what determines the capital structure of companies of the ICT sector, an empirical study is proposed with the main hypothesis based on the fact that the internal characteristics of ICT companies influence their financing decisions. In addition, the macroeconomic conditions of the country have an impact on the level of indebtedness of these companies.

One of the variables that can have the greatest influence on a company's capital structure is its profitability. Some studies suggest that the effect of this variable on indebtedness is positive. This is because a profitable firm would have to pay a higher tax rate on profit, so that, according to the trade-off theory, an increase in debt would provide a tax saving (Benito, 2003). However, it is also observed that profitable firms borrow less. Taking into account the dynamic trade-off theory, the adjustments costs predict a negative relation between debt and profitability, but in this case, debt is measured at market value (Hennessy & Whited, 2005; Strebulaev, 2007). Likewise, following the pecking order theory, a profitable firm has a greater availability of internal funds that it will use first (S. Myers, 1984; Frank & Goyal, 2009). In this regard, Rajan and Zingales (1995), in an empirical analysis of the determinants of capital structure in listed companies worldwide, find that profitability and debt are inversely related in most countries. The same negative effect is obtained by Booth *et al.* (2001), through their analysis of the capital structure of firms in ten developing countries, and by other authors in their respective studies on the capital structure of different types of firms located in different countries and regions (e.g., J. J. Chen, 2004; Deesomsak *et al.*, 2004; Antoniou *et al.*, 2008; Sbeiti, 2010; Ebrahim *et al.*, 2014; Belkhir *et al.*, 2016). Therefore, the following hypothesis is proposed.

***H_1**: The profitability of an ICT company negatively influences its level of debt.*

Another factor that influences a company's debt is the non-debt tax shield, NDTS. The elements included in the NDTS generate certain expenses that the company can use to reduce tax payments. Thus, the non-debt tax benefits arise, which could act as a substitute for the tax benefits derived from debt financing (De Miguel & Pindado, 2001; Schallheim & Wells, 2006). According to the trade-off theory, when NDTS increases, the fiscal savings from borrowing become less attractive, so that the observed relationship between NDTS and debt is negative (De Miguel & Pindado, 2001; Deesomsak *et al.*, 2004; Graham & Tucker, 2006; Ghosh *et al.*, 2011). This allows us to generate a second hypothesis.

H₂: *The non-debt-derived tax shield of an ICT firm negatively impacts its level of indebtedness.*

Liquidity, as an indicator of the firm's ability to repay debt (Kedzior *et al.*, 2020), is another factor which conditions the financing alternative used by firms. According to the trade-off theory, firms with higher liquidity ratios are expected to use more debt because they have the ability to meet their payment obligations (Morellec, 2001; Zeitun *et al.*, 2017). In this sense, it is observed that firms with higher liquidity decide to take on riskier projects to finance through debt, which is relatively easy to access due to their high level of solvency (Ramli *et al.*, 2019). However, it is also noted that the more liquid firms tend to follow the pecking order approach: they first resort to internal financing and then to external one. Even, as Lipson and Mortal (2009) show, debt may be the last financing option in these firms, because, after internal funds, they prefer equity issuance and, finally, debt. Thus, the relationship between liquidity and debt is inverse. These results are also reflected in a number of studies authored by Deesomsak *et al.* (2004), Udomsirikul *et al.* (2011), Pindadoa *et al.* (2012) and Zeitun *et al.* (2017). Therefore, the third hypothesis is as follows.

H₃: *The level of liquidity of an ICT company has a negative effect on its debt level.*

Tangible assets act as collateral for debt, so a higher proportion of tangible assets reduces the risk that lenders may face when lending capital to firms (Rajan & Zingales, 1995). Firms with much tangible assets have lower costs associated with debt (Deesomsak *et al.*, 2004) and, as a consequence, improve their access to debt financing. On the other hand, companies with little tangible assets find it more difficult to use debt and are forced to resort to equity issuance if the level of internal funds is insufficient (Scott, 1977). As a result, the observed relationship between the value of tangible assets and the level of indebtedness is positive. This effect is particularly noticeable for a long-term debt (J. J. Chen, 2004) and in bank-oriented economies (Antoniou *et al.*, 2008).

As Falato *et al.* (2022) explain in their study of US companies, technological transformation in any company increases intangible assets and this leads to a reduction in debt and a greater reliance on cash flow. The same applies to ICT firms, in fact,, they tend to have low levels of debt and limited fixed assets, with large proportion of intangible assets (Aoun, 2012). These assets, due to their low residual value and a high level of uncertainty, are not usually accepted as collateral for debt (Brierley, 2001; Carpenter & Petersen, 2002). So, these firms are less leveraged (Rajan & Zingales, 1995). As revealed by other studies, firms dedicated to software development usually have little assets, which makes them less secure and less attractive to borrowers (Talberg *et al.*, 2008). The fourth hypothesis, therefore, says the following.

