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DETERMINANTS OF INVESTMENT DECISIONS IN TECH FIRMS: EVIDENCE FROM GMM ANALYSIS OF PANEL DATA ACROSS 23 OECD COUNTRIES

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Determinants of Investment Decisions in Tech Firms: Evidence from GMM Analysis of Panel Data Across 23 OECD Countries

Corporate investment decision has been a recurrent topic in literature for the last decades. However, there is little studied about what internal and external factors influence this decision in the companies of the Information and Communication Technologies (ICT) sector, so important for technological development of business and economies. The objective of this empirical study is to analyze the impact generated by firm- and country-level variables on the investment decision-making by technological firms. The analysis, made with GMM of two steps of 19,613 observations obtained from 1,661 listed ICT companies in 23 OECD countries between 2003 and 2019. The data were obtained through various databases, such as S&P Capital IQ, World Bank's World Development Indicators, International Monetary Fund statistics and the OECD's Main Science and Technology Indicators (MSTI). The results of the study suggest that corporate investments of tech firms highly depend on internal and external financing. There are other interesting findings showing significant impact generated by other firm- and country-level variables both in ICT manufacturing and services subsectors.

Keywords: *ICT sector, technological firms, fixed investments, cash flow, leverage, OECD, two-step GMM, data panel.*

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Алексєєва-Алексєєв І. Детермінанти інвестиційних рішень у технологічних компаніях: дані аналізу з допомогою узагальненого методу моментів панельних даних стосовно 23 країн ОЕСР

Корпоративні інвестиційні рішення є постійною темою в спеціальній літературі протягом останніх десятиліть. Однак досить небагато досліджень стосуються питання, які внутрішні та зовнішні фактори впливають на ці рішення в компаніях сектору інформаційно-комунікаційних технологій (ІКТ), настільки важливого для технологічного розвитку бізнесу та економіки. Метою представленого емпіричного дослідження є аналіз впливу, який генерується змінними на рівні фірм і країн, на прийняття інвестиційних рішень технологічними фірмами. За допомогою двокрокового узагальненого методу моментів (GMM), проведено аналіз 19613 спостережень, отриманих від 1661 зареєстрованих ІКТ-компаній у 23 країнах ОЕСР у період з 2003 по 2019 рік. Дані було отримано з різних баз даних, таких як S&P Capital IQ, Індикатори світового розвитку Світового банку, статистика Міжнародного валютного фонду та Основні науково-технічні індикатори ОЕСР. Результати дослідження свідчать про те, що корпоративні інвестиції технологічних фірм значною мірою залежать від внутрішнього та зовнішнього фінансування. Є й інші цікаві результати, що свідчать про значний вплив, спричинений іншими змінними на рівні фірм і країн як у галузі виробництва ІКТ, так і в підсекторах послуг.

Ключові слова: *сектор ІКТ, технологічні фірми, інвестиції в основний капітал, грошовий потік, леверидж, ОЕСР, двокроковий узагальнений метод моментів, панель даних.*

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Introduction. Investment decisions are crucial in financial management of any company for achieving returns [1]. The technological sector, marked by high uncertainty and rapid technological advancements [2], pushed its companies to acquire and generate resources that bring value to business to maintain competitiveness [3]. So, investment decisions in this sector are vital but differ from other sectors due to the specific focus on Research and Development (R&D) projects and capacity to produce more intangible assets that contribute to long-term growth, new product and service design, new method of business organization and increased productivity [4; 5]. These investments often demand intensive and extended resource use, sometimes at the expense of other projects [6]. There is evidence that some companies try to secure and protect R&D investments to the extent that, when facing limited availability of funds, such as during an economic downturn, they would prefer a more drastic reduction in fixed investments than in R&D or reserve cash flow specifically for R&D investments rather than for fixed investments [7]. In a similar vein, Hyytinen and Pajarinen [8], in their study on the financing of technology firms, suggest that an R&D intensive firm is more prone to underinvestment, especially if internal funds are not sufficient and if there is difficulty in accessing external finance.

