A QUANTITATIVE ASSESSMENT OF TOTAL FACTOR PRODUCTIVITY AND TAX HAVEN USE IN DIGITAL FIRMS

SANTIAGO JUAN GALLEGO DE CÁCERES

Doctor of Philosophy

ASTON UNIVERSITY

April 2024

ASTON UNIVERSITY

A QUANTITATIVE ASSESSMENT OF TOTAL FACTOR PRODUCTIVITY AND TAX HAVEN USE IN DIGITAL FIRMS

SANTIAGO JUAN GALLEGO DE CÁCERES

PhD 2024

THESIS ABSTRACT

This doctoral thesis aims to provide a comprehensive exploration of the distinctive characteristics, ownership advantages, productivity dynamics, and tax behaviours of digital firms, addressing key gaps in the existing literature on the digital economy. Aiming to fill a series of gaps in the literature on digital firms, this thesis performs both theoretical and empirical analyses. We define digital firms as those primarily engaged in the production, distribution, or sale of digital objects, tangible and intangible. We push forward the idea of scalability as an advantage of the digital firm, linked to the digital object, and propose malleability as another ownership advantage. Combined, these ownership advantages have had a transformative impact on global competition and resource management. We operationalise the digital object criterion, employing firm-level data from ORBIS by Bureau van Dijk, to provide two additional empirical chapters.

Empirical findings reveal substantial variability in productivity across digital and traditional sectors. Digital service firms exhibit the highest total factor productivity, while digital manufacturers face challenges, often underperforming compared to their non-digital counterparts. Urban locations enhance productivity for service firms but provide limited advantages for digital manufacturers, underscoring the need for sector-specific strategies. This research challenges several assumptions about tax avoidance and the capabilities of the digital firm, arguing that digital service firms are indeed more productive as expected, but are not the worst offenders when it comes to tax avoidance practises, contrary to expectations. Increased levels of intangible assets in the hands of digital firms do increase the risk of tax haven use, but manufacturing firms in general pose a higher tax risk. The use of operating revenue turnover, a measure of size proposed for the Digital Service Tax, has been found wanting when assessing tax avoidance risk of digital firms.

This thesis has been written in the backdrop of the OECD-sponsored Base Erosion and Profit Shifting (BEPS) initiative, a set of new rules to tackle a series of deficiencies within the international tax system. Divided in fifteen Actions, Action 1, focused on the perils of the digital economy, is still standing. Our findings have wide implications on the BEPS initiative discussion, actionable not just for theory purposes, but also for managerial and policy purposes.

Key words: digital economy, digital firms, digital object, productivity, firm performance, tax avoidance, international finance, and taxation.

ACKNOWLEDGEMENTS

Had it not been for the unconditional support from my parents, this thesis would not have come into existence. It is thanks to their love, encouragement, and trust that this project has been completed. It is hard for me to express the gratitude I feel for their constant sacrifice and for their constant effort to build a good life and a better future for me and my brother. I would like to thank my brother for having always been there to cheer me up and for having taught me, in his own ways, about patience, compassion and understanding. I need to express my deepest gratitude to my aunt, my uncle, and my cousin, for their loyalty, and for their unwavering support over the last three years.

It has been a privilege to work with Professors Chris Jones, Yama Temouri and Karim Kirollos. I cannot express enough gratitude for Chris' empathy and understanding as this thesis took place through some of the most challenging times, as well as for his reliability, availability, and willingness to counsel. I would like to thank the three of them for their dedicated guidance, their investment in my future; and I cannot wait to do further work with them. I consider myself incredibly lucky to have had a chance to work with them.

I need to thank my examiners, Prof. Rajneesh Narula and Prof. Cher Li for their time, their feedback, and comments which helped me correct and strengthen my work. I would like to thank the following people from Aston University who took their time to help me with useful advice and practical help: Dr Ha-Phuong Luong, Dr Robert Riegler, Prof. Jun Du, Prof. Tomasz Mikiewicz, Dr Jonathan Crenshaw, Dan Thompson, Caroline Brocklebank and Farat Ara. For their recommendations as well as for encouraging me to enter academia, I want to take this opportunity to thank Professors Juan Pablo Murga, Isidoro Romero and María Cruz Arcos from Universidad de Sevilla. I would also like to thank Prof. Vijay Pereira for his insights and comments.

My years at Aston in Birmingham have been quite enjoyable thanks to the support and friendship of my fellow PhD colleagues: the “Hungry Guys” and the “11th Floor Gang”. This list would be incomplete without acknowledging the support of the community at the Birmingham Oratory, where I received much needed support and respite.

PRESENTATIONS AT CONFERENCES

Conferences	Empirical chapters
Doctoral Consortium at the 48^{th} Annual meeting Academy of International Business (AIB-UKI), April 2022, Henley Business School (Reading)	The third empirical chapter (Chapter 5)
Doctoral Consortium at the Annual meeting Academy of International Business (AIB World), July 2022, Florida International University (Miami)	The third empirical chapter (Chapter 5)
11th Annual meeting Academy of International Business (AIB-MENA), December 2023, Africa Business School (Rabat) (Competitive Sessions)	The second empirical chapter (Chapter 4)

CONTENTS

LIST OF ABBREVIATIONS

BEPS	Base Erosion and Profit Shifting
BvD	Bureau van Dijk
EU	European Union
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GPT	General Purpose Technology
IB	International Business
ICT	Information and Communications Technology
IS	Information Systems
IT	Information Technology
MNEs	Multinational Enterprises
NACE	Statistical classification of economic activities in the European Community
OECD	Organisation for Economic Co-operation and Development
R&D	Research and Development
TFP	Total Factor Productivity
UK	United Kingdom
US	United States of America

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1: INTRODUCTION

1.1. Philosophical underpinnings

Paul Virilio, a French philosopher, argued that speed (dromos) is the engine of history. Virilio argues that what often is called ‘progress’ can be understood as a continuous search for agility, speed and efficiency (Virilio, 1977/2006, p.64). Virilio goes on to argue about faster ships, faster production, faster militaries and faster political organisations; then about the opportunities for wealth for those who embrace the speed, the impoverishment of those who do not embrace it, and the societal problems created by this need for speed (Virilio, 1977/2006, p.46). In the 21st century, the application of this urge for speed has materialised in the application of digital technology to every sector of the economy, reaching a point where our grasp over the economy as individuals is tenuous at best, the interactions being too complex for a single person to apprehend. We have reached a point where humans need the help of algorithms to make decisions as the required information has become too dense to assimilate and process (Adner, Puranam and Zhu, 2019). Bratton (2006) applies Virilio’s philosophy to the digitalisation process. Although the digitalisation of the economy has created structures that are seemingly ‘virtual, immaterial or distant,’ in reality, digital technology serves as the glue that binds physical objects together through chains of supply, demand, and customer relationships. Broadly speaking, the modern economy is held together through a network of management software packages, coordinated steel containers, offshore factories and inter-modal exchange protocols, using “an unimaginably complex, robust and nimble assembly of every purchase command with vast economies of production and distribution.” Control over distance and time is achieved through the exchange of massive amounts of computerised information and inventories in permanent transit, where immense volumes of information are shared at massive speeds. In this environment, the most valuable assets that firms possess are their brands and immaterial assets, which they carefully protect and profit from. This process generates an “uncontrollable accumulation of-very real and opaque-unintended consequences” (Bratton, 2006, p.12-13).

1.2 Theoretical underpinnings

This doctoral thesis is built under the assumption, and develops the position, that there are a series of digital-based ownership advantages that allows digital firms to scale and adapt at a faster pace than non-digital businesses. Digital firms have an ability to alter the products they offer and to growth quicker than non-digital firms, which poses a challenge to traditional considerations of firms in general, and to the integrity of the international tax system in particular. This thesis starts from traditional theories of international business, considering that firms will try to maximise their performance by exploiting advantages among geographies. From there, we argue that digital firms enjoy a series ownership advantages that in turn allow them to benefit from maximisation of internal assets to a degree not observed by other traditional firms. To perform this task, we provide a theoretical framework that explains such firm behaviour. These advantages, previously intuited but not measured, are the reason why digital firms have been the focus of initiatives such as the OECD-sponsored BEPS initiative. We have no form of observing this maximisation in place, but we assume it can be inferred from higher productivity enabled by superior processes, assets, and performance. The availability of tax haven jurisdictions (for all firms) further blurs the difference between location bound and non-location advantages, due to legal fictions enabled by mismatches in taxation regimes. All these ideas will be appropriately developed in the next chapters.

Different economic operators observe reality from different perspectives and interests. This cognitive difference will increase the complexity of the topic. For some purposes, firms, especially multinational enterprises (MNEs) are a unified monolith. For others, a conglomerate of tasks, of contracts among different affiliates… This allows for all kinds of profit maximisation: the financial markets may consider a multinational enterprise a single unit, looking at the consolidated earnings and assets when it comes to profitability. The firm may be declaring losses in a jurisdiction, but the investors know the firm can pay with funds secured in a tax haven, for example. The managers look at how to maximise utility by leveraging the firm specific advantages of the firm compared to other firms. The financial planners of the firm will consider how to further leverage advantages by engaging in different types of foreign direct investment performing all kinds of movements of assets and contracts that are not necessarily effective, all enabled by cheap and readily available digital and telecommunication technologies.

This doctoral thesis is inserted in the internalisation theory research program, and as such this introductory chapter contains an explanation on what internalisation theory is and the current positions on the theory. Chapter 2 on the digital economy and the digital firm develops the ownership advantages of the digital firm. Chapter 3 provides an overview of the data and techniques utilised on the empirical chapters. Chapter 4 on the productivity of digital firms develops the outcomes of being a digital firm: an increase in productivity via the deployment of asset-type ownership advantages (Oa) and transaction-based ownership advantages (Ot). Chapter 5, on the use of tax havens by digital farms, brings in the rest of the eclectic paradigm in place: the location (L) and internalisation (I) in place and how the digital firm exploits the asset-type ownership advantages by distributing the transaction-based ownership advantages across geographies.

1.2.1 Internalisation theory

The term ‘internalisation theory’ is an umbrella term that refers to a series of theories (Buckley and Casson, 2019) and/or paradigms (Narula, 2010; Cantwell, 2015) that help predict repeating behaviour in firms engaging in international business, from internal organisational designs, entry mode choices and interactions with external economic actors (Narula et al., 2019). The research project involving internalisation theory spans the implications of transaction cost economics (TCE) (Coase, 1937; Williamson, 1985). Kenneth Arrow defined transaction costs as “the costs of running the economy” (Arrow, 1969, p.48). These transaction costs must not be conflated with production costs. Instead, transaction costs are the equivalent of friction in a physics model, something that needs to be considered for a model to be applicable to reality (Friedman, 1953, pp.16-19). When studying adaptive systems, the scope must include both statistical aggregates and ‘idiosyncratic knowledge’, since this knowledge – that we would now call embedded knowledge – also possesses great economic value (Hayek, 1945, pp.523-534).

TCE affirms that institutions in a capitalist society have the effect of reducing transaction costs. Economic organisation deals with the problem of devising contracts and government structures. Contracts and structures have the purpose and effect of economising on bounded rationality. Simultaneously, these also safeguard transactions against the hazards of ‘opportunism’ – what we would call today ‘moral hazards’ (Williamson, 1985, p.xiii). Economic organisation can be performed via two institutions: markets, the default tool according to Ronald Coase, and firms (Coase, 1937). The choice between having a task performed by a hierarchical organisation (a firm) or an autonomous firm (across the market) is determined by the transaction costs (Coase, 1937). Some degree of cost is unavoidable: firms that internalise an activity incur information costs, coordination costs and motivation costs. Information costs refer to the acquisition and transmission of information between employees working for different parts of the firm; coordination costs are those associated with communicating complementary actions and tasks; and motivation costs are those associated with incentivising members of the firm to align their interests with the goals of the firm (Ambos et al., 2019). TCE uses costs to solve the dichotomy between internalising an activity and relying on external markets. Firms will internalise if the costs of internalisation are lower than relying on external markets. All firms must choose between incurring the costs associated with the market imperfections, and the costs associated with internalising the activity. Because internalisation makes costs grow in scenarios where firms must deal with cross-national differences in languages, culture and attitudes, the international business (IB) discipline has become involved in the research on internalisation theory (Narula et al., 2019).

Stephen Hymer's doctoral thesis is the seminal text of the IB discipline. Hymer (1960) argued that firms wanting to expand face two choices: entering another industry or entering the same industry, but abroad. Firms that choose to enter the same industry abroad can choose between performing portfolio investment which can earn them a financial return; or performing foreign direct investment (FDI), where the firm possesses a degree of control over the operations abroad. Hymer (1960) got remarkably close to linking IB with TCE: he argued that firms can exploit advantages in market imperfections. However, Hymer fell short as he considered instead that firms internalising an activity sought to acquire a monopolistic advantage (Buckley, 2006). The full link for IB and internalisation theory was recognised by Buckley and Casson (1976). For these authors, internalising was no longer just about the difference in costs, but also about the potential of improving performance. Within IB, internalisation theory has traditionally comprised of four doctrinal streams. The first one began with the program started by (Buckley and Casson, 1976, 1998, 2009). The second one stems from (Hennart, 1977, 1982). The third stream is related to Rugman and Verbeke (1992, 2003, 2004). And the fourth stream is the Dunning stream, represented by Dunning and Lundan (2008), Narula (2010) and Cantwell (2015). The four streams that exist in internalisation theory cater to the interests of the scholars who formulated them and those who have subsequently followed those conceptual streams for their own investigation programmes. Nowadays these survive as a legacy feature in terms of terminology, having reached a high degree of convergence (Narula et al., 2019).

The streams within the internalisation theory literature use the expressions 'market imperfections' and 'market failures,' indistinctively (Narula et al., 2019). This apparent ambiguity can be traced all the way to the TCE research program. It was Kenneth Arrow who likely introduced it when he argued that a 'market failure' did not need to be 'absolute,' but rather referred to a broader category of transaction costs that impedes or locks the formation of markets (Arrow, 1969, p.48). Market imperfections arise for several reasons: information asymmetry between buyers and sellers, uncertainty in the futures market, impracticability of discriminatory pricing to exploit market power, indeterminate bargaining situations resulting from bilateral concentrations of markets and government intervention in the form of trade barriers, or the ineffective application of national patent systems (Buckley and Casson, 1976, pp. 37-38). However, IB was not going to be studying internalisation for the sake of reducing costs. There were promising discoveries to be made by focusing on the possibilities of recombining firm advantages with location advantages, generating economies of scope (Rugman and Verbeke, 2003).

Buckley and Casson (1976) assumed that, by default, firms prefer to rely on markets rather than internalising, just like Coase does. Firms internalise their operations if markets are highly inefficient or, if there is information asymmetry, tasks are internalised to avoid transaction costs of intermediate products such as technology and know-how. Hennart (1977, 1982), working in parallel with Buckley and Casson, considered further transaction costs, such as inefficiencies in markets of knowledge, reputation, intermediate products, distribution and financial capital, arriving at the implication that MNEs exist because markets can fail across borders (Hennart, 1989). Rugman (1981) leaned heavily on TCE before developing a series of contributions based on resource-based view (RBV), and this stream has sought to connect internalisation with RBV (Chi, 1994). Continuing the work of Hymer (1960), Rugman considered that firm-specific advantages (FSAs), the MNE’s proprietary assets, are the precondition for the MNE to exist. He also contributed the idea of how far an FSA can reach geographically, distinguishing between location and non-location bound FSAs (Rugman and Verbeke, 1992, 2003, 2004). Because Rugman’s stream was influenced by Penrose (1959), who focused highly on the firm, this stream uses the MNE as the object of his analysis unlike Buckley and Casson (1976), who analyse the entire economy. This focus on the internal operations of the MNE makes it useful at predicting interactions between subsidiary and headquarters, and subsidiary-specific advantages (SSAs) (Rugman and Verbeke, 2001; Asmussen, Pedersen and Dhanaraj, 2009).