H₄: *Fixed assets of an ICT company generate a negative impact on its debt use.*

The risk of the firm, perceived through the variation of results, such as operating profit, generates an important effect on the capital structure of a firm. A number of empirical studies show that firms with high operating profit volatility have a high level of risk and, therefore, have low debt ratios (Bathala *et al.*, 1994; Homaifar *et al.*, 1994; Ozkan, 2001; Psillaki & Daskalakis, 2009). This is also the finding presented by Dierker *et al.* (2019) who measured risk mainly through stock return volatility and asset volatility and found that the riskier companies tend to issue equity rather than debt and that this behaviour is aligned with the dynamic trade-off theory. Lenders understand that risky companies have greater financial problems (financing costs) and would, therefore, have difficulty in meeting their liability to repay the debt (Aoun, 2012; Sohn *et al.*, 2013). So, the formulation of the fifth hypothesis is as follows.

H₅: *The risk of an ICT company influences negatively its debt level*.

The market value of a company is another internal variable that influences the level of indebtedness of a company. According to the market timing theory, a higher market value reduces the debt ratio used by a company, as explained by Baker and Wurgler (2002). The authors show that low-debt companies issue equity when their market value is high. In contrast, the issuance of equity at a time when the firm's value is low corresponds to a high level of debt.

Some empirical studies suggest that the market value is one of the factors that cause firms to deviate from their optimal level of indebtedness. In this sense, authors such as Hovakimian (2006), Kayhan and Titman (2007), and Frank and Goyal (2009) show that the high market value of the company apparently reduces its level of debt. This result is more noticeable in the short term than in the long term. According to the above mentioned studies, high market value could be related to high investment opportunities, which would correspond to a low level of debt. On the other hand, successful companies tend to change the focus of their business as their optimal capital structure changes, so it would be the issuance of equity rather than debt that would provide the most significant financial support for this change. However, it is important to take into account other factors too, so the market timing model is not the only one that would explain the relationship between a company's value and its debt levels. With all these considerations, we can come to the formulation of the sixth hypothesis.

H_6: *The value of an ICT company generates a negative effect on its debt*.

Firm size is another important factor that determines the selection of the source of financing (Revest & Sapio, 2010). Size is directly related to the firm's debt capacity (Beck & Demirgüç-Kunt, 2006; Psillaki & Daskalakis, 2009). Larger firms are more diversified, have lower information asymmetry, probability of bankruptcy and supervision costs, and therefore have less risk and barriers to access to debt financing (Chittenden *et al.*, 1996; González & González, 2008). All this allows large companies to benefit from a greater borrowing capacity. On the other hand, small and medium-sized firms are more opaque, which not only restrict access to debt, but also generate a large difference between the cost of internal and external financing (Brierley, 2001). Another disadvantage for small firms, in general, is the high bankruptcy costs that hinder access to debt (S. Myers, 1984). Therefore, these companies manage their financing needs mainly through their internal funds, as documented by numerous authors in their respective empirical studies (Giudici & Paleari, 2000; Colombo & Grilli, 2007; Scellato & Ughetto, 2010).

In addition to this focus, other approaches should be taken into consideration with inconsistent or negative relationship between size and debt. Firstly, in large firms the costs of issuing capital are lower than in smaller firms, so that, contrary to what the pecking order theory postulates, they will tend to finance themselves through equity (Zeitun *et al.*, 2017).

Therefore, the relationship between size and debt in this case would not be so clear. Secondly, some studies show the negative effect generated by size on debt, which, a priori, is not in line with what is marked by theories on capital structure. Large and mature firms have more capacity to generate and retain profits and, therefore, have less need to resort to external financing than younger firms, as explained by La Rocca *et al.* (2011). Kara and Erdur (2015) add that large firms accumulate the profits generated over years and, because of this, the use of debt becomes unnecessary.

Regarding technological firms, small-sized but with great potential for development, especially those in the high-tech sector, in their initial stage turn to the private stock market rather than to banks for financing. This type of company is associated with a high level of risk, requires intensive external financing, and has little tangible assets and low levels of debt (Carpenter & Petersen, 2002). In addition, the opacity of information and high presence of intangible assets in these firms create adverse selection problems by hiding their weaknesses and emphasizing their strengths (Hogan & Hutson, 2005). In contrast, large and profitable tech firms generally follow the pecking order theory (Castro *et al.*, 2015). This is because, although banks seem prone to grant them credit, they prefer to use internal funds first to finance their investments (López-Gracia & Sogorb-Mira, 2008; Mihalca & Antal, 2009). All this seems to correspond to the results of the empirical study carried out by Aoun (2012) in which he compares the capital structure of firms of the ICT sector and other sectors. So, his suggestions is that size does not seem to be determinant of the level of debt in technological companies.