Theoretical approach. Theories emphasize the importance of investing in fixed assets for long-term operation, highlighting the investment decision as one of the most significant within a firm, influencing its future performance. While most academics agree on the importance of fixed asset investment, not all share the same view on the determinants of investment, which has led to the emergence of multiple theories.

One of the most significant contributions to investment theory was Modigliani and Miller's theorem, also called the principle of irrelevance of capital structure. It states that in perfect capital markets free from distortions generated by tax, transaction, bankruptcy or asymmetric information costs, a firm's value is independent of its financial structure [9; 10]. According to the theorem, firms, operating in a balanced market with full access to information, borrow at the same interest rate without transaction costs and taxes and always have an expected level of liquidity, so bankruptcy risk is not taken into account [11]. Thus, the cost of capital is the same for all firms, and investment decisions should be based solely on project profitability, regardless of their financing [12; 13]. Despite empirical testing challenges, this theorem revolutionized investment decision-making and spurred research on market imperfections [14; 15].

The agency theory, another theoretical approach, explores conflicts within firms due to differing interests of managers and directors [16]. It defines the agent-principal relationship as a contract where the principal delegates tasks to the agent. The principal is risk-neutral because he/she can diversify his/her stakes in different companies. The agent, on the contrary, is risk-averse because he/she is more interested in protecting his/her personal assets [17]. This conflict can lead to moral hazard, where agents act in their own interests, potentially lacking transparency [18]. Such conflicts hinder optimal investment levels [19; 20]. The agent, for example, may opt for those investments and expenditures that maximize the survival of the firm and thus ensure its permanence in the firm. In contrast, the principal may be more interested in high return investments that involve managing greater uncertainty. To mitigate this, the principal either incurs the opportunity costs of supervising the agent or assumes the incentives to align the agent's risk positioning with his/her own. All this increases investment costs [21].

In addition to the internal relationship that exists between owners and managers, agency theory analyses the relationships between the firm and the external environment, e.g. between the firm and its creditors, customers or suppliers. Each of these stakeholder groups provides the firm with some of the resources and, in return, seeks to satisfy their own interests [22]. Agency conflicts, in this case, could arise from divergences between what each of these external stakeholders expects (returns on capital, added value of products and services or profits from the sale of raw materials) and what the firm seeks to obtain (maximization of firm value).

Investment decisions are also impacted by informational asymmetries, leading to financial difficulties [23; 24]. The better informed party is in a privileged situation with respect to the other, so that, due to the different information handled by the company's internal and external stakeholders, differences in the perception of the company's value are generated. Managers often have more information about the firm's financial state than external investors, causing adverse selection and increasing the equity risk premium. As leverage rises, perceived risk and the cost of external financing increase, forcing firms to ration external financing. Consequently, firms may need to reduce or delay investments [25]. In such cases, firms might rely on internal funds or issue equity to finance investments [26], as limitations on external financing can constrain investment projects [13].

Information asymmetry is related to some firm characteristics, such as size, business opportunities and spending on research and development, R&D, among others. According to previous literature, information asymmetry is high in smaller firms and tends to decrease in larger firms, which tend to be more mature and have a higher level of transparency [27]. Information asymmetry is also found to be more prevalent in firms with high R&D expenditure and larger business opportunities [28; 29].

Bankruptcy costs, another market imperfection, arise from firm insolvency, affecting capital structure decisions. Insolvency probability increases with higher debt, raising financing costs and default risk [24]. Bankruptcy costs are divided into direct and indirect costs. Direct costs are administrative, legal and judicial expenses as they include payments to third parties as a consequence of the insolvency situation [30]. These expenses are deducted from the value of the firm, resulting in its diminishing value and affecting its cost of capital. However, the direct costs are often low, especially related to the potential tax benefits of using debt [31]. Indirect costs are opportunity costs, which affect the value of the company even before bankruptcy occurs and increase as bankruptcy becomes more likely. Empirical evidence suggests that indirect costs, although difficult to quantify, are important because they significantly increase total bankruptcy costs [32; 33].