Finally, the Dunning stream produced the eclectic or OLI paradigm, named after these three elements: ownership advantages, location advantages, and internalisation advantages (Dunning, 1977, 1993a; Cantwell and Narula, 2001; Lundan, 2009; Eden and Dai, 2010; Narula, 2010, 2012). According to the eclectic paradigm, it is the proprietary assets of firms (especially intangible assets and non-location bound capabilities) that provide firms with the ability to generate rents and competitive advantages. The eclectic paradigm refers to these proprietary assets as ownership advantages and equates them with Rugman’s FSAs. Cantwell

(2015) disagrees with this assimilation. The eclectic paradigm also uses Penrose's (1959) theory of firm growth, Coase's (1960) TCE to determine how firms choose their structure, and neoclassical trade theory to determine where the MNE performs FDI (Narula, 2012). The Dunning stream affirms that ownership advantages determine internationalisation choice. Firms that possess strong ownership advantages choose to perform foreign direct investment (FDI) over other forms of internationalisation and become MNEs. The eclectic paradigm cares about location since a firm can benefit from combining the location advantages of certain territories (countries, regions, cities) with their ownership advantages. These location-specific advantages that lend themselves to recombination are assimilated to Rugman's Country Specific Advantages (CSAs) (Narula, 2012).

1.2.2. Firm Specific Advantages and superior performance via internalisation

Alan Rugman considered internalisation theory as a general theory that explains how firms organise international business transactions, explaining and predicting regularities in international business governance choices. His contributions pushed forward the idea that internalisation theory is the general theory of the MNE and, by extension, the general theory of the firm (Narula and Verbeke, 2015). Internalisation theory can also be used to predict regularities in strategic governance involving secondary elements of governance design. For example, how routines and world products are assigned, and how orders are given to subsidiaries (Rugman and Bennett, 2002), how transfer pricing systems are determined (Rugman and Eden, 1985), how to establish tools to align goals and enable inter-unit coordination (Rugman and Verbeke, 2003; Verbeke and Kenworthy, 2008) or the practices of internal technology transfer (Rugman, 2010a). Rugman's formulation of internalisation theory is built upon the work of Coase (1937) and Penrose (1959). Rugman takes Coase's TCE as the foundation for his economic thinking and Penrose's resource-based view (RBV) to provide a realistic model on how MNEs can grow, spread internationally or diversify, constrained by time and the effort to construct managerial capabilities (Rugman and Verbeke, 2002). Rugman's internalisation theory integrates TCE with RBV, adding elements of entrepreneurial judgement and accounting for institutional characteristics of home and host countries.

Rugman developed the FSA/CSA matrix in the 1980s to determine how firms choose their internationalisation strategy (Rugman, 1981; Rugman, Lecraw and Booth, 1985). Succinctly put, FSAs correspond to managerial decision factors while CSAs are environmental factors. More precisely, FSAs refer to a firm's competitive strength resulting from advantages in upstream and downstream capabilities, while the CSAs refer to exogenous country level factors that have an impact in IB (Collinson and Rugman, 2011). Internalisation theory guides MNEs to design governance mechanisms:

- That determine the boundaries of the firm by establishing, for each activity or the firm, whether they will buy or make.
- For activities not performed internally, the interface with the external environment, such as relying on cooperative alliances, long-term contracts, or short-term contracts.
- For activities performed internally, organising these activities by structuring governance mechanisms that balance superior economising on bounded rationality, superior economising on bounded reliability and managing the innovation process (Grøgaard and Verbeke, 2012).

According to Rugman's stream, institutions of capitalism such as MNEs select more efficient governance mechanisms over less efficient ones. These governance mechanisms exist to develop, exploit, deploy and augment the FSAs of the firm across borders. FSAs are strengths a company possesses that allow for survival, profitability, and growth. FSAs are not extant, but relative to those owned by relevant relatives. It is FSAs that determine the geographical presence of firms and the scope of the economic activities (product diversification, vertical integration and geographical diversification) (Grøgaard and Verbeke, 2012).

As we saw earlier, TCE affirms that firms must choose between internalising activities or reliance in an external market. Then, Buckley and Casson (1976) sought to explain why firms internalise, by highlighting coordination benefits associated with linking individual plants to a multi-plant system. These authors argued that the capital market in the global economy determines whether a multi-plant strategy is chosen over a system of plants coordinating each other (via external markets or state intervention). An MNE appears when there are coordination benefits resulting from a multi-plant system working across different countries. Rugman (1981) finds a different approach to internalisation: the MNE is not a conceptual object that later jumped into reality. It is not a mechanism of control created in a laboratory. MNEs arise organically and end up controlling economic activities across borders; it is the scholar's task to explain the mechanisms of perception that lead firm managers to choose internalisation over relying on the market. Rugman (1981) believed in the existence of this internal mechanism for firms to determine their location and governance structure: the evaluation of the firm's strategic advantages. Whereas Buckley and Casson (1976) analysed the global economic system and considered that MNEs appear when there are more efficient governance mechanisms across borders, Rugman chose instead the MNE as the subject of his analysis (Hennart, 2015; Narula and Verbeke, 2015). The other important feature of the Rugman stream, apart from the FSA, are the country specific advantages (CSAs). CSAs reflect the importance of location when it comes to MNE decision making within Rugman's model. The result was the FSA-CSA matrix, where Rugman (1981) explained the different expansion paths available for MNEs by combining FSAs (strong or weak) with CSAs (also strong or weak). Williamson (1985, 1996) considers that firms and policy makers have a tendency to collude and create policies protecting domestic firms against foreigners, in strong-form self-interest. Without these policies, MNEs were more likely to be efficiency-driven and hold dominant positions from knowledge-based innovation. Rugman differs with Williamson and does not assume this dynamic in his research. Instead, he expects bounded rationality for MNEs in terms of asymmetry of knowledge would encourage MNEs to appropriate knowledge and capture value (Narula and Verbeke, 2015).

MNEs entering foreign markets suffer from a liability of foreignness they need to offset (Hymer, 1960) as it increases operational costs related to differences between the home and the host country (economic, institutional and cultural). Thus, MNEs deploy FSAs to internationalise, that derive from the CSAs of their home country (Narula, 2012). Thus, with their FSAs, CSAs and internalisation advantages, MNEs compensate for the disadvantages they may face against rivals in the host country (Dunning, 1988; Rugman and Verbeke, 1992). FSAs do not just refer to the ownership of assets. An efficient firm organisation is valuable and can create value by itself. The internal market of the MNE must be more efficient than the alternative of relying on unaffiliated firms. It needs to move knowledge, goods, ideas and people through different subsidiaries, and countries. And must do so efficiently (Narula, 2014b). FSAs are diverse. They range from items such as competences to transactional advantages – the MNE's capability of economising on transaction costs as the firm coordinates and controls assets (Dunning and Rugman, 1985; Rugman and Verbeke, 1992). FSAs can be unique resources, while higher order FSAs also involve recombining and bundling resources (Hennart, 2009b; Verbeke, 2013). The Rugman stream of internalisation theory considers that MNEs do not just rely on FSAs, but also leverage on their home-country advantages, or CSAs (Hennart, 2009a; Rugman, Verbeke and Nguyen, 2011). CSAs can be items such as natural resources, the local product demand and a favourable political system and regulations (Rugman and Verbeke, 1990; Collinson and Rugman, 2008; Dunning and Lundan, 2008; Hennart, 2009a; Verbeke, 2013). Firms will make strategic decisions to expand based on FSAs, which result from previous investment – in R&D, brands, etc. – or arise from managerial experience, superior management practices, in a context of bounded rationality (Chi, 2015). Entrepreneurial choices can reduce uncertainty and the impact of institutional variables across regions and countries. But Rugman sought to go beyond merely shrinking the sum of production and transaction costs, contrary to traditional TCE scholars. Rugman (1981), for example, focuses on maximising net present value (NPV) driving internalisation decisions. When it comes to governance decisions, Rugman mostly follows TCE. For example, in reducing knowledge dissipation risks by choosing internalising via wholly owned operations over licensing. When it comes to production costs, factor endowments and production cost differentials determined location choices for foreign affiliates. Penrose's RBV explained the internal works of the MNE and the function of the contract, and this RBV allowed Rugman to look at firms prioritising regional over global strategies to capture value from FSAs, and at the role played by the MNE headquarters, the interactions with subsidiaries, intrapreneurship and subsidiary specific advantages (SSAs) inside the MNE (Rugman and Verbeke, 2001, 2004; Rugman, 2005; Rugman, Verbeke and Yuan, 2011). The merging of streams occurs as Rugman argues that firms can economise on bounded rationality to exploit and augment further the MNE's FSA-base efficiently, leveraging links with location advantages home and abroad. For Rugman, having an FSA in comparison to rival companies is a necessary condition for international expansion. FSAs do not spawn into firms, countries have location advantages, entrepreneurs build success domestically, and then these FSAs generated by entrepreneurs in what becomes, after international expansion, the home country, are deployed abroad (Narula and Verbeke, 2015). Rugman's analysis applies to the decision-making process of all firms, not just the larger ones, but also smaller, and even the process of choosing to de-internalise an activity (Rugman, Verbeke and D'Cruz, 2005; Rugman and Almodóvar, 2011), as well as entrepreneurs who own firms and entrepreneurs who manage firms (Verbeke, Amin Zargarzadeh and Osiyevskyy, 2014).

Earlier versions of Rugman's internalisation theory assumed that FSAs are internationally transferable and deployable (Rugman, 1981). Afterwards, Rugman began distinguishing between location and non-location bound FSAs (Rugman and Verbeke, 1992), anticipating the dynamic capabilities approach (Teece, 2009). Rugman and Verbeke (1992) contributed to the research project on IB with the distinction between location-bound (LB) and non-location-bound (NLB) FSAs, which meant a large advancement in IB research. The distinction between LB and NLB FSAs mattered, regarding both the foundations of Rugmanite internalisation. Regarding the TCE pillar, Rugman and Verbeke (1992), argued that international expansion views based on TCE had been missing the notion that subsidiaries or foreign contracting parties were going to provide location-bound FSAs, that could be bundled with non-location-bound FSAs. This in turn meant that international contacts would become quite more complex, the needs going beyond the mere safeguard of extant proprietary knowledge. With regards to the RBV pillar, new location-bound FSAs were being created via resource recombination within the firm or with contracting partners (Rugman and Verbeke, 2001). This approach made Rugman switch from being concerned about protecting existing FSAs to rejuvenating FSAs by continuously recombining these later in his research, since, by recombining FSAs, the firm can access new resources, services or firms (Hennart, 2009b; Verbeke and Hillemann, 2013). And, when internationalising, firms need to combine their NLB FSAs with the location advantages the host country provides. Otherwise, internationalisation will fail (Verbeke, 2013, p.150). Internationalisation, however, requires an extra factor: that there are country specific assets (CSAs) that allow for the development of LB FSAs to achieve effective asset bundling (Hennart, 2009b; Verbeke and Hillemann, 2013).

Successful MNEs are expected to be the ones that have entrepreneurs recombining resources at every expansion move or delimiting subsidiary roles (Grøgaard, Verbeke and Amin Zargarzadeh, 2011; Verbeke, 2013). In Rugman's internalisation theory, information problems may cause frictions when interacting with contracting parties outside the firms. This creates a pressure to internalise in order to protect FSAs. Governance challenges are determined by bounded rationality, an imperfect information quality and information processing capacity (Narula and Verbeke, 2015). Internalisation theory allows for predictions when it comes to the management of the internal network of subsidiaries (Rugman, Verbeke and Yuan, 2011). Internalisation theory also determines that the optimal scope of the MNE is most likely going to be focusing on the home region of the firm rather than the entire world (Rugman and Verbeke, 2004; Rugman, 2005; Rugman and Oh, 2013). This happens because borders across the jurisdictions are soft but the liability of outsidership rises across the borders, creating an imbalance. Firms expanding across borders may need to rearrange their bundles of FSA, so these remain useful across borders. Sometimes, there is no way to do this, and the FSAs only operate within a certain region (Oh and Li, 2015). Even though 'internalisation' seems to posit a dichotomy between relying on internal vs external markets, Rugman's internalisation can also be used as a paradigm to manage the network of stakeholders that exist outside the firm's formal boundaries and are involved with the firm (Rugman, Verbeke and D'Cruz, 2005).

1.2.3 The eclectic paradigm and the tax advantage

Businesses must pay taxes and, for many, the tax bill is their largest yearly bill. Taxes influence the kind of investments firms make, how much is invested, where the funds come from and where the profits will be allocated. MNEs do not leave these affairs up to improvisation but deploy a series of strategies to reduce the amounts of taxation payable, a practice called 'tax planning.' Understanding how taxes influence corporate behaviour is necessary to understand the MNE (Cooper and Nguyen, 2020).

Internalisation of company activities across geographies creates a transfer of resources, semi-elaborated goods, and intellectual property across borders among affiliates that belong to the same MNE. After all, the MNE does not exist as a monolith, it is an amalgamation of affiliates and contracts that share a link of ownership and coordination. The transfers across affiliates are and must be formalised in contracts and will leave a trace in the form of financial transactions, accountancy, etc., which has legal implications.

IB has studied the phenomenon of transfer pricing, the price charged for these transactions performed between related parties within the network of an MNE, which include payments for intra-firm trade, intra-firm loans or knowledge flows of intellectual property, such as the use of patents, trademarks, copyrights, etc. (Cooper and Nguyen, 2020). Lorraine Eden's work on the use of transfer pricing for MNE tax planning contains some of the most important contributions to this field (for example, Rugman and Eden, 1985; Eden, 1998, 2016b; Eden and Kudrle, 2005; Eden, Juarez Valdez and Li, 2005).

From the early beginnings of the IB discipline, the literature has highlighted the relevance of transfer prices. Casson (1979) considered the potential advantages that transfer prices provide to MNEs by themselves, enough to encourage firms to internalise markets and become an MNE. Rugman (1980) considered transfer prices as the "*efficient response by the MNE to exogenous market imperfections"* (Rugman, 1980). The transfer price accounts for the intra-group transactions between headquarters and subsidiaries – and subsidiaries and other subsidiaries. It is the transfer price that determines the overall profitability and which profits correspond to each affiliate. Therefore, establishing an MNE implies establishing transfer prices across affiliates. By internalising, the MNE gains the ability to benefit from differences in factor input prices in different locations, differences in government regulations and from the differences in statutory corporate income tax rates (Rugman and Eden, 1985). This was spotted by (Buckley and Casson, 1976) in their internalisation-beyond-TCE seminal article, where they explained how transfer pricing explained why – at the time – MNEs were concentrated in R&D intensive and knowledge industries.

The first problem with transfer prices is that, for some transactions, there are too few comparable transactions performed by the market to determine what is called an 'arms-length price standard,' the price that would have been charged had the transaction been performed by the external market rather than the firm's internal market. This opacity makes it so, by internalising, firms can manipulate these transfer prices (Rugman and Eden, 1985). Right from the start, finance was determined to be important for the MNE. MNEs can obtain potential advantages over domestic firms by creating internal capital markets. Rugman (1981) included imperfections in the financial markets as drivers for internalisation and the creation of internal capital markets.

A second problem, even more grave than the lack of comparable transactions to determine the arms-length price standard, can be determined by the implications of internalisation theory in itself. Let us recapitulate all the way back to TCE: firms can use an internal or an external market to perform an activity, costs determine the choice. So far there is no problem with transfer prices. But Lorraine Eden spotted a flaw the moment internalisation theory (Buckley and Casson, 1976; Rugman, 1981; Casson, 2015) was brought into the fold. An 'arm's-length price standard' is an attempt at pricing the internal transaction the same as it would have been priced in an external market transaction. But these transactions are not comparable. Internalisation is not a cost-saving strategy. There are gains from internalisation that may make the transaction impossible to compare, in price, with an external transaction. An arm's-length price standard ignores the fundamental gains that are made by MNEs by the simple fact of being an MNE, and thus disregards the difference for the MNE that represents internalisation over external markets. There is no room to normalise transfer price, because firms become MNEs to – among other things – internalise knowledge transfer, and the gains of this internalisation are embedded in the transfer price, but cannot be isolated or separated from it (Eden, 2016a). These two issues make it hard to measure risk towards the international taxation system via analysis of transfer price.