H_7: *The size of an ICT company generates an inconsistent effect on its debt level.*

Among the macroeconomic variables that may influence the financing decisions of ICT companies, there is a country's economic growth. Numerous studies have analysed this relationship showing different results. However, the analyses that show and explain the positive impact of economic growth on the indebtedness of companies in various sectors stand out. This is the case of Köksal *et al.* (2013), who analyse economic growth in terms of the availability of growth opportunities in the market. The authors find a positive relationship between the economic growth and corporate debt especially in small firms because they mostly use debt to cover their working capital needs. Brown *et al.* (2009) and Hsu *et al.* (2014) also find a positive relationship between economic growth and debt, focusing on financing through innovation. Christopoulos and Tsionas (2004) confirm the same results, but they take into account other variables such as investment and inflation in the country. Another possible explanation for the positive results is that during the country's economic downturn the supply of loans is reduced and, thus, the borrowing capacity of firms is also reduced. In addition to being scarce, external financing becomes more expensive as the risk level of firms rises, idea supported by a number of authors, e.g. Ivashina and Scharfstein (2010), Akbar *et al.* (2013), B. Harrison and Widjaja (2014), Vithessonthi and Tongurai (2015) and Zeitun *et al.* (2017). Therefore, the country's economic growth and corporate debt seem to be aligned.

H_8: *The economic growth of a country influences positively the ICT company's debt.*

Inward foreign direct investment (FDI) offers numerous advantages to the host country, leading to higher economic growth and improving factors of production as well as capital accumulation (Lee & Tcha, 2004). In addition, it facilitates the access of firms in that country to external financing through credit, according to Mišun and Tomšík (2002), A. E. Harrison and McMillan (2003) and R. T. Harrison *et al.* (2004), as it provides an additional source of capital, especially in countries with less developed credit markets with significant difficulties in accessing debt financing. Also, the presence of more capital in the country, as one of the factors helping to create a favourable macroeconomic environment, leads to higher borrowing by firms, allowing them to adjust the capital structure towards the optimal level more quickly (Korajczyk & Levy, 2003). However, it should be noted that if foreign firms, mainly multinationals, decide to finance themselves in the credit markets of the countries where they set up, they may make it more difficult for local firms to access debt capital, as explained in their respective studies by Johnson (2006) and Forte and Moura (2013). However, Johnson points out that the relationship can be reversed if the presence of foreign firms serves as a stimulus to increase local production in different sectors and generate demand for intermediate products.

H$_9$: *The inflows of foreign direct investment impact positively on the ICT company's debt.*

Taxes are considered to be one of the relevant factors affecting the capital structure of their firms. Due to the deductibility of interest through taxes, tax systems in many countries favour the use of debt (Shyam-Sunder & Myers, 1999; Gordon & Lee, 2001). Therefore, according to the trade-off theory, higher taxes are expected to favour corporate borrowing, i.e. the higher the tax rate on profit, the higher the use of debt (Modigliani & Miller, 1963; A. N. Berger & Udell, 1998; Graham *et al.*, 1998; Benito, 2003; Graham, 2003; Brounen *et al.*, 2006; De Mooij, 2011; Belkhir *et al.*, 2016). However, this positive effect is not observed in all types of firms. For example, SME-type firms have to take into account the restrictions they face in accessing external finance. Therefore, they cannot make the same adjustment to their debt as larger firms, especially those in capital-intensive sectors (aus dem Moore, 2014). It is also observed that a high tax rate causes many firms to adopt an aggressive fiscal policy, using non-debt tax shields as much as possible (Lin *et al.*, 2014; Richardson *et al.*, 2014). These considerations look more adjusted to the reality and help to formulate the final tenth hypothesis as follows.

H$_{10}$: *The corporate tax impact generates a negative effect on the corporate debt of ICT companies.*

3. EMPIRICAL STUDY

3.1 Sample Composition

The empirical test of the above stated hypotheses is carried out for a sample of listed technological companies from 23 OECD countries between 2004 and 2019. The selection of these countries allows us to examine the impact of macroeconomic variables on the investment decision of listed companies worldwide. The corporate, accounting and financial information is obtained from the S&P Capital IQ database, which contains historical data on numerous listed companies. Macroeconomic information for each country is drawn from the World Bank's World Development Indicators database and the OECD's Main Science and Technology Indicators (MSTI) and International Monetary Fund statistics. The sample includes those companies and those countries that provide complete data for the indicated period. Table no. 2 shows the number of firms and observations per country, while Table no. 3 includes the time distribution of the sample.