All these circumstances negatively impact the value and competitiveness of the firm, leading to a loss of market share and production efficiency [32] as well as other inefficiencies, including inefficient investment decisions. On the one hand, con-

trol shifts from shareholders to creditors, as any decision about the future of the firm significantly influences the outcome of the insolvency situation. This creates a conflict of interest in the investment decision and raises agency costs [34; 31]. On the other hand, even if decision-making power is retained by shareholders, their investment decisions will be suboptimal because they will underinvest [35; 36]. This occurs because the firm diverts attention from investments that can generate higher returns in the longer term or because it is unable to meet investment opportunities due to a lack of financing.

Suboptimal investment decisions (under- or overinvestment) negatively impact firm value [37]. On the one hand, it is observed that the asymmetric information that exists between a company's shareholders and creditors means that investments, even profitable, are not undertaken, leading to underinvestment. However, additional investment can mitigate this and increase firm value [38]. On the other hand, the existence of asymmetric information between a firm's shareholders and managers or between managers and creditors generates problems of overinvestment. It happens when firms with high cash flow invest above the optimum level in fixed assets or acquisitions, without providing added value to the company, i.e. risky projects with negative net present value are undertaken [37]. It can also happen because managers prioritize firm growth over value, seeking higher salaries, greater control, and prestige [39]. So, overinvestment decreases firm value and harms shareholders.

Another imperfection of capital markets is corporate taxation. According to Modigliani and Miller [9], taxes benefit firms that decide to make an investment by financing it through debt because the interest becomes a tax-deductible expense. In contrast, equity issuance offers no tax benefit, so that the optimal capital structure should in principle be mostly, if not entirely, debt [40]. Thus, in the presence of taxes, higher debt increases the value of the firm [41] and the expected return on common stock, which grows proportionally to the degree of indebtedness [30; 42].

However, the profit tax leads to a decrease in after-tax profits and also in its investment capacity [43]. In contrast, the reduction of corporate taxes leads to an increase in corporate investments [44]. This negative effect generated by taxes has been observed in different sectors and types of firms. For example, Djankov et al. [45] focus their analysis on manufacturing firms and find that higher taxes negatively affect the cost of capital and, therefore, investment. Dobbins and Jacob [44] find that firms focused on the domestic market are the ones that suffer most from higher taxes by reducing investment, since their main source of financing is internal funds. This greater reliance on cash flow is also observed in SMEs that use less debt when the tax rate rises, so that with higher taxes there is less investment.

In addition to existing theories, numerous studies examine internal (firm-specific) and external (micro- and macro-environmental) factors influencing investment decisions. Key internal factors include financial structure elements like cash flow and debt, as well as growth opportunities, sales, and company size. Cash flow, or the ability to generate internal resources, significantly impacts investment [46]. Firms financed through cash flow face fewer financial constraints, enhancing their investment capacity [47]. The companies with harder access to external financing generate an excessive dependency on internal financing, which makes investments sensitive to cash flow [48]. This situation demands higher associated costs related to debt when it is needed to co-finance investments o high value [49; 50].

Growth opportunities significantly influence investment decisions: high growth opportunities makes the access to external financing easier [51]. Firms with profitable growth prospects tend to increase investments, expecting to obtain increased competitive advantage and higher future cash flows or profits, which reduces adverse selection and moral hazard [19]. However, the relationship between growth opportunities can turn negative if companies are heavily leveraged and experience financing difficulties. In the ICT sector, business opportunities must be seized quickly due to the short life cycle of technology products and the need to be first to market. Companies from the ICT manufacturing sector behave similarly to companies from other industries, counting with larger fixed assets due to larger business opportunities [52]. In this case, investments are done to increase the firm's productivity, as in the sector of semiconductors [53]. But in the ICT service sector this relationship is not so clear, maybe due to that the tech firms invest more in innovation through R&D, associated mainly with intangibles [54].