John Dunning formulated the eclectic paradigm or OLI framework (OLI referring to the advantages of MNEs: ownership, location and internalisation) and the four motivations for FDI (market, efficiency, natural resource and strategic asset seeking) (Dunning, 1977, 1980, 1993b, 2000; Cantwell and Narula, 2001; Lundan, 2009; Eden and Dai, 2010; Narula, 2010, 2012). Dunning (1993b) proposed that MNEs can gain advantages over non-MNEs via planning tax efficiently via profit shifting. Profit (and income) shifting is the practice of MNEs to transfer the profits or income from higher to lower tax jurisdictions. This has the effect of eroding the tax base of the higher tax jurisdiction (OECD, 2022), and the effect of shifting the profits to a lower tax jurisdiction reduces the total tax burden (Samuelson, 1982; Rugman and Eden, 1985; Zucman, 2014). Dunning referred to this firm advantage as a "financial asset advantage" but did not go beyond arguing that this advantage stems from the size, efficiency and knowledge of the firm (Dunning, 1993b, p.150).

It fell on Oxelheim, Randøy and Stonehill (2001) to consider the content of this financial asset advantage. These authors argued that the differences in the home country matter at internalisation. It is not the same for a would-be MNE to originate from a country with a well-developed financial sector and an industrialised economy or to hail from a developing country with an illiquid financial market. The latter need to overcome the disadvantage. Oxelheim, Randøy and Stonehill (2001) identified proactive strategies under the control of the MNE and reactive strategies in response to financial market failure. These authors described a category of ownership advantages arising from gaining and maintaining a global cost and availability of capital, which include:

- Sourcing competitive capital globally: a priority for R&D intensive firms such as those in the pharmaceutical, biotechnological, telecommunications and IT sectors. These firms hold a proportion of intangible assets over total assets that is too high and illiquid.
- Strategic preparatory cross-listing: the MNE can seek to be listed in a foreign, prestigious capital market, such as London or New York.
- Maintaining strong relationships with international bankers who will underwrite, and syndicate debt and equity issues sold abroad. This approach also enables:
- Transparent accountancy and disclosure: such readability will make the firm more attractive to international investors.
- Maintaining a competitive credit rating: it is not enough to access foreign equity markets. International debt markets also matter, particularly for firms where the financial markets are dominated by banks.

Oxelheim, Randøy and Stonehill (2001) then cited other advantages, such as the ability to reduce financial monitoring costs via performing the previous activities, and the ability to negotiate subsidies or lower taxation with local authorities. Finally, Oxelheim, Randøy and Stonehill (2001) included reducing operating and transaction exposure via FDI. MNEs need to deal with foreign exchange rate risks, with stock markets overvaluing and undervaluing stocks, with capital controls, and corporate taxes. For taxation, Oxelheim, Randøy and Stonehill (2001) argued that MNCs might undertake FDI in a tax haven jurisdiction and earn low-taxed income or deferred tax income via transfer pricing manipulation. This was not new: the novelty was that Oxelheim, Randøy and Stonehill (2001) had highlighted that minimising taxation was not just a location but also an internalisation advantage. The second part of this analysis, focused on market failure, is redundant: following TCE, without market failure there is no MNE (Jones and Temouri, 2016).

The second part of the eclectic paradigm is location-specific advantages (L), which are the advantages that countries (regions, geographies, jurisdictions) have to offer and make attractive to MNEs. MNEs choosing to locate in a country will get to benefit from the L advantages it offers. Ultimately, understanding the behaviour of the MNE means understanding which are the drivers of FDI (Rugman, 1981; Dunning, 1993b; Rugman, Verbeke and Nguyen, 2011). Regarding motivations, Dunning (1993b) acknowledged three more motivations for FDI apart from the classical four (market seeking, efficiency seeking, natural resource seeking and strategic asset seeking). These three motivations were:

- Escape investments.
- Support investments.
- Passive investments.

Overall, these motivations remain an underexplored topic that requires further research (Cuervo-Cazurra and Narula, 2015; Cuervo-Cazurra, Narula and Un, 2015; van Tulder, 2015). Dunning (1993) identified avoiding corporate tax as a motivation for FDI investment. MNEs wishing to escape high levels of corporate tax in the home country would perform escape investments. Witt and Lewin (2007) identified institutional constraints and regulations as another motivation that might encourage MNEs to perform escape FDI. In terms of location advantages, differences in tax between countries affect MNE decisions to perform FDI; a stream of literature shows that tax serves as a determinant of location advantages (Markle and Shackelford, 2009; Hanlon and Heitzman, 2010; Dharmapala and Riedel, 2013; Fuest et al., 2013; Taylor, Richardson and Lanis, 2015).

Profit shifting is hard to investigate for researchers because firms are not required to disclose their sales or profits on a country-by-country basis (Cooper and Nguyen, 2020). Therefore, alternatives must be sought. Using Rugman's FSA/CSAs, Jones and Temouri (2016) and Jones, Temouri and Cobham (2018) highlighted how tax havens enable tax avoidance. These tax havens being jurisdictions with zero or low rates of corporate tax and high levels of secrecy (Zucman, 2016).

1.3. Research context

"Every technology carries its own negativity, which is invented at the same time as technical progress. […] when you invent electricity, you invent electrocution" (Virilio, 1999, p. 89). That the digital economy was going to cause problems in its deployment and in it its use was evident from the beginning. The ease of cross-border trade and the ability to make almost infinite copies of intangible digital objects at practically no cost was going to pose a challenge to existing institutions (Shapiro and Varian, 1999). Today, scholars and practitioners have identified several negative consequences of the digital economy and the digitalisation of the economy – terms often used as synonyms. Among these are:

- The risk of tax avoidance and erosion (Sutherland and Jarrahi, 2018).
- The challenges at regulating new and emergent business models dominated by increased speed and scale (Yeung, 2019).
- The issues of market dominance and concentration in areas such as social media, e-commerce and cloud computing (Khan, 2019).
- The concerns regarding the security and privacy of consumer data in terms of breaches, unauthorised use, privacy violations, intellectual property and corporate security (Acquisti, Brandimarte and Loewenstein, 2015).
- The problems of economic inequality arising from the differences in high digital skill compared to lower digital literacy (Bell, 1999, p.14), and overall the risks of dehumanisation, loss of human control and oversight and of alteration of human behaviour (Sundberg, 2024).

The purpose of this thesis is to investigate the first and second of these risks we have mentioned: the integrity of the tax system and the position of the digital firms within the rest of the economy. This research is practical in nature and is framed within the objectives of the Base Erosion and Profit Shifting (BEPS) initiative. The BEPS initiative began in 2012 as a task given by the G8 and G20 to the Organisation for Economic Co-operation and Development (OECD) after having identified a series of inefficiencies linked to the application of mortar-and-brick taxation rules to an economy becoming increasingly digitalised (Ting and Gray, 2019). In response, the OECD prepared a series of initiatives, called Actions (OECD, 2013), among which stand:

1. Action 1: *Addressing the Tax Challenges of the Digital Economy*, aimed at ensuring that digital businesses would pay taxes in the jurisdictions where they have significant consumer engagement despite lacking physical presence.
2. Action 2: *Neutralising the Effects of Hybrid Mismatch Arrangements*, designing rules to annul the effects of hybrid instruments that create mismatches in tax outcomes across jurisdictions.
3. Actions 8 to 10: on *Transfer Pricing*, to align transaction prices between related firms with value creation, especially regarding intangible assets and risk allocation.

4. Action 12: *Mandatory Disclosure Rules*, to increase transparency and gain visibility into aggressive or abusive tax schemes.
5. Action 15: *Multilateral Instruments*, to modify bilateral tax treaties quicker and implement the BEPS project.

As of the moment of submitting this doctoral thesis, Actions 2 to 15 have mostly been solved, and only Action 1 stands unsolved (OECD, 2023). There are several reasons why this has happened, and this doctoral thesis is dedicated to the problems of Action 1.

We identify four problems of conceptualising the digital economy that have prevented Action 1 from being successful. First, there is the excessive focus on contingent dynamics (such as the most promising technology at the time, like the Internet, AI, Cloud Computing) instead of the underlying dynamics of the process. This focus has created a series of obsolescent definitions (Bukht and Heeks, 2017). Second, the fact that the digital economy is a global phenomenon defined by local laws that do not always fit well for these new products, creating inconsistencies (Cannas, 2015). Third, the overwhelming amount of data and changes that have taken place in a period too short for many to assimilate (Kallinikos, 2006). And fourth and final, the difficulty at quantifying the digital economy due to the fast and large volume of digital transactions, and the intangible nature of many goods and services (Corrado and Hulten, 2010). Ultimately, we argue that this is because it is hard to neatly separate the digital economy from the traditional economy. The digital economy has been simultaneously, as Chapter 2 explains, whatever the researcher wanted it to be when doing their research. Its extent is unmeasurable, spreading from a few economic sectors to potentially being the glue that keeps the modern economy together, coordinating the non-digital economy through space and time.

The consequence of this is that, to this day, neither the OECD nor academia have a definition of the digital firm that allows for a full investigation of this phenomenon and to find a boundary to the digital economy or to perform quantitative research with large enough samples to evaluate the expectations about the digital economy being a threat to the international tax system or being as dynamic and able to generate profits due to the reliance on intangible assets. Therefore, the purpose of this thesis is to throw light on the object of BEPS Action 1, the digital firm. The next five chapters contain a series of contributions to this ongoing conversation.

1.4. Research questions

This thesis puts forward the following research questions:

1. What are the defining elements of the digital firm?
2. What are the ownership advantages / firm specific advantages of the digital firm?
3. How do these ownership advantages affect digital firm productivity?
4. What role do intangible assets that are accounted for play in digital firm productivity?
5. Do digital firms benefit from their location in metropolitan areas? More or less than other types of firms?
6. Are digital firms more prone to using tax havens than traditional firms?
7. What role do intangible assets play when it comes to tax haven choice?
8. Is operating revenue turnover a good determinant to determine tax avoidance risk?

1.5. Brief overview of the methodology and data

In order to investigate the research topic, we have conducted one review of the definitions that the literature has collected about the digital firm, digitalisation and the digital economy (Chapter 2). The goal has been to identify common threads and unifying criteria to overcome the difficulties of describing a phenomenon as complex and embedded in the economy as the digital economy. After describing the digital firm, the operator of the digital economy, we provide an overview on how the data has been prepared (Chapter 3). Then we conduct two empirical studies that utilise secondary data and econometric analysis (Chapters 4 and 5). These studies operationalise the definition of digital firm to formulate a series of hypotheses, which are in turn tested empirically using firm-level data from the ORBIS database, a commercial firm-level dataset provided by Bureau van Dijk, which publishes annual accounts information for firms and provides comprehensive data on firms and their subsidiaries, financial statements, expenses, location and sectors these firms operate in.

In terms of digital firms – understood as those that operate in the digital economy, we measure whether a firm is a ‘digital firm’, understood as a firm that participates in the ‘digital economy’ by using information on the industry in which the firm operates, utilising NACE Rev. 2 (2008) to construct binary variables that track whether a firm is a digital service firm, a digital manufacturer, a non-digital service firm or a non-digital manufacturer, building on the contributions from Chapter 2. These variables have been carefully constructed in consideration of whether the firm produces a digital object (Faulkner and Runde, 2019), looking through the four-digit classification on whether the nature of the objects produced by the firms is digital or not. Then Chapter 2 produces two contributions, for international business scholarship the identification of scalability and malleability as the traits of the digital object that digital firms then benefit from as ownership advantages under the eclectic paradigm (Dunning, 2008), and the critical evaluation of the existing literature on digitalisation and the digital economy. The financial data from ORBIS is used in Chapter 4 to calculate total factor productivity (TFP). We utilise the ORBIS data on number of employees, tangible assets and creditors to calculate the TFP of individual firms across the OECD using the Levinsohn and Petrin (2003) and the Wooldridge (2009) methods. With these estimates, we calculate a model that utilises TFP as the dependent variables and the binary variables using the conclusions from Chapter 2. A host of control variables were identified as determinants of productivity, including a ratio on intangible over total assets (Marrano, Haskel and Wallis, 2009), total assets, the age of the firm and firm cash flows (Temouri, Driffield and Higón, 2008). Chapter 5, on the other hand, utilises four dependent binary variables on whether a firm possesses a subsidiary in a tax haven, using criteria established by Hines and Rice (1994), Jones and Temouri (2016) and Jones, Temouri and Cobham (2018), the same measures of digital and non-digital used in Chapter 4, and a selection of controls including cash flows, turnover, a ratio of intangible assets over total assets and the age of the parent firm (Jones and Temouri, 2016; Jones, Temouri and Cobham, 2018; Temouri et al., 2022). Empirically, our analysis utilises random effects in Chapter 4 and logit in Chapter 5 to test a number of hypotheses. Also, our econometric models include a number of interaction terms to investigate the moderating effects.

1.6. Brief overview of the empirical findings

This doctoral thesis has found that digital service firms are the most productive across all sectors, benefiting from scalability and process efficiency to achieve superior total factor productivity. Conversely, digital manufacturers face distinct challenges and perform worse than both their service-oriented counterparts and traditional manufacturers. These results illustrate the varied impact of digitalisation on industries, emphasising that digital transformation alone does not guarantee greater productivity or profitability. Sector-specific analysis is essential before making assumptions. This thesis also explores how metropolitan locations influence firm productivity. Urban areas offer skilled labour, advanced infrastructure, and knowledge networks that significantly enhance the competitive advantage of digital service firms. However, these benefits are less impactful for manufacturing firms. Therefore, the advantages of urban environments cannot be generalised across sectors.

We have explored and provided contributions to foreign direct investment (FDI) literature within the FSA/CSA paradigm (Rugman, 2010a), focusing on digital firms' FDI in tax havens, their destination preferences, and the role of intangible assets. Contrary to widespread belief, digital firms are not uniquely inclined towards tax haven use. Traditional firms, especially manufacturers, also engage heavily in tax avoidance. While intangible assets facilitate tax avoidance, their impact differs by sector, with manufacturing firms (both digital and non-digital) demonstrating higher tendencies. These findings challenge the narrative that digital firms pose the greatest tax avoidance risk and call for more nuanced regulatory oversight.

Empirically, this thesis contributes significantly to literature on digital firms. We have showed that participating in the digital economy increases productivity and influences tax haven use and preferences. Our first empirical contribution reveals that digital firms are the most productive of all. Compared to non-digital manufacturers (baseline), digital firms are 29.51% to 32.56% more productive, depending on whether the Levinsohn and Petrin (2003) or Wooldridge (2009) productivity measure is used. Non-digital service firms follow, with a productivity advantage of 21.55% to 24.69%. Digital manufacturers lag, with productivity ranging from -6.52% to 2.46%. These results account for variables such as intangible assets, firm age, cash flow, long-term debt, total assets, and year effects. Sub-sector analysis reveals diversity within digital service firms. Some, like digital retail – comprising firms that design but do not produce tangible digital products – have lower TFP than digital manufacturing. However, digital publishing, video, film, sound, broadcasting, programming, and information services rank among the most productive industries within the OECD.

The second empirical contribution shows a correlation between intangible assets and productivity, but not specifically for digital firms. While the general coefficient is significant, it is close to zero, and interactions with digital service or manufacturing firms are insignificant. This suggests that while past studies (Chen and Dahlman, 2006; Crass and Peters, 2014; Calligaris et al., 2018). provide evidence of intangible assets enhancing digital firm TFP, balance sheet intangibles like brands do not significantly boost TFP. Instead, investments not appearing on balance sheets, such as expensed intangibles or employee training, drive productivity improvements. Nevertheless, intangible assets remain crucial across firms, as highlighted in the eighth contribution.

The third contribution shows that metropolitan areas increase productivity by 0.1025 to 0.1039 for service firms. However, the interaction of service firms with metropolitan presence has a positive but insignificant coefficient, indicating that access to urban resources and skilled labour benefits digital service firms similarly to other service firms. For manufacturers, productivity increases are more pronounced, ranging from 0.1268 to 0.1532. Yet, for digital manufacturers, metropolitan presence negatively impacts productivity, with a significant coefficient of -0.0573 (Levinsohn and Petrin, 2003). This raises concerns for policymakers, as digital manufacturers within the OECD underutilise metropolitan resources compared to digital service firms.