Table no. 2 – Sample composition: number of companies and observations per country

Country	no. of observations	no. of companies
Australia	295	32
Austria	81	6
Belgium	77	7
Canada	418	37
Denmark	83	7
Finland	221	16
France	818	68
Germany	786	64
Israel	637	53
Italy	244	22
Japan	3,837	314
Korea, Rep.	3,380	303
Luxembourg	54	5
Mexico	59	5
Netherlands	124	9
New Zealand	59	7
Norway	124	11
Poland	298	34
Spain	70	7
Sweden	450	42
Switzerland	243	18
United Kingdom	597	64
United States	4,387	379
Total	**17,342**	**1,510**

Source: own elaboration

Table no. 3 – Sample composition: distribution of observations per year.

Year	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
no. of observations	631	702	788	871	949	1,050	1,098	1,134
Year	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
no. of observations	1,206	1,229	1,273	1,293	1,323	1,300	1,275	1,220

Source: own elaboration

Following Aoun and Hwang (2008), the sample of ICT companies used in this study includes the sub-sectors corresponding to the following SIC Standard Industrial Classification codes: (manufacturers) 3357, 3571, 3572, 3575, 3577 - 3579, 3651, 3661, 3663, 3671, 3672, 3674 - 3679, 3699, 3823, 3825, 3826; (communications) 4812, 4813, 4822, 4832, 4833, 4841, 4899; (wholesalers and retailers) 5045; (services) 7371 - 7379. All sectors have been grouped into two large clusters called ICT Manufacturing Sector and ICT Service Sector, which are highly interdependent (Miozzo & Soete, 2001; Guerrieri & Meliciani, 2005). Table no. 4 shows the distribution of the observations into these main groups.

Table no. 4 – Distribution of the sample by subsectors

ICT sector: subsectors		**no. of observations**	**companies**	
subsector description	**sic code**		**number**	**% over the total number of the sample**
ICT Manufacturing Sector				
Drawing and insulation of non-ferrous wire	3357	378	28	1.9%
Electronic computers	3571	73	6	0.4%
Computer storage devices	3572	97	8	0.5%
Computer terminals	3575	18	2	0.1%
Computer communications equipment	3576	348	30	2.0%
Computer peripheral equipment, NEC	3577	500	40	2.6%
Calculating and accounting machines	3578	230	19	1.3%
Office machines, NEC	3579	187	15	1.0%
Home audio and video equipment	3651	447	38	2.5%
Telephone and telegraphic apparatus	3661	326	26	1.7%
Radio and television communication and transmission equipment	3663	1,264	112	7.4%
Printed circuit boards	3672	575	42	2.8%
Semiconductors and related devices	3674	1,856	174	11.5%
Electronic coils, transformers and other inductors	3677	73	5	0.3%
Electronic connectors	3678	161	11	0.7%
Electronic components, NEC	3679	933	78	5.2%
Automatic industrial process controls	3823	512	41	2.7%
Instruments for measuring and testing electrical power and electrical signals	3825	344	26	1.7%
Laboratory analytical instruments	3826	365	26	1.7%
Measuring and control apparatus	3829	405	33	2.2%
Total ICT Manufacturing Sector		**8,762**	**760**	**50.3%**
ICT Service Sector				
Radiotelephone communications	4812	478	35	2.3%
Telephone communication, except by radiotelephones	4813	410	34	2.3%
Radio broadcasting stations	4832	148	14	0.9%
Television broadcasting stations	4833	500	45	3.0%
Cable television and other pay-television services	4841	212	18	1.2%
Other communication services	4899	580	61	4.0%
Wholesale-Computers and peripheral equipment and software	5045	367	34	2.3%
Computer programming services	7371	116	11	0.7%
Computer programming and software	7372	3,184	301	19.9%
Computer integrated systems design	7373	1,708	147	9.7%
Data processing and computing centres	7374	547	50	3.3%
Total ICT Service Sector		**8,250**	**750**	**49.7%**
Totals		**17,342**	**1,510**	**100.0%**

Source: own elaboration

The sample is well balanced, with 50.3% of ICT manufacturing firms and 49.7% of ICT service firms. We can highlight the presence of 174 companies (11.5% of the total sample) dedicated to the manufacture and sale of semiconductors and related devices in the ICT manufacturing subsector. In the ICT services subsector, which is characterised by being innovative and fast-growing, the companies involved in computer and software programming and the design of integrated computer systems stand out: 301 companies with 19.9% and 147 companies with 9.7% of the total sample, respectively.