Debt also impacts a firm's investment capacity by providing additional funds and increasing investment efficiency by reducing costs [21]. Debt helps firms generate sufficient funds during tough times and increases assets for collateral [55]. Besides that, if companies use cash flow and debt as independent financing sources, the debt is not expected to condition the investment decision [46]. Additionally, the positive relationship between debt and investment is stronger in secure or liquid projects and in more diversified firms [25]. Finally, companies with higher business opportunities would also have higher debt level associated with larger and more profitable investments to undertake. On the contrary, companies with lower business opportunities usually show lack of resources and less leverage, so their investment capacity is reduced [56]. Nonetheless, debt is also seen as a factor that increases the firm risk: the interests applied to debt can increase, reducing the level of cash flow, which consequently impacts negatively the investments [46; 57; 58].

Regarding the firm's size, small firms face significant financing limitations, reducing their investment capacity [59]. Large firms, with greater transparency, access external financing more easily, optimizing investments. However, small firms often seize better business opportunities, leading to larger investments compared to large firms, which may grow slower and invest less [60]. In the ICT sector, smaller firms grow faster than larger ones [61]. As firms grow, they increase fixed assets and working capital, but larger firms may delay investments until cheaper financing is available [62]. Sales turnover, another firm-level variable, positively influences investments by increasing cash flow and investment capacity [19]. In the tech sector, higher turnover is positively related to R&D investments [63], but this support to innovation can reduce fixed investments, especially during liquidity shortages or crises [64].

External factors influencing investment decisions include economic growth, foreign direct investment (FDI), and

corporate profit taxes. Economic growth is a key benchmark for investment climate, with high or low business investments corresponding to periods of high or low growth [65]. FDI increases a country's capital stock and productivity, fostering new growth and investment opportunities, especially in countries with developing financial systems [66]. Tax policy changes impact capital investments immediately. While high profit taxes theoretically encourage investment through debt tax savings [67], empirical evidence shows a negative effect on investment decisions. Higher taxes reduce productivity, distort factor prices, and lower net returns on investment [68]. For firms with limited access to external financing, higher taxes also reduce net profit and cash flow, their main financing source [69].

Considering the above-mentioned theoretical approaches and analysis of the factors conditioning corporate fixed investment, the following hypotheses are proposed.

Hypothesis 1: *Cash flow positively impacts the investment of technological companies.*

Hypothesis 2: *Growth opportunities have a positive influence on the investment of technological companies.*

Hypothesis 3: *The level of debt has a positive effect on the investment of technological companies.*

Hypothesis 4: *The size of technological firms has a negative effect on investment.*

Hypothesis 5: *The volume of sales has a negative impact on investment by technological firms.*

Hypothesis 6: *The level of economic growth in the country has a positive effect on investment by technological firms.*

Hypothesis 7: *The level of inward foreign direct investment (FDI) positively influences investment by technological firms.*

Hypothesis 8: *Corporate profit taxes have a negative effect on investment by technological firms.*

Methodology, Sample, and Variables. The empirical test of the hypotheses is carried out on a sample of listed ICT firms from 23 OECD countries between 2003 and 2019. Corporate, accounting and financial information of the firms is drawn from the S&P Capital IQ database, while macroeconomic data are taken from the World Bank's World Development Indicators, International Monetary Fund statistics and the OECD's Main Science and Technology Indicators (MSTI). The sample includes companies and countries that provide complete data for the given period. Table 1 shows the number of companies and observations per country (Panel A) as well as temporal distribution of data (Panel B).

Following Aoun and Hwang [61], the sample of tech firms 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 main categories: Manufacturing Industry and Service Industry, which show a very similar distribution, with 822 companies in the manufacturing sector (49.5%) and 839 in the service sector (50.5%). The manufacturing sector refers in general to the manufacturing industry of components, parts, equipment and other elements necessary in the technology sector. Within this group, the presence of 194 companies (11.7% of the total sample) dedicated to the manufacture and sale of semiconductors and related devices stands out. The ICT service sector is characterized by being innovative and fast-growing, capable of creating added value through intangible solutions. Most of the companies in the sample within the ICT service sector belong to the sub-sector of computer and software programming and the design of integrated computer systems.