The fourth contribution examines tax haven FDI preferences, revealing that digital firms are more inclined to invest in tax havens than non-digital manufacturers, though preferences vary. Digital manufacturers show minimal preference for small tax havens (1.2%, insignificant) but strongly favour large economies (9.47%, significant). Digital service firms prefer large havens (6.64%) over smaller ones (2.13%). This suggests that location advantages, not just tax benefits, drive FDI into large havens. Interestingly, non-digital service firms are more likely to use small havens (3.46%) but less likely to invest in large ones (4.68%) than digital service firms. Industry-specific analysis reveals further differences. For example, software and programming firms have only a 2.23% higher likelihood of small tax haven presence than non-digital manufacturers, but an 8.36% higher likelihood for large havens. Digital retailers show a 4.55% and 5.82% propensity for small and large havens, respectively, while intellectual property leasing and rental firms exhibit a 14.1% preference for large havens. These patterns are not exclusive to digital firms, as non-digital service sectors such as water transport (13.2% for small havens; 8.52% for large), legal and accounting (8.5%; 4.7%), and real estate (11.7%; 7.91%) also display significant tax haven usage.

The fifth contribution finds that a 1% increase in intangible asset proportion raises the likelihood of small tax haven presence for digital service firms by 3.55%, though the effect is insignificant for large havens. Manufacturing firms show a much greater propensity, with a 13.4% increase for small havens and 13.1% for large ones. This indicates that digital manufacturers, not service firms, pose a greater risk to international tax systems.

Finally, the sixth contribution critiques the European Union's digital tax criterion, operating revenue turnover, as it does not indicate a unique predisposition for digital service firms to use tax havens. A 1% turnover increase raises tax haven likelihood by 2.17% for large havens and 0.768% for small ones, reflecting firm size rather than digital-specific behaviour. Interestingly, turnover-related results for specific sectors are significantly negative, except for digital manufacturers, which show increased tax haven use with turnover growth. This suggests that digital manufacturers, not service firms, represent the greatest tax risk, contrary to EU assumptions.

1.7. Research contributions

This thesis analyses a series of assumptions made about the digital economy, especially about the role that intangibles play in the digital economy (Zeng, Khan and De Silva, 2019).

First, our research contributes to the limited number of existing empirical studies on determinants of tax haven across economic sectors. For example, Janský (2020) looks at the preferred tax havens by industries, using NACE two-digit codes, but acknowledges limitations due to the small number of firms in their samples. This thesis is thus the first one to comprehensively look at the impact of operating in the digital economy in terms of productivity and tax avoidance. Our analysis thus generates a number of insights in this area that has been lacking comprehensive research, and that will generate a discussion and a follow up on this field.

The findings in this thesis contribute to several literature gaps. We provide a definition of the digital economy and the digital firm that is compatible with industrial categorisations; we describe the competitive advantages that these firms have: scalability and malleability; we provide a measure of the productivity of digital firms and their use of tax havens. The thesis empirically shows that "intangibles" are not uniform in their influence on digital (and non-digital) firms. Intangible assets within balance sheets do not boost productivity significantly, that role corresponds to the ones that are expensed (such as R&D or employee training).

The findings have important applications for practitioners and for policy: for policymakers, they reveal that sectors that could be argued are part of the digital economy but are not always identified as a part of it (such as the digital manufacturers) pose a significant risk that is not always considered. It confirms that the suspicions of the BEPS initiative are correct for digital firms, but also that some firms that arguably operate in the digital economy and pose a significant risk are being overlooked. For the managers of digital firms, the research shows that they must invest in ways that will enhance scalability (if they produce intangible objects) and the malleability of their products (in all cases). Scalability will allow these firms to produce at increased levels and cater for higher numbers of customers without incurring higher costs. Malleability will allow their products to unlock new features and be constantly adapted, even after delivery. Practitioners need to cultivate their intangible assets, but they need to be aware that the intangibles within the balance sheets do not really provide a productivity boost: it is the ones like in-house developed software, the ones coming from R&D expenditure or employee training that boost productivity. But that does not mean that intangible assets within the balance sheets are not valuable for digital firms, their use when performing foreign direct investment in tax haven jurisdictions is a testament of their worth.

1.8. Organisation of the thesis

The thesis is structured in six chapters, as follows:

Chapter 2 is a theoretical chapter that provides the definition of the digital object, the digital firm and the economy, the competitive advantages that digital firms enjoy, the review of the literature on the digital economy and the characteristics of the digital economy determined from that literature.

Chapter 3 explains the nature of the data used in the two empirical chapters coming from the ORBIS database, the procedures to clean that data and how the dependent variables (total factor productivity and tax havens) and the variables of interest (digital vs non-digital firms) were prepared.

Chapter 4 contains an overview on digital and non-digital firm total factor productivity and its determinants, with an explanation for the differences in performance.

Chapter 5 contains a study on tax haven use by digital and non-digital firms, looking at each particular sector, with an overview of the impact that intangible assets play in tax evasion and the merits of using operating revenue turnover to discriminate when it comes to the digital services tax.

Chapter 6 contains a summary of the key findings in this thesis, the policy and managerial implications and an overview of the limitations of this study and the future avenues of research.

CHAPTER 2. THE DIGITAL ECONOMY AND THE DIGITAL FIRM: WHAT THESE ARE AND WHY THEY MATTER FOR THE OECD BEPS PROJECT

2.1. Introduction

The OECD (2013) began their Base Erosion and Profit Shifting (BEPS) initiative warning about the dangers that digitalisation and the digital economy posed for the tax system. This became a rallying cry for scholars and researchers to look at this phenomenon, fostering a number of contributions. As we will see in the next sections, the OECD project assumed that digital firms posed a real risk, but did not elaborate on the nature of such risk beyond highlighting characteristics such as the ability to generate value outside the formal borders of the firm or the reliance on information and intangibles (OECD, 2013). Worse still, with the way the BEPS initiative had been framed, no one could really tell which were the firms that should be affected by this initiative. At the time of submitting this doctoral thesis, the management and international business (IB) disciplines lack a clear-cut criteria to separate digital firms from non-digital firms. Most firms fulfil this common criterion of using IT tools and therefore all firms in existence, at least in developed countries, are “digital firms.” The heterogeneity of firms identified as “digital” further hinders the effort at classifying them (Hennart, 2019). What makes Hennart (2019) affirm that, is due to the different possibilities at digitalising elements of the value chain. We bring this to its logical conclusion: the use of IT in the value chain cannot be used to determine whether a firm is digital or not. If it were valid, then every firm operating in the modern economy is digital, and the categorisation of firms into digital and non-digital becomes moot. What we need to do, instead, is determine which are the firm specific advantages (FSAs) that digital firms enjoy while simultaneously determining which firms are digital. This is not an easy task, and it is not aided by the fact that the term “digital,” as this chapter shows, has been used with incompatible and contradictory purposes.

In our first contribution we argue that what makes a firm digital is the production of digital objects. A digital firm is one that produces or sells digital objects. Our second contribution goes beyond the circularity, by defining the digital object, bringing the concept previously restricted into the IT discipline, into management and international business. Digital objects, traditionally studied as an information systems discipline, are those associated with information as well as machines that process information. Digital objects can be either intangible (with zero replication cost) or tangibles (with more capabilities than non-digital objects) (Faulkner and Runde, 2019). Our third contribution brings up the ownership advantages/firm specific advantages that digital firms possess, provided by the products these firms produce. These characteristics are linked to the nature of digital objects, as we will see in the following sections. All digital objects are malleable, that means they unlock new abilities; and intangible digital objects have potential for scalability, which allows the firm to grow without processes that require building physical production plants and a supply of inputs with their associated logistics. Previous research has scratched the surface of this phenomena, noticing the apparent immunity to Baumol's cost disease despite being labour-intensive (Nordhaus, 2006), or observed how the business models associated with these objects are "asset light" (Casella and Formenti, 2018). Our fourth contribution performs a review of the literature on digital firms, to identify the recurring themes and topics, with the goal of integrating these disperse characteristics into the new criterion, and confirming the boundaries of what is and is not a digital firm, while keeping the concept consistent with previous assumptions. Our fifth and final contribution is perhaps the most interesting for future researchers and for national and supranational bodies who want to regulate the digital economy. If digital firms produce or sell digital objects, then we can utilise existing industrial classifications to spot the firms that are digital. We list these sectors that we consider digital as of 2024, enabling quantitative research using large datasets.

The rest of this chapter is as follows: first, we define the digital object and enumerate the types of digital objects that exist, and their characteristics. Then, we provide a background on how internalisation theory explains why these firms show the characteristics highlighted by the OECD and the literature. Afterwards, we identify which firms are digital based on the digital object criteria and apply internalisation theory to identify these companies and their ownership advantages. We continue with an implementation of the definition of the digital firm on the NACE Rev.2 industrial classification, on a four-digit level. Next, we perform a literature review on the previous definitions, their shortcomings, and the limitations of their approach. We then proceed to identify common topics that appear in these definitions, linking them to the concept of digital, explain what these are and how they link to the digital object. We then analyse the phenomena of digitalisation through the lens of the international business discipline and observe its consequences in terms of internationalisation and productivity. We finish this chapter with our contributions, conclusion, and avenues of future research.

2.2. The digital object

Defining digital objects is challenging, so let us begin with a mental image. Intangible digital objects are things like software and computer programs. Tangible digital objects are those we use to interact with intangible digital objects such as computers or smartphones. Finally, we can add a third type of intangible digital object, those that existed before digitalisation but have dematerialised since, such as electronic books. All objects, digital and not digital, can be tangible, intangible or hybrid. It depends on their spatial attributes, on whether they occupy a physical presence in reality (tangible), do not (intangible), or a combination of both (hybrid).

From a more technical perspective, the common denominator for digital objects is “those whose component parts include one or more bitstrings." In turn, bitstrings are chains of zeros and ones, which means they are binary (they take only two values), and syntactic (because they contain instructions that computers have to execute) (Faulkner and Runde, 2019). From the point of view of physics, intangible digital objects are strings of text, written in code, that manifest from the difference of voltage through a logic gate (Hui, 2012), and can be classified into “program files” and “data files”. Program files are instructions for computers on how to operate, while data files are those used by computers or other systems (Faulkner and Runde, 2019).

It is easy to define tangible and hybrid digital objects. We interact with them physically and they give us access to the rest of ICT and digital technologies. Computers, and their related general-purpose technologies, (GPTs) are digital objects since they rely on bitstrings to work (Faulkner and Runde, 2011). Even though the bitstrings are immaterial, these objects are durable and structured (that means, they are made of other objects) and exist regardless of the media where they are incorporated (Faulkner and Runde, 2019). The nature of bitstrings makes them malleable, so giving a pure definition of intangible digital objects is hard. The information these bitstrings contain can be manipulated. By manipulating the information, we activate new functions in the bitstrings. This means new possibilities for the users of intangible digital objects, performing new activities or improving how an activity is performed (Kallinikos, Aaltonen and Marton, 2013). This malleable nature of the digital object is what has accelerated the creation and evolution of new products and services (Nambisan, Lyytinen and Yoo, 2020) or has changed the nature of sectors that did already exist (Ahmad and Schreyer, 2016). We may consider, for example, the application of lasers in retail. Beginning in 1974, the usage of laser technology and barcodes was meant to boost labour productivity (and it did, by 4.5%), but there were several challenges to be addressed before barcodes became functional. To begin with, products needed to have a barcode printed, barcodes needed to become smaller, and lasers needed to be able to read wet barcodes. The productivity boost induced by the barcode was not through enhancement of cashier work performance. It was what came after with the integration of computers: an improvement in stock management systems, customer loyalty schemes, employee performance measuring, and a wealth of data regarding inventory management and consumer preferences. And finally, years after, the increased capability at managing references brought an increase in product references and the growth of physical store size (Basker, 2012; Hortaçsu and Syverson, 2015).

2.3 Internalisation theory and the digital firm

Internalisation theory serves as a broad concept, encompassing various theories (Buckley and Casson, 2019), and paradigms (Narula, 2010; Cantwell, 2015). It provides a framework for predicting recurring patterns in firms involved in international business, including their internal organisational structures, entry mode strategies, and interactions with external economic entities (Narula et al., 2019). Its core is transaction cost economics (TCE), from which it stems. TCE establishes that economic organisation operates through two main institutions: markets, identified by Ronald Coase as the default mechanism, and firms (Coase, 1937). The decision to carry out a task within a hierarchical organisation (a firm) or through an autonomous entity in the market depends on transaction costs (Coase, 1937). Some level of cost is inevitable: firms that internalise activities face information, coordination, and motivation costs.

- Information costs involve acquiring and transmitting knowledge among employees working in different parts of the firm.
- Coordination costs arise from managing complementary actions and tasks within the organisation.
- Motivation costs relate to incentivising members to align their interests with the firm's objectives (Ambos et al., 2019).

Buckley and Casson (1976), in line with Coase's view, assumed that firms naturally prefer to use markets rather than internalise operations. However, firms choose to internalise when markets are highly inefficient or when information asymmetry exists, enabling them to avoid the transaction costs associated with intermediate products like technology and know-how. Hennart (1977, 1982), working concurrently with Buckley and Casson, expanded the scope by considering additional transaction costs. These include inefficiencies in markets for knowledge, reputation, intermediate goods, distribution, and financial capital.

From this intellectual basis two academic streams arose, streams that would eventually merge and assimilate: Rugman’s internalisation theory and Dunning’s eclectic paradigm. The Dunning stream introduced the eclectic, or OLI, paradigm, which is based on three key components: ownership advantages, location advantages, and internalisation advantages

(Dunning, 1977, 1980, 1993, 2000; Cantwell and Narula, 2001; Dunning and Lundan, 2009; Eden and Dai, 2010; Narula, 2010, 2012). According to this paradigm, a firm's proprietary assets – particularly intangible assets and non-location-bound capabilities – are what enable it to generate rents and maintain competitive advantages. John Dunning's ownership advantages (O) have been assimilated for a long while to Alan Rugman's firm specific advantages (FSAs). FSAs encompass a wide range of elements, from competencies to transactional advantages, which reflect the MNE's ability to minimise transaction costs while coordinating and managing assets (Dunning and Rugman, 1985; Rugman and Verbeke, 1992, p. 762). FSAs can consist of unique resources, but higher-order FSAs involve the capacity to recombine and integrate resources effectively, enhancing value creation (Hennart, 2009; Verbeke, 2013). FSAs extend beyond the mere ownership of assets; an efficiently organised firm can independently generate significant value. For a multinational enterprise (MNE), its internal market must outperform the alternative of relying on external, unaffiliated firms by efficiently transferring knowledge, goods, ideas, and people across subsidiaries and countries (Narula, 2014b). FSAs do not emerge spontaneously within firms. Instead, they are often rooted in the location advantages of a firm's home country. Entrepreneurs initially build success domestically, leveraging these location advantages to develop FSAs. Once the firm expands internationally, the FSAs created by these entrepreneurs in the home country are then deployed abroad to drive global competitiveness (Narula and Verbeke, 2015).

2.3.1. Internalisation as the theory of the firm

So far, it might seem a bit 'out of place' to talk about internationalisation, MNEs and such, in this exposition. But Alan Rugman gave compelling arguments to regard internalisation theory as the foundational framework for understanding how firms structure international business transactions. This theory explains and predicts patterns in governance choices within international business. And, logically, internalisation theory serves as the broader theory of the firm (Narula and Verbeke, 2015). Rugman's analysis is relevant to the decision-making processes of firms of all sizes, not only large corporations but also smaller enterprises. It also extends to decisions regarding the de-internalisation of activities, illustrating its applicability across various scales of business operations (Rugman, D'Cruz, and Verbeke, 1995; Rugman and Almodovar, 2011).