3.2 Econometric model

Based on the different theories regarding business financing decision discussed in previous sections, and taking into account the specificities of the ICT sector, an econometric model is proposed that attempts to explain the level of indebtedness of technology companies based on company-specific, sector-specific and country-specific variables in terms of the economic conditions of the country in which they are located. The model builds on others proposed in the work of Deesomsak *et al.* (2004) and Aoun (2012) and integrates the interaction with both firm-specific and country-specific variables. As a result, equation (1) is obtained:

$$(LEV)_{it} = ß_0 + ß_1(LEV)_{it-1} + ß_2 ROA_{it} + ß_3 NTDS_{it} + ß_4 LIQ_{it} + ß_5 TANG_{it} + ß_6 RISK_{it} + ß_7 MV\_PERF_{it} + ß_8 SIZE_{it} + ß_9 GDP\_GRTH_{jt} + ß_{10} FDI_{jt} + ß_{11} TAX_{jt} + \sum_j \gamma_j CONTRY_{jit} + \sum_k \lambda_k YEAR_{kit} + \sum_m \varphi_m SECTOR_{mit} + \varepsilon_{it} \quad (1)$$

where $ß_0$ is the constant term of the equation, $ß_1$ is the coefficient of the lagged dependent variable of debt (*LEV*), $ß_2$ to $ß_{11}$ are the coefficients of the independent variables which impact on the level of debt we are analysing, ε_{it} is the error term. The corresponding dummies are also introduced to take into account the effects generated by the countries and years we use for the sample, as well as the groups of technological sectors previously identified. The variables included in our model are as described below.

Dependent variable:

- LEV: measures the level of indebtedness of a firm and is calculated as the ratio of the book value of total debt to total assets (Aivazian *et al.*, 2005; Gaud *et al.*, 2005; Delcoure, 2007; Ramalho & Silva, 2009; Serrasqueiro, 2011).

In this analysis, besides the book value of total debt, an additional analysis is carried out on debt calculated through the market values of debt. Therefore, an additional variable is included, which is described below:

- LEV_MV: is the ratio of the market value of total debt over the sum of the market value of total debt and market value of equity. The book and market values of debt are different due to the inclusion of quoted prices of the company's shares in the estimation of the market value of debt. The book value of debt provides backward-looking measurements and, therefore, does not coincide with the market value of debt and can lead firms to make financing decisions that are not entirely accurate (Welch, 2004). According to Campello (2006), debt estimated in terms of market values reflects the assessment of performance in the near future. Aoun (2012) explains that, although the book value of debt is a relevant measure of the obligations of a firm that acquired the debt, the market value of debt seems to be a determinant of the real value of that firm.

Control variables:

- ROA: represents the profitability of the firm and is calculated as operating profit (EBITDA) divided by total assets of the firm (De Miguel & Pindado, 2001; Bauer, 2004; Delcoure, 2007; Ramalho & Silva, 2009; Degryse *et al.*, 2010).

- NTDS: is the non-debt tax shield corresponding to the ratio of the sum of depreciation, depletion and amortisation to total assets (Ozkan, 2001; Bauer, 2004; Delcoure, 2007; Ramalho & Silva, 2009; Degryse *et al.*, 2010).

- LIQ: corresponds to the firm's ability to meet its obligations and is calculated as the ratio of current assets to current liabilities (Ozkan, 2001; Deesomsak *et al.*, 2004; Eriotis *et al.*, 2007).

- TANG: refers to the firm's fixed assets and corresponds to the ratio of total fixed assets to total assets of the firm (Cuñat-Martínez, 2007; Bastos & Pindado, 2013; Garcia-Appendini & Montoriol-Garriga, 2013).

- RISK: calculated as the difference between the variation of earnings before interest and taxes expressed in percentage and the ratio of its average value.

- MV_PERF: is the firm's performance at market value. It represents the return on the market value of the firm and is calculated as the difference between the logarithm of the market value of equity and the lagged variable of the market value of equity.

- SIZE: corresponds to the logarithm of total assets (Cuñat-Martínez, 2007; Kestens *et al.*, 2012; Sanfilippo-Azofra *et al.*, 2016).

Country variables:

- GDP_GRTH: this is the economic growth rate of the country. It is measured as the change in the logarithm of GDP between the periods t and t-1.

- FDI: measured as the ratio of inward FDI flows to the GDP of the host country.

- TAX: is the average corporate tax rate applied on the profit (EBT) of a company in a country.

The descriptive statistics of the variables used in this study and correlations to identify the potential collinearity problems are presented below (Table no. 5 and Table no. 6).