The basic model used in this analysis is the investment model used by Fazzari et al. [70], which includes the explanatory variable of cash flow, generating equation (1):

$$(I/K)_{it} = f(X/K)_{it} + g(CE/K)_{it} + u_{it}. \qquad (1)$$

Where I_{it} is corporate investment made by a company i in t-period; X is a vector of determinants of the investment. The function g depends on cash flow and shows sensibility investment-cash flow. All the variables are divided by the replacement value of firm's assets as at the beginning of the period. u is the error. Throughout the literature, the Fazzari model has been enriched by the incorporation of numerous variables that affect investment. Based on all previous studies, the model proposed with adaptation to the characteristics of the technology sector is the one shown in equation (2):

$$\begin{aligned}(I/K)_{it} = {} & \beta_0 + \beta_1 (I/K)_{it-1} + \beta_2 CF_{it} + \beta_3 Q_{it} + \\ & + \beta_4 LEV_{it} + \beta_5 SIZE_{it} + \beta_6 SALES_{it} + \\ & + \beta_7 GD\_GRW_{jt} + \beta_8 FDI_{jt} + \beta_9 TAX_{jt} + \\ & + \sum_j \gamma_j COUNTRY_{jit} + \sum_j \phi_m SECTOR_{mit} + \\ & + \sum_k \lambda_k YEAR_{kit} + \varepsilon_{it}.\end{aligned} \qquad (2)$$

Where $(I/K)_{it}$ is corporate investment; β_0 is a constant term; β_1 is a coefficient of the dependent lagged variable of investment; $\beta_2 - \beta_9$ are coefficients of the independent variables used in the model. We included temporal dummies of country, sector and year. ε_{it} is the error. The variables used in equation (2) are as follows:

I/K reflects the investment made by the company and is calculated as the ratio of investment, *I*, over the replacement value of assets, *K*. Investment, *I*, is the difference between the current and previous year's fixed assets plus the current year's depreciation expense. *K* is calculated as the replacement value of fixed assets plus the replacement value of inventories plus the book value of the remaining assets [71].

Independent variables include CF, Q, LEV, SIZE, SALES, GDP_GRW, FDI and TAX. CF is cash flow and represents the internal funds of the firm. It is measured as earnings before interest, taxes, depreciation and amortization, over the replacement value of assets [71]. Q is Tobin's q representing business opportunities [72]. It is calculated as the market value of the firm over the replacement value of its assets [73]. LEV is the ratio of total debt to total assets [74]. SIZE corresponds to the logarithm of total assets [75]. SALES is the ratio of the firm's annual net turnover to total assets [19]. GDP_GRW is the economic growth rate of the country. It is measured as the change in the logarithm of GDP between period t and t-1. FDI represents inward foreign direct investment (FDI) flows measured as the ratio of FDI to GDP of the recipient country. TAX is the tax rate imposed on corporate income. Table 2 shows the descriptive statistics of the variables used in the analysis.

Table 1

Sample composition

PANEL A: Number of observations and companies per country		
Country	**Number of observations**	**Number of companies**
Australia	355	38
Austria	87	6
Belgium	84	7
Canada	507	50
Denmark	91	7
Finland	243	17
France	926	73
Germany	887	70
Israel	695	54
Italy	274	24
Japan	4,31	334
Korea, Rep	3,763	323
Luxembourg	63	6
Mexico	64	5
Netherlands	133	9
New Zealand	74	9
Norway	135	11
Poland	352	39
Spain	93	11
Sweden	533	52
Switzerland	265	19
United Kingdom	722	74
United States	4,957	423
Total	19,613	1,661

PANEL B: Temporal distribution of the sample										
Year	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**Total Observations**
Number of observations	672	747	830	911	977	1.068	1.127	1.177	1.231	
Year	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**		
Number of observations	1.278	1.309	1.363	1.388	1.432	1.404	1.379	1.320	19.613	

Source: Own elaboration

There is no correlation among the variables, so no potential collinearity problems are identified.