From this literature, what mostly matters to us is the FSA/O as a concept. According to Rugman and Verbeke, FSAs are "knowledge bundles that take the form of intangible assets, learning capabilities and even privileged relationships with outside actors" (Rugman and Verbeke, 2003, p.127). FSAs, assimilable to ownership advantages of the eclectic paradigm, are normally classified between asset-based ownership advantages (Oa) and transaction-based ownership advantages (Ot). Examples of Oa include product innovations, marketing capabilities or privileged relationships. Examples of Ot include those that emerge from economies of common governance and cross-border coordination. Transaction-based ownership advantages were referred to in the past as ‘economies of common governance advantages.’ A third type, a sometimes-overlooked type of advantage, is the institutional advantage (Dunning, 1988; Dunning and Lundan, 2008; Lundan 2009). The literature considers not just the FSAs of the firm, but also the FSAs of potential partners, which can be bundled or integrated with those of the firm (Hennart, 2009).

An attempt to describe the FSAs of digitalisations was performed by Banalieva and Dhanaraj (2019). The authors cite as advantages of digitalisation the reduction in transaction costs, the user network economies, speed and scalability (Kotha, Rindova and Rothaermel, 2001; Singh and Kundu, 2002; Brouthers, Geisser and Rothlauf, 2016), and follow Strange and Zucchella (2017) when arguing that digitalisation alters the nature of FSAs and the information costs of transfers of FSAs.

Banalieva and Dhanaraj (2019) argue that networks are the natural forum of the digital service firm, and affirm that, alongside the asset-based ownership advantages (Oa) and transaction-based ownership advantages (Ot), digital firms possessed an On, an ownership advantage originating in what they consider an alternative digital firms exploit compared to the typical coordination mechanisms of markets and firms. This phenomenon occurs as digital platforms can leverage the economics of networks and increasing returns to scale (Parker and Van Alstyne, 2005; Bharadwaj et al., 2013). When looking at internationalisation of e-commerce firms, Singh and Kundu (2002) build on the theoretical framework of Metcalfe's law, further supported by the empirical studies of Brouthers, Geisser and Rothlauf (2016) and Chen et al., 2019). Metcalfe’s law provides a ratio on how increasing amounts of users in a network increases its total financial worth. And from there, Banalieva and Dhanaraj (2019) argue that the importance of network externalities in digital platforms is so important it requires the recognition of the ‘network-based advantage’ (On) as a separate category from traditional asset-based (Oa) and transaction-based (Ot) advantages (Collinson and Narula, 2014; Dunning, 1988; Lundan, 2009).

Within the framework of international business, Banalieva and Dhanaraj (2019) used Simon (1962) concept of near decomposability (breaking down complex systems into a few sufficiently broad components) to examine how digitalisation differently influences two types of FSAs: technology FSAs and human capital FSAs. Then they used modularity, the ability to integrate across multiple firms via interfaces, to create value for customers (Langlois, 2002; Hennart, 2009a). Banalieva and Dhanaraj (2019) identified digital platforms as modular systems and applied these theories to explain how service MNEs could embrace complementary assets from local firms and used near-decomposability to analyse how technology and human capital FSAs are impacted by digitalisation.

Technology FSAs encompass a firm's collection of IT-driven innovation processes, along with patents, copyrights, and trademarks made possible by advancements in digital technology. Digital service firms require a foundation of core knowledge developed at the corporate level, complemented by peripheral knowledge applied at the point of service delivery. Modern digital service firms like Uber, according to these authors, can separate the human capital from the technological capital. The technological capital can be developed by the company as a core resource, while the human capital is the local driver-partners who drive and provide the vehicles. Digitalisation increases transferability and risk associated with appropriating technological FSAs (Banalieva and Dhanaraj, 2019).

Technology FSAs encompass a firm's collection of IT-driven innovation processes, along with patents, copyrights, and trademarks made possible by advancements in digital technology. SMNCs require a foundation of core knowledge developed at the corporate level, complemented by peripheral knowledge applied at the point of service delivery. For example, consider Uber: the human capital involved in driving can be separated from Uber's technological assets, enabling the company to develop its core knowledge as a corporate technology resource while utilising local driver-partners who provide the driving service and the vehicle. We suggest that digitalisation enhances both the transferability of, and the risks associated with appropriating technology FSAs in the following ways. Modularity refers to a framework that simplifies complexity within a system by dividing it into distinct components that interact exclusively through standardised interfaces (Langlois, 2002). A modular system is considered decomposable when interactions between its various modules are minimal (Simon, 1962; Langlois, 2002; Gawer, 2009). IB research uses the concept of modularity when it comes to asset-bundling (Hennart, 2009a) and recombinant advantages (Collinson and Narula, 2014), allowing firms to address weaknesses in one FSA by leveraging another. Recent IB studies have further explored the role of modularity in developing architectural knowledge, which concerns understanding how different system components are interconnected and function cohesively (Asmussen, Larsen and Pedersen, 2016). Digital service MNEs, according to Banalieva and Dhanaraj (2019) internationalise fast because they can easily integrate their FSAs with other firm FSAs and their knowledge assets. This easy integrating of technological FSAs also represents a risk when it comes to other firms appropriating the technology as transfer barriers are reduced. Competitive advantage stems from the superior quality of a firm’s intangible knowledge resources and the causal ambiguity that makes them difficult to replicate (Reed and Defillippi, 1990), and the firm’s long-term success depends on them being able to prevent imitation of the firm's technological advantages. Digitalisation allows for simultaneously transferring FSAs and copying them. Digital firms can make their technology more complex and raise the costs of users changing platforms (Banalieva and Dhanaraj, 2019). Another possibility is incorporating proprietary components that are essential for system assembly, preventing foreign competitors from replicating the complete system. Vertical integration, leveraging their in-house proprietary technologies, can significantly increase imitation barriers and strengthen their competitive advantage (Reed and Defillippi, 1990).

Human capital, another form of firm-specific advantage (FSA), refers to the collective knowledge and skills individuals develop through education, training, experience, and peer interactions (Becker, 1964; Nelson and Winter, 1982; Coff and Kryscynski, 2011; Mahoney and Kor, 2015). Polanyi (1967) categorised knowledge into two types: tacit and explicit. Tacit knowledge, or "know-how," is deeply ingrained within people, systems, and organisations, making it challenging to articulate or codify. In contrast, explicit knowledge, or "know-what," is easily identified, shared, and applied. Simon (1985) further distinguished between general knowledge, such as generic skills, and more specialised, firm- or industry-specific knowledge, like advanced skills.

Digitalisation impacts human capital in contrasting ways. For individuals with specialised skills, it amplifies their competitive advantage. However, for those with generic skills, digitalisation tends to commoditise their value. Firms benefit from digitalisation by integrating both types of human capital FSAs (Banalieva and Dhanaraj, 2019). Following Chi, (1994), they argue that advanced skills are challenging to incorporate into technology, limiting their tradability. These skills are hard to bundle with external resources for greater returns compared to utilising the firm's existing resources. Conversely, generic skills involve rule-based, repetitive tasks that are not location- or firm-specific, making them easy to codify and replicate (Kogut and Zander, 1992).

Internalisation theory suggests that advanced human capital skills, being complex and tacit, are difficult to transfer across borders or to third parties through market transactions (Kogut and Zander, 1992, 1993; Rugman and Verbeke, 2003, 2004). Instead, these skills are best developed internally (Buckley and Casson, 1976; Rugman, 1981), as they are proprietary FSAs unlikely to be acquired externally (Lepak and Snell, 1999).

Moreover, uniquely human capabilities such as moral judgment, systems thinking across abstract concepts, and empathy will remain challenging for AI to replicate. Despite advancements in technology, firms must continue relying on employee’s adept at operating specialised technologies. This co-specialisation of advanced human skills with AI within firms makes it harder for competitors to pinpoint the specific factors driving the success of digital service multinational enterprises (Chi, 1994).

2.3.2. Ownership Advantages and the FSAs

The eclectic paradigm (OLI, the FSA/CSA matrix) argues that firms must have ownership advantages/FSAs to compete. Ownership advantages are made of intangibles, and internalisation protects and enhances these. However, Hennart (2019) argues that the eclectic paradigm has limitations: it does not explain every instance of foreign direct investment.

While the OLI paradigm effectively explains foreign direct investments (FDIs) by firms leveraging their intangible assets, it struggles to account for other types of FDIs (Hennart, 1991; Asmussen and Foss, 2014). Hennart gives the example of firms engaging in backward vertical investments, such as those in mineral resources, not to capitalise on technological advantages or reputational strengths, motivated by a need to avoid holdup issues arising from limited supplier options (Stuckey, 1983; Hennart, 1988). Or vertical forward integration, such as manufacturers investing in distribution, which is not driven by a desire to exploit manufacturing-based FSAs in distribution. Rather, it is often a defensive move to mitigate the risk of dependence on distributors (Hennart, 2010). Another category of FDIs unrelated to exploiting FSAs involves investments made to acquire FSAs. For example, firms may acquire foreign companies specifically to gain access to their intangible assets. In such cases, the primary objective of the investment is to obtain, not utilise, FSAs (Hennart, 2012; Asmussen and Foss, 2014).

Dunning sought to solve the issue of this missing ownership advantage by creating a new type of firm-specific advantage (FSA), termed "advantages of common governance" (Ot), that the literature calls now “transaction-based ownership advantage,” a new type attributed to the benefits arising from a firm's multinational nature. Narula (2014, 2017) elaborates that these Ot advantages involve a firm's capacity to manage internal operations effectively and integrate its FSAs with assets controlled by external entities (Narula et al., 2019). However, since these advantages depend on successfully internalising the transaction, they can only be identified after the fact, making the concept tautological.

Hennart (2019) spots a conceptual flaw in the Ot as proposed by the literature. The causal link between the Ot and internalisation is not clear. Essentially, theory suggests a firm internalises because it has Ot advantages, while simultaneously asserting that Ot advantages exist because the firm internalised – resulting in circular reasoning. The Ot must be valid empirically by predicting internalisation outcomes beforehand (ex ante) rather than only explaining them afterward (ex post). While it is possible to test how a firm's Oa advantages, such as patent holdings, influence its FDIs, Ot advantages lack a measurable, pre-transaction framework. Consequently, the OLI paradigm's ability to explain FDIs is largely confined to those driven by intangible assets. For the OLI framework to be empirically valid, it must predict internalisation. This doctoral thesis deals with this issue in Chapter 4, arguing on whether the alleged superior performance of digital firms is an Oa or Ot, by measuring the productivity of digital firms.

Hennart (2019) also criticises several of the arguments made by Banalieva and Dhanaraj (2019) regarding the internationalisation strategies of digitalised service MNEs. One of the primary claims made by Banalieva and Dhanaraj is that digitalised service MNEs possess a new firm-specific advantage (FSA), which they term "network advantages" (On). These advantages arise from network externalities, where the value of a platform increases as more users adopt it. Hennart (2019) challenges this assertion by arguing that network externalities are not inherently firm-specific but rather characteristics of an industry or its business model. For example, any firm operating a dating platform, or an e-commerce site can potentially benefit from network externalities, as these advantages are tied to the structure of the market rather than the specific firm.

Furthermore, Hennart (2019) points out that network advantages become identifiable only in hindsight (ex post), after a firm has established dominance in a market. This retrospective observation renders the concept tautological and unsuitable for predicting firm success beforehand. Again, as with the Ot, Hennart (2019) explains that ownership advantages (FSAs) must be observable ex ante to serve as effective predictors of internationalisation. By contrast, network advantages can only be assessed after the firm has succeeded, making them less useful as a theoretical construct. Banalieva and Dhanaraj (2019) argue that digitalised service MNEs operate through networks, which they present as a governance structure distinct from markets and hierarchies. Hennart refutes this claim, asserting that networks are not a third governance structure but rather a combination of hierarchical and market mechanisms. He refers to these combinations as "external hybrids," which have been extensively studied in existing literature on international business. According to Hennart, structural networks in industries often arise due to differences in minimum efficient scale (MES) between various stages of the value chain. For instance, a platform with a high MES, such as a digital marketplace, may rely on a large number of smaller-scale local service providers. However, this configuration is not unique to digitalised service MNEs; similar patterns can be observed in traditional industries such as franchising. Hennart (2019) critiques Banalieva and Dhanaraj (2019) for conflating structural networks with governance structures, noting that all interdependencies are ultimately governed by markets, hierarchies, or hybrids.

Hennart (2019) also takes issue with the emphasis that Banalieva and Dhanaraj (2019) place on technology and human capital as the primary drivers of DSMNC internationalisation. While acknowledging the importance of these factors, Hennart argues that their analysis neglects the critical role of reputation. Reputation, he explains, is especially important in the service sector, where consumers face uncertainty in assessing quality before purchase. By building and leveraging strong reputations, service firms can reduce consumer uncertainty and facilitate international expansion. Reputation becomes particularly relevant in foreign markets, where home-country firms often attract customers who are familiar with their services. This initial customer base can provide a foothold for expanding to local markets. Hennart (2019) emphasises that neglecting the role of reputation undermines the comprehensiveness of Banalieva and Dhanaraj's framework.

Another critique levelled by Hennart concerns the scalability and limitations of network externalities. While network effects can provide competitive advantages, he argues that their impact is often geographically constrained. For example, a dominant ride-sharing network in one city does not necessarily translate into an advantage in another, as network effects are tied to specific locations. Hennart also notes that low switching costs in digital markets reduce the sustainability of network advantages. Competitors can replicate business models and attract users with relative ease, as seen in industries like e-commerce and social media. This dynamic undermines the long-term effectiveness of network externalities as a source of competitive advantage.

2.4. Previous definitions of digital firms and the digital economy

The question at this point is: what were Banalieva, Dhanaraj, Hennart, and the other authors talking about when they spoke about the digital firm? The authors cited companies but did not really provide a definition of a digital firm, assuming the reader knew. But as we will see in this section, defining the digital firm is not easy.

Producing a definition of the digital firm is not enough if this definition does not adjust with societal expectations about the digital firm. This section shows previous attempts at defining the digital firm, highlights the difficulties at defining the firm from previous definitions, and then analyses these definitions to find commonalities that can bring them closer to the digital object as described by Faulkner and Runde (2019).

2.4.1. The issues with defining the digital economy

Seventy years of digitalisation of the economy and thirty years of scholarship have created a series of diverse and contradictory definitions on the digital firm and the digital economy. These definitions are the product of their time and reflect contemporary trends and the promises of technology. Current definitions contain references to Cloud computing and Big Data, late 2000s definitions emphasise mobile technology networks and late 1990s to mid-2000s focus on the Internet (Bukht and Heeks, 2017). Building on the work of Bukht and Heeks (2017), we provide an exhaustive breakdown on digital definitions (Table 2.1).

Table 2.1: Historical definitions of “digital.”