Table no. 5 – Descriptive statistics

variable	mean	deviation	min	max
ROA	.0706	.1554	-2.2875	.6899
NTDS	.0462	.0417	.0001	.6826
LIQ	2.3539	2.4969	.1350	73.3730
TANG	.1764	.1688	2.7100	.9182
RISK	4.0770	33.2906	1.5100	2007.7490
MV_PERF	.0487	.5856	-4.5714	4.2095
SIZE	12.3848	2.0489	7.1880	19.2761
GDP_GRTH	1.5786	2.4822	-8.2690	7.2017
FDI	.0132	.0202	-.0587	.2386
TAX	28.7406	5.5638	15.0000	37.9960

Source: own elaboration

Table no. 6 – Correlations

	ROA	NTDS	LIQ	TANG	RISK	MV_PERF	SIZE	GDP_GRTH	FDI	TAX
ROA	1									
NTDS	0.0378	1								
LIQ	-0.0383	-0.1191	1							
TANG	0.0922	0.3141	-0.1088	1						
RISK	-0.0497	-0.0013	-0.0155	-0.0313	1					
MV_PERF	0.1690	-0.0304	0.0008	-0.0052	-0.0137	1				
SIZE	0.2714	0.0487	-0.0851	0.1262	-0.0570	0.0042	1			
GDP_GRTH	0.0355	-0.0101	0.0018	0.1093	0.0160	0.0931	-0.0661	1		
FDI	0.0397	0.0678	-0.0679	-0.0900	-0.0101	0.0108	-0.0356	0.0341	1	
TAX	-0.0332	0.0130	0.0531	-0.1672	-0.0010	-0.0177	0.2635	-0.1465	0.0653	1

Source: own elaboration

The model proposed in equation (1) is estimated through the System-GMM dynamic panel data methodology, Generalised Method of Moments, which allows the use of lags (Arellano & Bover, 1995; Blundell & Bond, 1998). The GMM estimator generates coefficients that are consistent and efficient in the presence of the endogenous independent variables. The GMM method controls for endogeneity, which is very appropriate for the model proposed.

In the estimation of the model the macroeconomic indicators - economic growth of the country, FDI inflows and profit taxes - are considered as exogenous variables, while firm-specific variables are considered endogenous. The estimation strategy for the endogenous variables applied in our analysis employs between the second and fourth lags as instruments.

4. RESULTS

4.1 The model with book value of debt

The results of the analysis of total debt in the sample companies - model (a) and model (b) - are presented below (Table no. 7). Both models include control variables and country variables and analyse the impact of these variables on the book value of total debt. Model (a) does not include the subsector dummy and model (b) does include it.

In model (a) ROA has a significant and negative associated coefficient. It means that the higher the profitability the lower the debt of an ICT firm. Therefore, hypothesis H_1 is supported. NTDS is shown with a negative and significant coefficient, which means that ICT firms use less debt when they have high NTDS. This result provides evidence for the hypothesis H_2. The coefficient of LIQ is negative and significant, showing an inverse relationship between liquidity and debt. Therefore, hypothesis H_3 would be supported. The variable RISK has a positive and significant associated coefficient, so that ICT firms with higher variability of operating profits take on more debt. This result would therefore support hypothesis H_5. The coefficient associated to GDP_GRTH is positive and significant, which means that ICT firms increase their leverage when the country's economic growth is higher. Therefore, the result of our analysis would support hypothesis H_7.

Model (b), which serves as a robustness check of the model under analysis, includes an additional dummy variable to control for the specific effect of the two subsectors into which the sample has been divided. To this end, a value of 1 is assigned to the companies belonging to the group of ICT manufacturing subsectors and 0 to the rest of the companies of the ICT service subsector. In this sense, the aim is to capture whether there is any difference in financing behaviour between these two subsectors. The results of this analysis are similar to those of model (a). Again, the variables ROA, NTDS, LIQ, RISK and GDP_GRTH are shown to be significant and with the same associated signs. There is one new significant variable, which is FDI, with a significant and positive associated coefficient. This means that technological firms increase their debt when there is an increase in the inflows of foreign direct investment into the country. Consequently, hypothesis H_8 would be supported by this model. Likewise, the sector dummy comes out significant too. This means that there would appear to be differences in investment behaviour between the ICT manufacturing and services subsectors.

Table no. 7 – Results of the analysis:
model (a) without subsector dummies and model (b) with subsector dummies

	MODEL (A)	**MODEL (B)**
LEV_{t-1}	.6885 (9.04)***	.6910 (8.95)***
ROA	-.0564 (-2.05)**	-.0653 (-2.25)**
NTDS	-.6801 (-1.80)*	-.6595 (-1.68)*
LIQ	-.0138 (-3.40)***	-.0131 (-3.13)**
TANG	.0337 (0.40)	-.0011 (-0.01)
RISK	.0003 (2.28)**	.0003 (2.16)**
MV_PERF	-.0008 (-0.06)	-.0008 (-0.06)
SIZE	-.0005 (-0.09)	.0009 (0.14)
GDP_GRTH	.0059 (1.88)*	.0052 (1.69)*
FDI	.0013 (1.51)	.0016 (1.65)*
TAX	.0006 (0.58)	-.0000 (-0.02)
Constant	.1851 (2.06)**	.1614 (1.46)
Country dummies	Yes	Yes
Subsector dummies	No	Yes -.0038 (-1.73)*
Year dummies	Yes	Yes
AR2	0.109	0.147
Hansen	0.255	0.274

Note: For each variable its coefficient and T-student is shown in brackets; *** indicates a significance level of 1%, ** indicates a significance level of 5%, * indicates a significance level of 10%. AR2 is the second order serial correlation statistic distributed as an N(0,1) under the null hypothesis of non-serial correlation. Hansen is the over-identification test, distributed as a chi-square under the null hypothesis of no relationship between the instruments and the error term.