The model proposed in equation (2) is estimated through the Generalized Method of Moments System, GMM of two steps, methodology used for dynamic panel data [76; 77]. The GMM estimator generates coefficients that are consistent and efficient in the presence of the endogenous independent variables and fixed effects. Macroeconomic and sector indicators– country economic growth, FDI inflows, income taxes– are considered as exogenous variables, while firm-specific variables are endogenous. The estimation strategy for endogenous variables applied in our analysis employs between the second and fourth lags as instruments to avoid over-identification of the model.

Findings and Discussion

Table 3 shows the results of the analysis of investment decision-making of ICT companies.

In the general model without the sector dummy, the variable CF is positive, indicating that cash flow directly impacts technology company investments, supporting hypothesis H1. The positive coefficient for LEV supports hypothesis H3, aligning with literature [46], which says that debt should enhance investment capacity when used independently of cash

Table 2

Descriptive statistics of the variables

Variables	Mean	Standard Deviation	Minimum	Maximum
I/K	0.1366	0.1820	-2.5610	0.8958
CF	0.0451	0.1351	-2.5143	1.3677
Q	1.5082	1.4167	0.0900	31.7639
LEV	0.4418	0.2100	0.0145	0.9999
SIZE	12.4330	2.1337	6.1112	20.3799
SALES	0.8133	0.5629	0.0001	7.1461
GDP_GRW	1.9983	1.9072	-8.0746	8.3372
FDI	1.8584	4.0820	-58.3228	86.5890
TAX	31.7473	6.6543	19.0000	44.4290

Source: Own elaboration

Table 3

Estimations: general models (a) and (b)

Variables	(a) General model without sector dummy			(a) General model with sector dummy		
I/K_{t-1}	0.1632	(0.437)		0.1713	(0.411)	
CF_t	0.4158	(0.091)	*	0.3900	(0.097)	*
Q_t	0.0056	(0.622)		0.0046	(0.670)	
LEV_t	0.5694	(0.004)	**	0.5788	(0.004)	**
$SIZE_t$	-0.0392	(0.081)	*	-0.0389	(0.083)	*
$SALES_t$	-0.1021	(0.099)	*	-0.1054	(0.092)	*
GDP_GRW_t	-0.0026	(0.725)		0.0035	(0.633)	
FDI_t	-0.0024	(0.382)		-0.0025	(0.374)	
TAX_t	-0.0010	(0.774)		0.0015	(0.672)	
CONSTANT	0.3883	(0.242)		0.3652	(0.268)	
Dummy Country	Yes			Yes		
Dummy Sector	No			Yes		
Dummy Year	Yes			Yes		
AR2	0.126			0.100		
Hansen	0.469			0.522		

Note: For each variable its coefficient is shown and in brackets the T-student; *** 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 no 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

flow. The negative coefficient for SIZE supports hypothesis H4, consistent with evidence that larger firms invest less due to lower urgency and slower growth [78]. Smaller tech firms seem more agile by making investment decision. The negative coefficient for SALES indicates that higher sales in service sector technology firms reduce fixed investments, supporting hypothesis H5. This aligns with studies showing increased turnover leads to more R&D investments rather than fixed investments [33; 34]. The other variables are not significant in this estimation. Model (b), shown in Table 3, includes a sector dummy variable to differentiate between manufacturing and service subsectors, assigning 1 to manufacturing firms and 0 to service firms. This aims to capture any differences in investment behavior between the two subsectors. The results are similar to model (a): CF and LEV have significant positive coefficients, while SIZE and SALES have significant negative coefficients. So, hypotheses H1, H3, H4, and H5 are supported. The sector dummy is not significant, indicating no substantial differences in investment behavior between the manufacturing and service technology subsectors.