Author(s) and year	**Content**
(Tapscott, 1996)	Described the digital economy (“Age of Networked Intelligence”) as being “not only about the networking of technology… smart machines… but about the networking of humans through technology” that “combine intelligence, knowledge, and creativity for breakthroughs in the creation of wealth and social development.”
(Lane, 1999)	Defined the digital economy as “…the convergence of computing and communication technologies on the Internet and the resulting flow of information and technology that is stimulating all of electronic commerce and vast organisational changes.”
(Margherio et al., 1999)	Described the digital economy as being driven by “building out the internet ... electronic commerce among businesses ... digital delivery of goods and services ... retail sale of tangible goods.”
(Brynjolfsson and Kahin, 2000)	Defined the digital economy as “...the recent and still largely unrealized transformation of all sectors of the economy by the computer-enabled digitization of information.”
(Kling and Lamb, 2000)	Described the digital economy as “...includes goods or services whose development, production, sale, or provision is critically dependent upon digital technologies.”
(Woodall, 2000)	Does not record a definition but explains that the digital economy is the same phenomena previously called the "knowledge-based economy", "borderless economy", "weightless economy", "networked economy" and "information-based economy".
(Mesenbourg, 2001)	Defined the digital economy as being composed of three elements: “e-business infrastructure is the share of total economic infrastructure used to support

	electronic business processes and conduct electronic commerce" – "electronic business (e-business) is any process that a business organization conducts over computer-mediated networks" – "electronic commerce (e-commerce) is the value of goods and services sold over computer-mediated networks."
(Persaud, 2001)	The digital economy is based: "on intangibles, information, innovation and creativity; and consists of the combination of networks, computing, technologies and new business models, creating entirely new markets, industries, business and work practices.
(Gärdin, 2002)	"The digital economy consists of the convergence of communications, computing and information". The driving force behind this new economy is the symbiosis between changing production, business processes and ICT.
(Shepherd, 2004)	"The digital era is characterised by technology which boosts the speed and breadth of information turnover within the economy and society."
(Malecki and Moriset, 2007)	"The digital economy represents the pervasive use of IT (hardware, software, applications and telecommunications) in all aspects of the economy, including internal operations of organisations (business, government and non-profit); transactions between organisations; and transactions between individuals, acting both as consumers and citizens, and organisations."
(OECD, 2013)	"The digital economy enables and executes the trade of goods and services through electronic commerce on the Internet."
(European Commission, 2013)	Defined the digital economy as "...an economy based on digital technologies (sometimes called the internet economy)."
(British Computer Society, 2014)	"The digital economy refers to an economy based on digital technologies, although we increasingly perceive this as conducting business through markets based on the internet and the World Wide Web".
Australian Parliament (Li, 2014)	The digital economy is "the global network of economic and social activities enabled by platforms such as the internet, mobile and sensor networks".
(Li, 2014)	"The digital economy is characterized by an unparalleled reliance on intangible assets, massive use of data (notably personal data), widespread adoption of multi-sided business models capturing value from externalities generated by the free products and the difficulty of determining the jurisdiction where value generation occurs".
(European Parliament, 2015)	Defined the digital economy as "A complex structure of several levels/layers connected with each other by an almost endless and always growing number of nodes. Platforms are stacked on each other allowing for multiple routes to reach end-users and making it difficult to exclude certain players, i.e., competitors."
(Cannas, 2015)	Does not define the digital economy but argues that cryptocurrencies are not well covered by EU regulations for the digital economy, as well as points out that the traditional goods and services distinction causes issues when regulating the digital economy.
(British House of Commons, 2016)	"The digital economy refers to both the digital access of goods and services, and the use of digital technology to help businesses."
(Ahmad and Schreyer,	One of the manifestations of digitalisation is "peer-to-peer

2016)	transactions, facilitated by web intermediaries". Despite the modern lexicon, the authors argue the novelty lies in the greater scale and the pass from the informal to the formal economy.
(G20 DETF, 2016)	Defined the digital economy as "...a broad range of economic activities that include using digitized information and knowledge as the key factor of production, modern information networks as an important activity space, and the effective use of information and communication technology (ICT) as an important driver of productivity growth and economic structural optimization."
(Boccia and Leonardi, 2016)	The digital economy is the result of the transformational effects of the new GPTs in the fields of information and communications. Its implications go beyond ICT, impacting all the economy and society. Digitalisation is affected by three factors: mobility (which increases relevance of intangible assets over physical assets, allowing for zero cost replication and outsourcing), the effect of networks (pushing down marginal costs of products, prices and incentivising growth to create economies of scale) and data (as ICT reduces costs of collecting, analysing and storing data).
(Elmasry et al., 2016)	The digital economy "creates value at the new frontiers of the business world, optimizes the processes that execute a vision of customer experiences, and builds foundational capabilities that support the entire structure."
(Knickrehm, Berthon and Daugherty, 2016)	"The digital economy is the share of total economic output derived from a number of broad "digital" inputs. These digital inputs include digital skills, digital equipment (hardware, software, and communications equipment) and the intermediate digital goods and services used in production. Such broad measures reflect the foundations of the digital economy."
(Bogner et al., 2016)	Argues that digitalisation is not something that occurs in isolated areas of the firm but takes place in all operation areas. The approach is meant to cover all business areas to find potential for improvement in each step of the value chain.
(Dahlman, Mealy and Wermelinger, 2016)	"The digital economy is the amalgamation of several general-purpose technologies (GPTs) and the range of economic and social activities carried out by people over the Internet and related technologies. It encompasses the physical infrastructure that digital technologies are based on (broadband lines, routers), the devices that are used for access (computers, smartphones), the applications they power (Google, Salesforce) and the functionality they provide (IoT, data analytics, cloud computing)."
(Casella and Formenti, 2018)	Define digitalisation as the application of internet-based technology to the production and sale of goods and services. Describe three typologies of digital firm according to their level of business digitalisation: ICT companies, which provide the services other firms use to digitalise and manage the tangible elements of the internet; companies where the internet plays a major role in their business as they fully operate on a digital environment, or their digital contents are the most relevant; and firms that operate in a traditional business undergoing digitalisation.
(OED, 2024)	The digital economy is "an economy which functions primarily

	by means of digital technology, especially electronic transactions made using the Internet."

The interest in the "digital economy" began in 1993 when the Internet first opened to individuals outside of organisations, businesses, etc. The term that ended up dominating the discussion was coined by Tapscott (1996) strongly focusing on the Internet, a novelty at the time. By 2000, digitalisation was related to information processing as well as value generation in the traditional economy (Brynjolfsson and Kahin, 2000). Margherio et al. (1999) were the first to observe the heterogeneity of business activities and attempt a classification of digital businesses. There were no substantial contributions to the concept of the digital economy after the publication of the book *Digital Economy, Impacts, Influences, and Challenges* by (Kehal and Singh, 2005) until the OECD sponsored the Base Erosion and Profit Shifting (BEPS) initiative in 2013. The OECD produced a reductionist definition that equated the digital economy with e-commerce, ignoring how digital goods can also be acquired outside e-commerce (Báez and Brauner, 2019). The OECD definition seems to build on the effort from nearly a decade ago and seems to draw inspiration from Margherio et al. (1999), who identified not only the "retail sale of tangible goods" but also the sale of dematerialised objects: "airline tickets and securities transactions over the Internet already occur in large numbers. Other industries such as consulting, services, entertainment, banking and insurance, education and healthcare face some hurdles but are also beginning to use the Internet to change how they do business." In the end, the most lasting impact of the OECD definition was e-commerce becoming a staple of digital definitions. Still, the definition of the digital economy provided by the OECD was far more useful than the circular definition proposed by the European Commission (2013): "an economy based on digital technologies", or the Business Computer Society (2014) "an economy we increasingly perceive […] as conducting business through markets based on the internet and the World Wide Web."

As if this wasn't enough, Boccia and Leonardi (2016) affirmed that the digital economy was "the product of a number of transformational effects that have taken place in the field of information and communication by general purpose technologies; transformation effects that affected sales and production" while Casella and Formenti (2018) defined "digitalising" as applying Internet based technology to the production and sale of goods and services. If we were to follow their criterion, then "digitalisation" and the "digital economy" are the same thing.

In any case, if we want to perform research to figure out if the fears and suspicions underlying the BEPS initiative (that the firms within the digital economy were not paying their ‘fair share’ of taxes), then these definitions aren’t well suited for this purpose, nor is the focus towards structural circumstances, such as the separation of business activities and locations where profits are declared (Self, 2013; Zeng, Khan and De Silva, 2019), a characteristic shared with firms that aren’t considered to be digital.

How about other definitions? The United Nations Conference on Trade and Development (UNCTAD) has their own definition of digital firms, used in UNCTAD (2015), and by Casella and Formenti (2018), who implemented this definition for quantitative research. Being cautious, the UNCTAD criteria have only been applied to the largest one-hundred digital multinationals, arguing that sectorial information such as standard industry classifications from NACE or NAICS included in company databases are not sufficient for the identification of digital firms. What the UNCTAD calls “digital firms” are bundled together in the industrial classifications with what they call “non-digital firms” on the basis of what they produce and sell, independent of the level of digitalisation (UNCTAD, 2017). UNCTAD (2017) argues that this methodology avoids dealing with outdated industrial classifications.

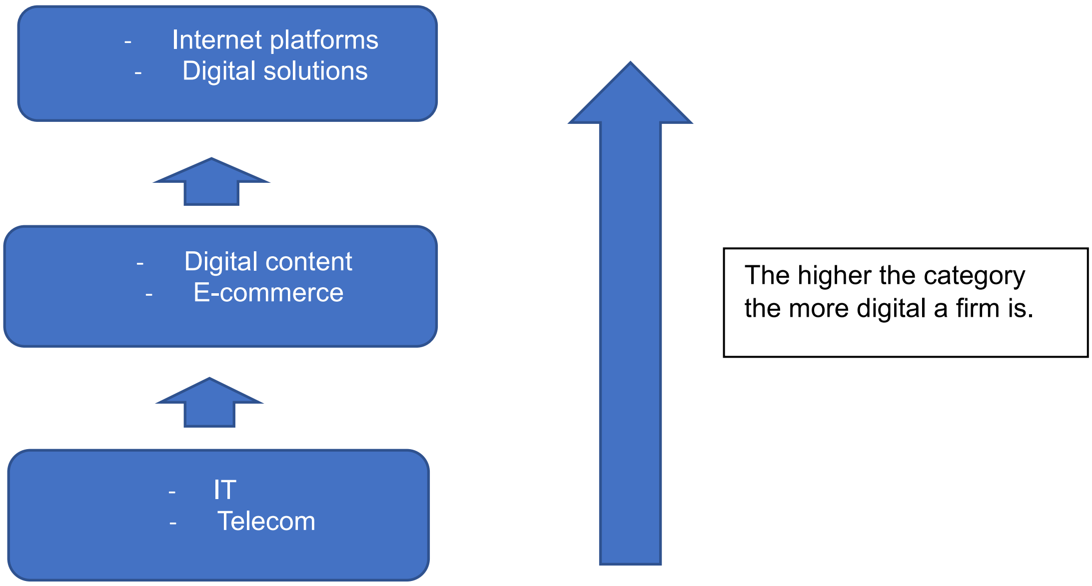

Figure 2.1: Casella and Formenti (2018) categorisation of digital firms, adapted and simplified.

We find this UNCTAD taxonomy too restrictive. It mostly focuses on service firms, and it does not consider the IT and telecom industry to be “truly” digital. IT and telecommunications are just the infrastructure that supports the digital economy. E-commerce and digital content firms are a “mix” of digital and non-digital, and digital solutions and internet platforms are the only truly pure digital firms. The borders between these sectors are not well delineated. The explanation between purely digital and mixed is determined by presence in the virtual world relative to the physical world, but this criterion is hard to apply in practice. An e-commerce firm retailing physical goods requires tangible infrastructure (warehouses) just like an internet platform requires server farms that are very tangible, consume a large amount of energy to remain powered and produce a great deal of pollution (Avgerinou, Bertoldi and Castellazzi, 2017). In any case, the caution of UNCTAD (2017) in applying their own criterion reveals that, ultimately, their criterion suffers from flaws, and they don't really know what the characteristics are of what they call a "digital firm". For example, the authors of UNCTAD (2017) argue whether *Expedia* is a digital company. For them, that company operates fully using IT, but provides a service that lies within "travel agency activities." For us, the situation is exactly the opposite: travel agency activities are a digital service that have been affected by digitalisation, dematerialising them, which makes *Expedia* a digital firm. If anything, our own criterion could be accused of being conservative: our criterion would not automatically consider *Amazon* a digital firm, since their NACE code core, is "Retail sale of books in specialised stores," despite the evolution that the firm has experienced ever since this was their core business. Industry classification codes operate on legacy considerations, but they are the only feasible way to classify firms and observations by the tens of thousands when performing quantitative research.

The UNCTAD terminology also lends itself to confusion with other branches of the literature. For example, what Heeks (2008) called the "IT sector" or "ICT sector" (what would now be called the "digital economy") does not match the UNCTAD (2015) criteria. Heeks (2008) puts goods, software and infrastructure at the base, services and retail in the middle, and content at the very top.

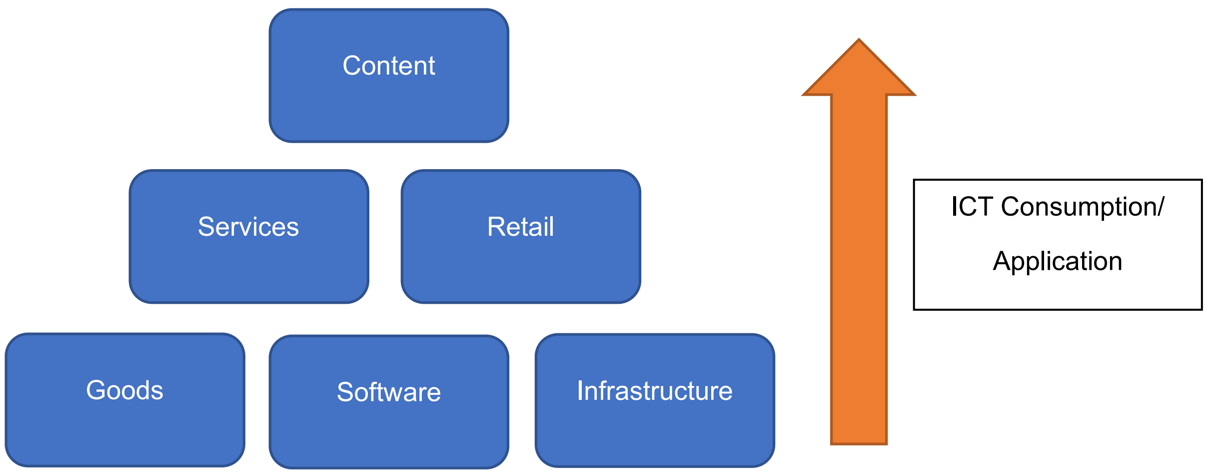

Figure 2.2: Heeks (2008) categorisation of "IT firms", adapted and simplified.

The literature found a workaround to this problem: not defining what the digital economy or the digital firm is, limiting themselves to highlighting the traditional elements within the businesses. For example, Valenduc and Vendramin (2017) have linked current flexible work structures in today's economy to formulas that were already ongoing before digitalisation. Ahmad and Schreyer (2016) explained that the "gig economy" is not new. Hennart (2019) compared new digital firms such as Airbnb with parts of firms that perform a traditional business, such as airlines selling tickets online. Although the transaction may be performed in a new format, the underlying transaction is not necessarily new. Political impulse towards the measure and categorisation of these transactions arises not from their novelty (since taxi services, car boot sales, renting of rooms and such are not new) but from the sheer volume of these transactions. Companies such as Uber, eBay and AirBnB have benefitted from opportunities provided by web intermediaries to allow households to become service providers while making it easier for consumers to access these services thanks to advances in digitalisation (Ahmad and Schreyer, 2016; Hennart, 2019). For many businesses the only changes are the greater scale of transactions and the passing of some of these activities from the informal to the formal economy. Portolese and Folloni (2018) argued that the internationalisation of firms has probably been sped up by the digitalisation of the economy and by intangible assets, but these tendencies existed before ICT systems became a staple within firms.

Ultimately, the concept of "digital" cannot be linked to any specific definition. Trying to argue one definition is superior to the other is not the best way to spend our time. We propose a different solution to this problem. We argue that the concept of "digital" consists of the combination of multiple definitions, shaped by the history of the digitalisation process. Five elements repeat over time within the definitions: the use of computers and the computer as a GPT, the use of networks, engaging in e-commerce (understood either as the retail of intangibles or tangibles as well), the use of information and data and the reliance on intangibles. We believe these are all digital objects, characteristics of the digital object or consequences of producing digital objects. The reiteration of these concepts can be seen in the diagram below:

Table 2.2: Recurring themes in definitions of digital firms, digital economy, and digitalisation

Year	Authors	Intangibles	Information / data	Computer technology / GPTs	Networks	E-commerce / Internet
1996	Tapscott (1996)		X	X		X
1999	Lane (1999)		X	X		X

1999	Margherio et al. (1999)					X
2000	Brynjolffson & Kahin (2000)		X	X		
2000	Kling & Lamb (2000)			X		
2000	Woodwall (2000)		X			
2001	Persaud (2001)	X	X	X	X	
2001	Mesenbourg (2001)			X	X	X
2012	OECD (2012)			X		X
2013	European Commission (2013)			X		X
2014	Li (2014)	X	X		X	
2014	British Computer Society (2014)			X		X
2016	Eden (2016)		X	X	X	X
2016	Boccia & Leonardi (2016)	X	X	X	X	X
2016	Ahmad & Schreyer (2016)					X
2016	House of Commons (2016)			X		
2016	G20 DETF (2016)		X	X	X	
2016	Knickrehm et al. (2016)			X		
2016	Dahlman et al. (2016)		X	X		
2018	Casella & Formenti (2018)			X		
2018	Portolese & Folloni (2018)	X				
2019	(Banalieva and Dhanaraj, 2019)		X	X	X	X
2024	OECD (2024)			X		X

We look in the next section at the meaning of each of these five concepts, explain how these evolved and how they have shaped the understanding of the digital firm and the digital economy. We then link these five concepts to the digital object, thus letting our definition find its place within the literature.