Source: own elaboration

In both models, the variables TANG, MV_PERF, SIZE and TAX show no significant associated coefficient, which means that the results are inconclusive. Therefore, the hypothesis H_4, H_6 and H_{10} are not likely to succeed. However, the hypothesis H_7, which says that the ICT firm's size generates an inconsistent effect on its debt, is well justified.

4.2 The model with market value of debt

The models presented below analyse the effects generated by the independent intra-firm and macroeconomic variables on the market value of the total debt of ICT firms. Table no. 8 shows the results of these analyses in models (c) and (d). Model (c) does not include the subsector dummy and model (d) does include it.

Table no. 8 – Results of the analysis:
model (c) without subsector dummies and model (d) with subsector dummies

	MODEL (C)	MODEL (D)
LEV_MV_{t-1}	.8265 (19.84)***	.8325 (20.54)***
ROA	.0078 (0.39)	.0083 (0.42)
NTDS	-.4968 (-1.98)**	-.5168 (-2.01)*
LIQ	-.0076 (-2.65)**	-.0076 (-2.76)**
TANG	.0180 (0.24)	.0005 (0.01)
RISK	.0001 (1.70)*	.0001 (1.74)*
MV_PERF	-.1497 (-10.99)***	-.1483 (-11.01)***
SIZE	.0007 (0.18)	.0009 (0.23)
GDP_GRTH	.0019 (0.71)	.0020 (0.78)
FDI	.0004 (0.59)	.0005 (0.69)
TAX	-.0003 (-0.42)	-.0003 (-0.40)
Constant	.0733 (1.16)	.0754 (1.20)
Country dummies	Yes	Yes
Subsector dummies	No	Yes -.0017 (-1.30)
Year dummies	Yes	Yes
AR2	0.101	0.136
Hansen	0.188	0.214

Note: For each variable its coefficient and T-student is shown in brackets; *** indicates a significance level of 1%, ** indicates a significance level of 5%, * indicates a significance level of 10%. AR2 is the second order serial correlation statistic distributed as an N (0,1) under the null hypothesis of non-serial correlation. Hansen is the over-identification test, distributed as a chi-square under the null hypothesis of no relationship between the instruments and the error term.

Source: own elaboration

The variable LIQ, once again, has a negative and significant coefficient. This means that the higher the liquidity, the lower the level of market value of debt in ICT firms. So, hypothesis H_3 would be supported. The variable RISK has a positive and significant coefficient which means that technological companies take on more debt when they show greater variability in operating profits. This result, therefore, would support hypothesis H_5. The variable MV_PERF is shown to have a significant and negative coefficient, so that the higher the market return of the ICT firm, the lower its level of debt measured at market level. Therefore, the result of this analysis would support hypothesis H_6. The variables ROA, TANG, SIZE, GDP_GRTH, FDI and TAX in this model present a non-significant coefficient. Therefore, these results are inconclusive with respect to market value of debt. As stated previously for the models (a) and (b), the non-conclusive results for SIZE do support the hypothesis H_7.

Model (d) serves to check the robustness of model (c) and, as done in the analysis of the previous models, includes a dummy variable to control for the specific effect of the two subsectors present in the sample. Model (d) presents very similar findings to those of model (c) with significant coefficients for the same variables.

5. DISCUSSION AND CONCLUSIONS

This research has studied the influence that the internal factors characteristic of the company and the macroeconomic factors characteristic of the country generate on the level of indebtedness of companies in the information and communication technologies sector. The study used a sample of 1,510 listed companies from 23 OECD countries between 2004 and 2019. The proposed model was estimated using the Generalised Method of Moments System-GMM dynamic panel data methodology. Regarding the internal firm characteristics, the following variables have been analysed: profitability, the non-debt tax shield, liquidity, tangible assets, risk understood as the volatility of operating profits, performance of the firm's market value and firm size. The main hypothesis of this paper is that the internal characteristics of technological companies influence their debt financing decisions. In addition, the macroeconomic conditions of the country were considered since they also generate an impact on the level of debt of ICT companies.