The additional models (c) and (d), shown in Table 4, attempt to analyze the effects generated by the independent variables on investments in technology companies classified by sector groups.

Model (c) analyses manufacturing subsector companies and shows that CF has a significant positive coefficient, indicating that higher cash flow leads to greater investments, supporting hypothesis H1. The variable Q also has a significant positive coefficient, meaning high business opportunities boost investment capacity, supporting hypothesis H2 [49]. SIZE has a significant negative coefficient, indicating small ICT firms invest more than large ones, supporting hypothesis H4. GDP_GRW has a significant positive coefficient, showing economic growth promotes higher fixed investments, supporting hypothesis H6 [79].

Table 4

Estimations: additional models (c) and (d)

Variables	(c) Manufacturing ICT sector			(d) Service ICT sector		
I/K_{t-1}	0.0526	(0.678)		0.0270	(0.803)	
CF_t	0.2422	(0.077)	*	0.2217	(0.016)	**
Q_t	0.0361	(0.081)	*	0.0016	(0.795)	
LEV_t	0.0937	(0.514)		0.2352	(0.050)	**
$SIZE_t$	-0.0285	(0.099)	*	-0.0193	(0.096)	*
$SALES_t$	-0.0280	(0.409)		-0.0809	(0.029)	**
GDP_GRW_t	0.0178	(0.041)	**	0.0071	(0.235)	
FDI_t	-0.0003	(0.930)		-0.0008	(0.600)	
TAX_t	-0.0004	(0.894)		-0.0002	(0.920)	
CONSTANT	0.3820	(0.208)		0.3389	(0.050)	**
Dummy Country	Yes			Yes		
Dummy Year	Yes			Yes		
AR2	0.176			0.462		
Hansen	0.516			0.152		

Note: For each variable its coefficient is shown and in brackets the T-student; *** 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 no 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

Model (d) focuses on the ICT services subsector. As in previous models, CF has a significant positive coefficient, indicating that high cash flow boosts investments, supporting hypothesis H1. LEV also has a significant positive coefficient, showing that higher debt levels lead to more investments, supporting hypothesis H3. SIZE has a significant negative coefficient, meaning small ICT firms invest more than large ones, supporting hypothesis H4. Finally, SALES has a significant negative coefficient, indicating that higher sales volumes reduce fixed investments, supporting hypothesis H5 [63; 64].

Conclusions. This research has studied how internal and macroeconomic factors influence the investment decisions of firms in the information and communication technology sector. We used a sample of 1,661 listed companies from 23 OECD countries with economic and financial data generated during 2003–2019. The proposed model is estimated through the GMM of two steps methodology.

The analysis shows that ICT companies invest more in fixed assets when they have higher cash flow and debt levels. Company size negatively impacts investments, with smaller firms investing more than larger ones. Higher sales reduce fixed investments, likely because profits are used for R&D. The extended model, including sector-specific variables, shows similar findings. In both ICT manufacturing and services subsectors, cash flow and company size are key investment factors. Smaller firms invest more, while larger firms invest less. Manufacturing firms' investments, as expected, depend on growth opportunities and are positively influenced by the country's economic growth. In contrast, the services subsector's investments are highly influenced by debt and sales, with higher debt supporting larger fixed investments and higher sales leading to reduced investments due to increased R&D spending. The evidence of this study support totally or partially hypotheses H1, H2, H3, H4, H5 and H6. However, there is no strong evidence to validate hypotheses H7 (inward FDI impacts positively investments) and H8 (corporate taxes impact negatively investments). So, further research is suggested in this line to dig in deeper considering other variables which might create a greater and more significant impact on investment decisions of tech firms or generate a moderate effect on the analyzed relationships.

These findings can be useful to design and implement public policies, establish metrics of healthy investment levels in the ICT industry, and provide mechanisms that enable technological companies to optimally manage their fixed investments balancing with their needs for investment in innovation and considering their financing needs and possibility to access it.

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