2.4.2. The computer as a general-purpose technology

Table 2.3: Sixty years of computers

Decade	
1940s	Computers as calculation tools
1950s	Automatic data processing and scientific research
1960s	Early business applications and first simulations

1970s	Static representation of data and preparation of data for managers
1980s	Dynamic data and widespread usage
1990s	Integration of computers through the Internet
2000s	Integration of computers into communications via smartphones

Computers, computer technology or simply "technology" are one of the most common elements featured in "digital" definitions. Computers are a type of general-purpose technology (GPT). A GPT is "a single generic technology, recognizable as such over its whole lifetime, that initially has much scope for improvement and eventually comes to be widely used." GPTs can have many uses and spillover effects (Lipsey, Carlaw and Bekar, 2005, p.98). A GPT is the common denominator across many technological transformations. Although applications may differ, these all have in common that they were developed and enhanced by the GPT. For example, electricity is a GPT. The pre-1900 era has electricity serving as a common denominator for the following revolutionary applications in communications (telegraph and telephone), heating (radiators and electric hobs), lighting (lightbulbs), manufacturing (the milling lathe), chemistry (electrolysis) and physics (the x-ray).

Computers started as single-purpose technology and have created new processes, products, organisational forms, political relations, and social relations after decades of improvements and diffusion through the entire economy. Scholars became aware of these transformations in the 1970s. Examples of computers being used as GPTs include the use of robots in manufacturing, the use of computer assisted design (CAD) instead of paper blueprints, online meetings replacing in-person meetings, the ability to perform highly intensive calculations on data across all sciences and the integration of satellite communications in road, railway, maritime and air traffic (Lipsey et al., 2005, p.114).

The earliest computers appeared during the Second World War (Smil, 2017, p. 337). General Electric was the first firm to purchase a computer and undergo digitalisation, in 1954 (McLeod and Schell, 2004, p.4), back when most computers were located at research institutions and universities (Wirth, 2008). The 1960s saw the first iteration of firms investing in information technology (IT) to enhance businesses (Cohen, 2008, p.33) with management level systems to increase productivity, raise profits and increase responsiveness to market changes (Strassmann, 1985). Between 1964 and 1965, Gordon Moore observed that the number of transistors in a microchip had doubled from 32 to 64 (Moore, 1965). Moore's Law was then formulated as a justification for increased expectations on future computers (Smil, 2017, p.339). Computers arrived at smaller firms in the 1970s and new powerful microprocessors meant mainframe computers on every desk, interconnected through networks to central mainframes. Strategic-level systems became available in the 1980s (Laudon and Laudon, 1988, p. 97). Firms centralised efforts to avoid duplicity of entries and lack of coordination to avoid errors and redundancies within databases. This process gave senior managers a large deal of control over business areas (Laudon, 1988. p.643). Managerial limitations on organisational size shrunk. Fewer managers were needed to control firm activities and oversee increasing numbers of employees. The number of tasks an employee could perform increased, and training became cheaper, but in the process the value of work provided by unskilled workers diminished. Corporate hierarchies became flatter than before (Cohen, 2008, p.14). Advancements in miniaturisation brought laptops in the 1990s and smartphones in the 2000s (Smil, 2017, p.343).

2.4.3. Networks and communications

Digitalisation would not have gotten far if computers could not be connected to other computers. The first network, ARPANET, connected four US universities. Emails appeared in 1972 to send messages through ARPANET (Partridge, 2008). A few isolated organisations started operating networks during the 1970s, which were brought together in 1985 by the nascent Internet. Hobbyists started joining the early Internet in the 1980s. The developments were accelerated through easy access to the World Wide Web in 1989 (Brynjolfsson and McAfee, 2014) and the invention of the first web browser in 1993 (Smil, 2017, p.343). Mass consumer access began in September 1993 and overwhelmed the existing, self-regulated communities. It began the urge to regulate the Internet like any other part of society and the economy (Fidler, 2017).

Meanwhile, in the telecommunications sector, microelectronics, and rocket launchers during the 1960s allowed for cheaper intercontinental calls thanks to automatic dialling via artificial satellites in geostationary orbit. The first mobile phones were made available in the U.S. in 1983 and became commonplace during the late 1990s, with one hundred million units sold in 1997 (Smil, 2017, p.343).

2.4.4. Information

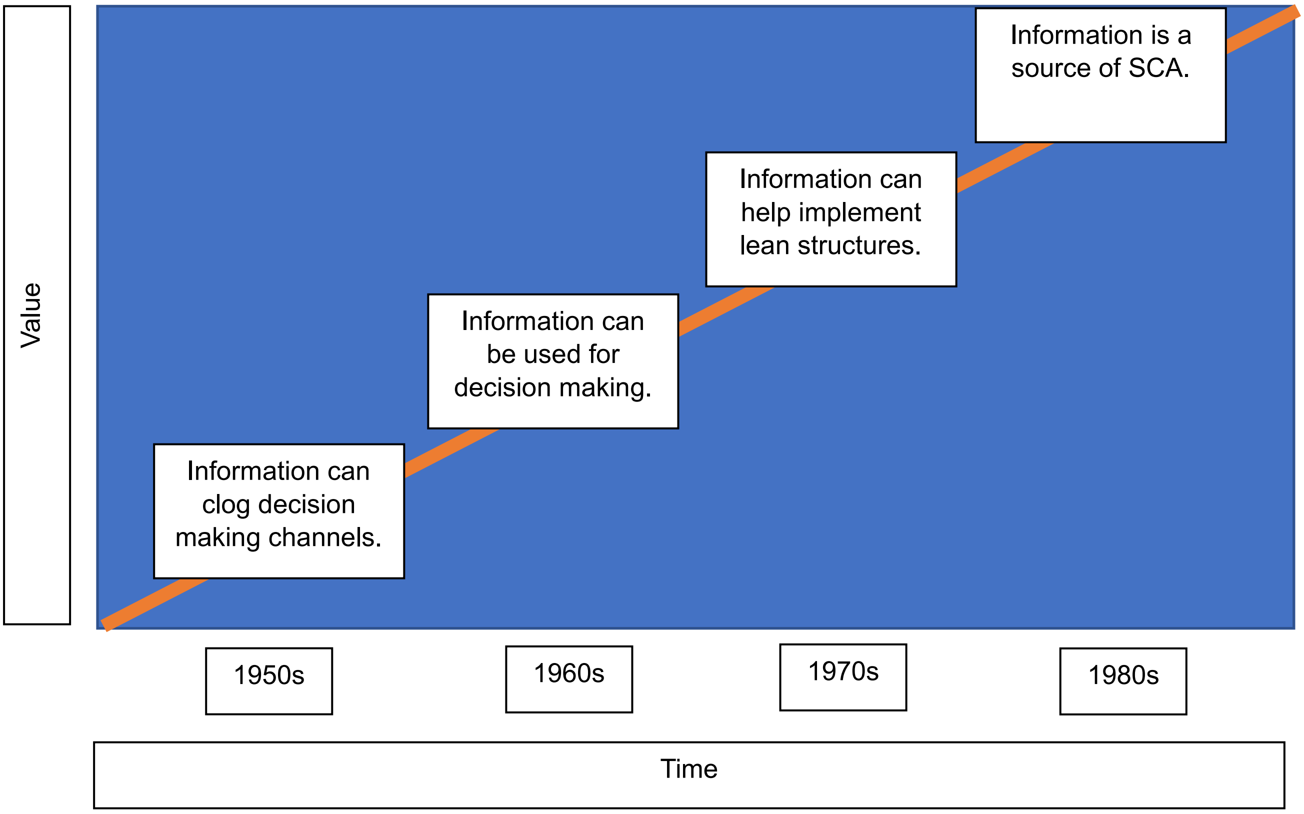

Figure 2.3: Evolving views on information value

Information views evolved over time, starting as a necessary evil during the 1950s (Laudon, 1988, p. 62). Database management systems (DMBS) sped up digitalisation by allowing firms to store information and generate core applications – such as company records, payrolls, customer relationship management, etc. - and led to more firms purchasing mainframes (Grad and Bergin, 2009). Combined with office printers, which arrived in the 1970s, data started circulating across organisations (Smil, 2013, p.51). Management of information systems (MIS) studied early digitalisation. MIS was defined at the time as a tool to plan allocations of resources via information systems tasks and included tasks such as managing accounts receivable or inventory control (Gorry and Scott-Morton, 1971). Expectations on what computers were able to do were high and businesses began investing in IT (Wirth, 2008).

Decision support systems (DSS) arrived a decade later, advertised as tools that allowed managers to achieve fine-tuned control over organisations by supplying specific information (Keen and Scott-Morton, 1978). Examples of tasks that could be optimised via the use of DSS included budget preparation, R&D planning and mergers and acquisitions (Gorry and Scott-Morton, 1971). However, firms often struggled to obtain returns for their IT investment. MIS and DSS lacked conceptual frameworks, which made it hard to determine the best frameworks to solve tasks or how to recognise a skilled consultant (Naylor, 1982). Despite the challenges in digitalisation, information was acknowledged as a source of competitive advantage that could be used to assist in strategic planning (Porter, 1985).

The digitalisation of the firm information did not stop at administrative work. Computer assisted design (CAD) appeared at a time when paper blueprints had depleted their potential. Designs had become too complex – the Boeing 747, designed in 1965, required 75,000 drawings weighing eight tons (Smil, 2013). CAD was developed to coordinate the movement of millions of surfaces (Mowery and Rosenberg, 1981) and its use unlocked new possibilities. It halved time spent on tasks. Labour requirements went down between 10 and 20%. Computer screens allowed for 3D capabilities. Errors could be mitigated by editing files instead of throwing away blueprints (Smil, 2013). Employee training became available in the form of "learn by using" from other designers (Mowery and Rosenberg, 1981).

2.4.5. Intangibles

Other than not being physical, intangible assets have very little in common. This diversity allows for multiple definitions, each one highlighting an aspect of the intangible object. Intangible assets are the result of investing in technological ideas, product design or business capabilities. They can be proprietary relationships or codified information (Haskell and Westlake, 2018, p.22). Investing in intangibles leads to developing processes, products, organisational capabilities, and advantages when competing in certain markets (Hulten, 2010).

Dematerialisation removes tangibility from a physical object. Sometimes this is more apparent than real – intangibles still require a physical bearer for us to interact with them (Faulkner and Runde, 2019). An e-book, CAD blueprint or a public company share are no longer made of paper, but these intangible objects nevertheless require infrastructure in the forms of communication networks, software, and mass storage. Pulp, paper and storage cabinets have been traded for electronic parts and electricity consumption (Smil, 2013, p.119).

Researching intangible assets is difficult. Before the 1980s, most intangible asset heavy businesses operated in consumer products (that relied on brands) and chemical, pharmaceutical, and electronic sectors (which invested heavily in R&D). Software and biotech firms appeared in the 1980s. The rise of the Internet and telecommunications increased the reliance on intangibles within the entire economy (Lev and Gu, 2016, p.88). Despite the relevance of intangible assets in the modern economy, balance sheets mostly feature tangible assets over intangibles (Lev and Gu, 2016, p.71). Intangibles are often underreported. Patents or brands pose risks. These will lose value due to obsolescence or if ownership is lost in an infringement case. Expensing intangibles instead of incorporating them into the balance sheets shields managers from criticism regarding faulty intangible acquisition or development and eases auditor duty of explaining to shareholders what the risks associated with these assets are (Lev and Gu, 2016, p. 90). Aggregate US investment in tangible assets has decreased by a third in the last forty years, while investment in intangible assets has risen by 60%, from 9 to 14% of gross value added (Lev and Gu, 2016, p.71). Holding onto this industrial era criteria overstates ROE and ROA and understates ratios of earnings over investment. For intangible-intensive businesses asset and equity values are understated (Lev and Gu, 2016, p.71) and when valuing securities, the role that earnings and book values play has dropped by half over the last fifty years (Lev and Gu, 2016, p.34).

2.5. Defining the digital firm

So, we know that digital firms are somewhat perceived to be different, and we have identified five elements within the definitions. We affirm that, if a firm delivers a product that is not digital in nature, it is not a digital firm. It does not matter how much a firm incorporates ICT to digitalise their value chain. Their value chain will eventually be constrained by some requirement that cannot be digitalised. Let's look back at the elements that Banalieva and Dhanaraj (2019) considered as advantages of digitalisation: the reduction in transaction costs, the user network economies, speed and scalability (Brouthers, Geisser, and Rothlauf, 2016; Kotha, Rindova, and Rothaermel, 2001; Singh and Kundu, 2002), and the alteration of the nature of FSAs and the information costs of transferring FSAs (Strange and Zucchella, 2017). After Hennart (2019) criticises Banalieva and Dhanaraj (2019), we are still left with a few elements of the digital firm FSAs. In particular, we consider that scalability is an ownership advantage that digital firms benefit from, and we then name a second ownership, malleability, the combination to alter the nature of FSAs and the speed.

Dunning and Lundan (2008) and Lundan (2009) identified three types of organisational advantages: asset-based ownership advantages, economies of common governance advantages and institutional advantages. Malleability shows characteristics of an asset-based advantage, one that allows digital firms to constantly update, patch, expand and enhance their product, whereas scalability relates to a transaction-based ownership advantage (previously known as economy of common governance advantage). One of the limits on how much a firm can grow is the necessity to coordinate the inputs from external contractors and other activities residing outside the formal boundary of the firm (Verbeke and Yuan, 2010). We believe that these advantages are the characteristics that the OECD referred to in their BEPS initiative on internet-based businesses and intangibles (Ross and Herrington, 2013), and these ownership advantages we just described sound like the right fit for businesses that often have entire areas of their value creation outside their formal boundary, such as the "user participation in value creation" that the European Commission referred to in 2018 as they proposed their Digital Tax (Gabbai and Ross, 2018).

All digital firms, both producers of tangible and intangible digital objects, produce items that are made of bitstrings or incorporate bitstrings. Their products can unlock new functions and abilities via bitstring manipulation, making them adaptable and easy to modify, leading to that speed in reacting to market trends that the literature has identified. We call this ownership advantage "malleability."

Banalieva and Dhanaraj (2019) describe digital service firms as uniquely capable of scalability. Since their outputs are scalable, these firms can potentially digitise the entire value chain, maximising all aspects of their ownership advantages. Additionally, because their operations are digital, these firms can leverage malleability. Scalability manifests in diverse ways, as discussed by Hennart (2019):

- Firm-Level Scalability: This type of scalability occurs when the fixed costs associated with intangible resources, such as technology, reputation, or knowledge, can be distributed across multiple markets or production sites. Unlike physical assets, intangible resources are not subject to logistical challenges, allowing them to be replicated simultaneously and inexpensively in various locations (Hennart, 2019).
- Plant-Level Scalability: Concentrating production in a single facility enables cost reduction through large-scale output. However, this method is constrained by transportation expenses and trade barriers, which make it difficult to deliver physical goods to distant markets (Hennart, 2019).
- Network Externalities: Network scalability arises when the value of a product or service grows as more people use it, fostering first-mover advantages for firms that successfully capture a critical mass of users. However, there is a geographical limit to these advantages. For example, networks need to be rebuilt in every spot. Uber having a strong network in one location does not provide leverage automatically in another location. Adaptation to local infrastructure, regulations, and norms is often required, hindering what is otherwise a seamless international expansion (Hennart, 2019).