According to the results obtained from the four models presented, it can be derived that the level of indebtedness of ICT companies depends to a large extent on the firm-level factors. More profitable technological companies take on less debt measured at book value. This result is supported by the pecking order theory that suggests that firms use internal funding as their first choice (S. Myers, 1984). Profitable ICT firms follow the same pattern showing lower levels of debt (Booth *et al.*, 2001; Frank & Goyal, 2009). Similarly, the market performance value of these companies also impacts debt negatively, but in this case debt measured at market value. This evidence corresponds to the idea proposed by Baker and Wurgler (2002) in their market timing model, which establishes an inverse relationship between the market value of the company and debt. For both variables the results are conclusive in the respective models and in those including the subsector dummy.

Besides that, ICT firms with much non-debt tax shield, NTDS, and liquidity tend to be less leveraged. Regarding NTDS, the result is in line with the trade-off theory, according to which the observed relationship between NTDS and debt is negative (Ghosh *et al.*, 2011). Concerning liquidity, the results correspond the pecking order proposal (Deesomsak *et al.*, 2004). They point out that technological firms, as in other sectors, reduce the level of debt when they have abundant cash flow, which they use to finance outstanding investments and projects (Ozkan, 2001; J. J. Chen, 2004; Degryse *et al.*, 2010).

It is also observed that when the ICT sampled companies have higher levels of risk associated with the variability of operating profits, they exhibit high levels of debt. These results are repeated in the basic models and in those incorporating the sector dummy, so that in this sense the results would be similar for both the manufacturing and services subsectors. The same relationship is also stated for debt at book and market value. The risk may be related to variations in growth and higher business opportunities of the firms, as suggested by Huynh and Petrunia (2010). So, this situation possibly requires more financing, for which the companies resort to debt to make new investments (Brown & Petersen, 2015).

However, fixed assets and the size of the ICT companies do not seem to be determinants of the level of their debt, since the results are inconclusive in all the models. This may correspond to the specific characteristics of the ICT sector. Firstly, technological companies have fewer tangible assets than intangible ones. But even if they have large tangible assets, their level of debt remains low because it is generally not the first source of finance they use (Castro *et al.*, 2015). As suggested by Hogan and Hutson (2005), equity issuance is probably the most commonly used type of financing in this case. Secondly, small and large ICT companies do not seem to use debt as a first financing option. Small firms find it very difficult to access debt, as explained by a number of authors (López-Gracia & Aybar-Arias, 2000; A. N. Berger & Udell, 2002; Carpenter & Petersen, 2002). Large firms, on the other hand, seem to follow the pecking order theory, choosing internal funds as their first financing option (López-Gracia & Sogorb-Mira, 2008; Mihalca & Antal, 2009).

Additionally, external factors seem to have certain impact on the decisions of ICT firms to take on debt. On the one hand, the country's economic growth favours greater indebtedness in these companies, but only applied to book value of debt. This result is in line with the proposals of various studies previously mentioned (Christopoulos & Tsionas, 2004; Brown *et al.*, 2009; Köksal *et al.*, 2013; Hsu *et al.*, 2014). On the other hand, a greater presence of capital from foreign direct investment in the country contributes to an increase in debt in technological companies. This result is in line with the observations of other studies which suggest that inward FDI capital improves the access of host-country firms to external financing through credit (A. E. Harrison & McMillan, 2003; R. T. Harrison *et al.*, 2004) and that with increased availability of capital in the country the corporate debt of firms also increases (Korajczyk & Levy, 2003). This result is validated in the model that analyses book value of debt with the incorporation of the sector dummy, so that there might be some differences between ICT firms in the manufacturing and services subsectors regarding their decision to use debt financing.

Finally, corporate income taxes do not seem to be a determinant of the level of debt, both at book and market value. This result may suggest that technological companies could follow the same pattern as SMEs, as explained by aus dem Moore (2014) or that probably they could use more non-debt tax shields, whenever as possible, to reduce the tax base, as suggested by Lin *et al.* (2014) and Richardson *et al.* (2014).

The findings of this paper contribute to the existing literature by providing empirical results on the particular behaviour of ICT firms in terms of decisions to use debt financing. The study provides evidence of the impact of some factors, both at company and country level, jointly on the level of corporate debt. It is interesting to note that the variables impacting debt levels are different when analysing debt measured at book and market values. The research also offers evidence that helps to explain that firm size, the variable widely used in many studies as a determinant of the financing decision, is irrelevant for technological companies. Probably, future research should be developed to analyse this behaviour in detail distinguishing between firms in the manufacturing and service subsectors, as the presented models suggest that the patterns of financing decisions might be different. This work can also contribute to the design and development of policies, measures and mechanisms for optimal management of the financing decisions of companies in the ICT sector.

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