For Adner, Puranam and Zhu (2019), data is the ultimate scalable resource. Once information or processes are digitised, they can be replicated perfectly and at little to no cost.

If digitalisation intersects with connectivity, then scalability increases significantly. An improvement in an algorithm used by an e-retailer can be made available instantly to millions of users. An AI learning from one user's experience can produce insights extensible to the user experience. Aggregation further enhances connectivity, contributing to scalability. For instance, while traditional audio speakers involve sophisticated physical technology, their market remains fragmented due to low entry barriers. In contrast, modern smart speakers like Amazon Echo or Google Home integrate with AI-powered services. By collecting increasing amounts of data and learning from users, these devices continually improve, attracting additional users and increasing market share. This supply-side data network effect can create positive feedback loops and reinforce competitive barriers (Adner, Puranam and Zhu, 2019).

Digitalisation can also diminish transaction costs, allowing for firms to bundle skills across geographies (Banalieva and Dhanaraj, 2019). For example, a strong presence of Uber in a location does not mean it is strong in another geographical area, but the expansion of the firm can be done fast at a worldwide scale. Previously, monolithic services faced scalability challenges as entire systems had to be upgraded for minor changes, but the use of APIs enables modular upgrades, accelerating international scalability, and reducing the reliability on physical infrastructure (Banalieva and Dhanaraj, 2019). Scalability is not fungibility. Fungible resources are those that retain value across different uses, while scalability measures if the value of a resource in its primary use diminishes when extended to others. For instance, a brand worth $100 million in Business A may retain its value while contributing $80 million to Business B. However, if its overall value drops due to brand dilution, it is not truly scalable (Adner, Puranam, and Zhu, 2019). Haskel and Westlake (2018) emphasise that intangible capital scales more effectively than tangible assets. Its productivity declines minimally as it is deployed across broader applications. For example, a brand can be applied to multiple products without losing effectiveness, whereas a machine can only perform one task at a time. Scalability favours intangible investment by increasing the likelihood of extreme success outcomes, which raises expected returns. However, firms differ in their capacity to scale intangible resources and benefit from spillovers. Those with superior capabilities stand to gain more from such investments (Haskel and Westlake, 2018).

There are, of course, limitations, and scalability is an ownership advantage, not a superpower. Network externalities produce durable first-mover advantages if switching costs are high. If the costs are low, such as in digital markets, then firms are vulnerable. For example, it was not hard for users to switch from the Yahoo search engine to the Google one. Competitors can and will copy digital business models: Taobao replicated eBay, and eventually eBay abandoned China. The same happened with Didi Chuxing and Uber (Solomon, 2016).

Amazon has found resilient rivals in the Netherlands (Bol) and France (FNAC) (Hennart, 2019).

Network externalities can provide significant advantages to first movers, but these benefits are only sustainable if switching costs are high, as Lieberman and Montgomery (1988) argue. However, in digitalised businesses, switching costs tend to be relatively low. For example, Yahoo, once the leading search engine, was quickly replaced by Google, and MySpace lost its dominance to Facebook. Similarly, users and drivers can easily move between platforms like Uber and Lyft, or between Uber and its Indian competitor Ola, demonstrating the low barriers to switching in digital markets (Hennart, 2019). The limitations of network externalities mirror those of firm-level scale economies. For instance, a firm's firm-specific advantages (FSAs) may be geographically restricted due to their reliance on home-country-specific business models. Google, which holds over 80% of the global search market, failed to dominate in Korea, where Naver, a locally developed search engine, commands 70% of the market share (Rugman and Verbeke, 1992; Hennart, 2019). There is a distinction between platforms. Communications software such as WhatsApp can function globally with minimal adaptation, while platforms like Uber are subjected to geographical constraints. Again, Uber’s strong presence in Boston does not translate to an advantage in Bombay because its network of drivers and customers is location specific. Entering a new market like Bombay requires rebuilding the network from the ground up. In such cases, Uber can be at a disadvantage compared to local competitors, especially when its software can be easily imitated, and its business model requires significant adaptation to local conditions (Hennart, 2019).

Within the IT discipline, which is relevant to our study since these ownership advantages are linked to the digital object, scalability is a concept that reflects the ability of a system to operate efficiently and with an adequate range of services, over several configurations (Jogalekar and Woodside, 2000). Scalable systems need to be capable of accommodating growing elements, objects, processes while remaining functional and susceptible to enlargement (Bondi, 2000). Moreover, this ability of the firm to handle increasing levels of workload needs to remain cost-effective (Weinstock and Goodenough, 2006). The opposite would be an unscalable system, those that can withstand increased levels of use but at the expense of increasing operation costs or cannot withstand increasing levels at all.

Scalability can be local scalability (the system can work gracefully at any level of use), space scalability (the system can handle increasing levels of use while costs remain tolerable) space-time scalability (like the previous, but the levels of use increase by orders of magnitude) and structural scalability (the system can be upgraded to allow for greater processing of items) (Bondi, 2000). Scalability can be applied to the tangible and intangible digital object, and to the human beings that work within the system and the human users (Weinstock and Goodenough, 2006).

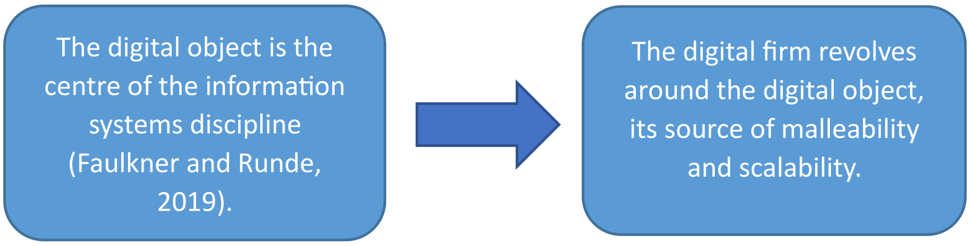

Figure 2.4: From the digital object to the digital firm

2.6. Which firms are digital?

This section looks at the application of the digital object criterion to identify firms that are digital from those that are not. We utilise NACE Rev.2 from 2008. There are inconveniences to that classification, perhaps the worst being that its code 58 doesn't distinguish publishing of printed books from e-books. We acknowledge this as a limitation. This list is made for 2024, and as such is dynamic, should more parts of the economy become dematerialised, or new products appear. However, the rule on itself is scalable, allowing itself to fit these new realities in further categorisations.

2.6.1. Digital manufacturers

Digital manufacturers are those firms that produce the tangible digital goods required to access the digital world, connect with other users, or that serve as bearers for intangible digital objects:

Table 2.4: Digital manufacturers

Category	**Subcategory**	**NACE**
Digital manufacturer	Manufacture of electronic components	2611
	Manufacture of loaded electronic boards	2612
	Manufacture of computers and peripheral equipment	2620
	Manufacture of communication equipment	2630

	Manufacture of consumer electronics	2640
	Manufacture of magnetic and optical media	2680

Having moved away from magnetic storage in the 1990s, the categories of magnetic and optical media, as well as optical instruments and photographic equipment are pretty much obsolete, but it is safe to assume that surviving firms utilising these codes in the 2020s are now operating with the digital technology that succeeded these obsolete formats.

2.6.2. Digital service firms

Digital service firms are more varied than manufacturers. Distinguishing between services and goods is hard when it comes to dematerialised goods and their interaction with the VAT system (Cannas, 2015). For example, the EU VAT Directive (2006/112) establishes in its Article 98.2(2) that States cannot apply reduced VAT rates to electronically supplied services, which is a form of ring-fencing around the digital economy and causes issues when goods and services are interchangeable between digital and non-digital (such as printed books and e-books) (Westberg, 2014). Knowing this, the following activities meet the requirement of being focused on the production of intangible digital objects or the retail of digital objects.

Table 2.5: E-commerce

Category	Subcategory	NACE
E-commerce	Retail sale via mail order houses or via Internet	4791

E-commerce fulfils the requirement of being an activity performed via the Internet and was the original focus of the BEPS initiative (OECD, 2013).

Table 2.6: Digital retailers and wholesalers

Category	Subcategory	NACE
Sale of tangible digital objects	Wholesale of computers, computer peripheral equipment and software	4651
	Wholesale of electronic and telecommunications equipment and parts	4652

	Retail sale of computers, peripheral units and software in specialised stores	4741
	Retail sale of telecommunications equipment in specialised stores	4742
	Retail sale of audio and video equipment in specialised stores	4743
	Retail sale of music and video recordings in specialised stores	4763

All these objects are digital objects. It must be stated that some companies choose to use this code even though they do not come to mind as retailers in first place.

Table 2.7: ICT companies

Category	**Subcategory**	**NACE**
ICT	Other software publishing	5829
	Computer programming activities	6201
	Computer consultancy activities	6202
	Computer facilities management activities	6203
	Other information technology and computer service activities	6209
	Repair of computers and peripheral equipment	9511
	Repair of communication equipment	9512

ICT is considered a part of the digital economy in some definitions, the most important being UNCTAD (2017). These are all services delivered to tangible digital objects.

Table 2.8: Telecommunications

Category	**Subcategory**	**NACE**
Telecommunications	Wired telecommunications activities	6110
	Wireless telecommunications activities	6120
	Satellite telecommunications activities	6130
	Other telecommunications activities	6190
	Radio broadcasting	6010
	Television programming and broadcasting	6020

	activities	

The following activities keep the entire network that is the digital economy tied together. In the case of radio and television broadcasting, although these activities have existed for nearly a century, the degree of digitalisation in these has increased since 2006 as television broadcasting switched from analogue to digital terrestrial television (ITU, 2008).

Table 2.9: Information

Category	Subcategory	NACE
Information	Data processing, hosting and related activities	6311
	Web portals	6312
	News agency activities	6391
	Other information service activities n.e.c.	6399

The following categories deal with intangible digital objects related to information and data. The activity of news agencies has been included as digital since the sector, today, deals mostly with digital files (audio, video and written).

Table 2.10: Audio-visual industry

Category	Subcategory	NACE
Audio-visual industry	Publishing of computer games	5821
	Motion picture, video and television programme production activities	5911
	Motion picture, video and television programme post-production activities	5912
	Motion picture, video and television programme distribution activities	5913
	Motion picture projection activities	5914
	Sound recording and music publishing activities	5920
	Leasing of intellectual property and similar products, except copyrighted works	7740

These activities refer to dematerialised pieces of work and art that exist in our times as digital files, a type of intangible digital object.

Table 2.11: Other dematerialised objects

Category	Subcategory	NACE
Other dematerialised objects	Advertising and market research	7311
	Travel agency activities	7911
	Tour operator activities	7912
	Other reservation service and related activities	7990
	Activities of call centres	8220
	Gambling and betting activities	9200
	Other monetary intermediation	6419
	Financial leasing	6491
	Other credit granting	6492
	Other financial service activities, except insurance and pension funding n.e.c.	6499

The following activities refer to sectors that have been heavily impacted by digitalisation and now mostly deliver dematerialised objects. For example, the banking industry digitalised relatively early; Laudon and Laudon (1988) already observed that banks had switched large parts of their operations to computers back in 1983.

An example of this classification being applied to existing businesses could be:

Table 2.12: Examples of digital and non-digital firms

Category	Example Firms	Inputs	Outputs/Products
Digital Manufacturing	Samsung	Raw materials (e.g., silicon, metals), R&D, software designs	Memory chips, semiconductors, lithography equipment
	ASML		
Digital Service	Netflix	Digital content, software development, cloud infrastructure	Streaming platforms, enterprise software
	SAP		
Non-Digital Manufacturing	Toyota	Raw materials, mechanical components	Cars, food products
	Nestlé		
Non-Digital Services	DHL	Logistics infrastructure, consultancy tools, human labour	Parcel delivery, legal and accounting advice
	PwC		

2.7. The impact of digitalisation

2.7.1 Productivity

At a firm level, the 1970s saw the service sector become the main engine of the economy, and the professional and technical class became the predominant type of employee, at the expense of the industrial sector and the semi-skilled employee (Bell, 1999, p.14). Previous organisational methods were perceived as wasteful, and unaffordable after the 1973 and 1979 OPEC oil embargoes (Smil, 2017, p. 320). A new organisational culture, based on flexible ways of production, parts delivery, employee multitasking, continuous product improvement and quality control spawned between the 1970s and 1990s. Known as “Toyotism” it combined technological advancements with total quality management, six-sigma principles, lean manufacturing and steel mini-mills (Fujimoto, 1999, p.16). At the country level, GDP and measures of productivity were not reflecting the impact of those changes. Early expectations of computerisation triggering "the biggest technological revolution men have known" (Snow, 1966) did not happen. Loss of productivity became a major source of concern. Productivity laggard countries have their competitive advantage swapped to that of a purveyor of cheap labour and cannot specialise in the same industries as before (Baumol, Blackman and Wolff, 1989, p.22). The United States in the 1970s felt they were lagging behind in the manufacturing revolution, a view summarised in the expression “you can see the computer age everywhere but in the productivity statistics” (Solow, 1987).

The first issue was hardware improvements during the 1970s and 1980s were not immediately followed by software improvements. Without this complementary good, firms struggled to maximise return on IT investment (Wirth, 2008). Then there was the issue that GDP might not be the best unit to measure productivity in the digital era. Traditional services (such as telephone calls and the music industry) have been replaced by digital services which generate value without leaving a trace on the GDP. Dematerialised digital goods can be copied at zero cost. Intangible assets that lack legal protection (such as customer data or research) are never formalised as intellectual property and are missing from GDP calculations (Brynjolfsson and McAfee, 2014). But flaws in GDP measuring cannot explain the entire productivity gap. While the productivity gap was first recorded in the 1970s, dematerialisation did not spread until computers were combined with the Internet during the 1990s (Gordon, 2014). Also, the GDP has always been understated. Past calculations do not include the impact of the combustion engine, the upgrade from gas to electric streetlights, tramways, air conditioning, the use of PCs for office work, e-commerce, e-books, ATMs and barcode use in warehouses and supermarkets. Yet, the increase in GDP between 1920 and 1970 was larger than the one during the digital era (Gordon, 2014, p. 54).

Two interpretations are possible. One could argue that the ICT revolution did take place and did impact the economy even in the absence of an ICT productivity bonus (Lipsey, Carlaw and Bekar, 2005, p.118). Or it could be that digitalisation had an impact on the economy, but the signs lie somewhere else. For example, digitalisation of inventory management, better control of firm operations and overall better management of firms during normal times and crisis made US output volatility decline between 1950 to 2000 and stabilised economic activity from the 1980s (Blanchard and Simon, 2001). Encouraged by the possibilities of the Internet and the need to avoid the Y2K bug, company investment in information technologies increased during the latter 1990s. Advances in miniaturisation and semiconductors made computer power and investments in IT more efficient. Companies that embraced IT intensively became more productive (Brynjolfsson and McAfee, 2014).

2.7.2 The Value Chain of the digital firm

Investing in ICT is not enough. Productivity only increases if accompanied by effective organisational changes, especially those that increase employee participation, autonomy at work and decentralisation of responsibilities. This can be achieved through forms of employment based on networking, collaborative platforms and the development of virtual work (Valenduc and Vendramin, 2017). Internalisation theory explains how a firm's boundaries expand across national borders. In a world of imperfect external markets, firms will try to maximise profits by creating internal markets for intermediate products owned or controlled by the firm. The MNE is the result of this process (Buckley and Casson, 1976). Internalisation theory deals with the precise configuration of the internal architecture of the firm and its governance structure (Buckley and Strange, 2011).

The changes we describe are rooted in a series of technological, economic, and social trends that started in the 1980s (Valenduc and Vendramin, 2017). Driven by 3D printing, additive manufacturing, artificial intelligence, big data analytics, cloud storage, machine learning, mobile devices and social media (Banalieva and Dhanaraj, 2019), digitalisation has posed a challenge to previous assumptions of the IB discipline and requires a re-examination of previous assumptions (Eden, 2016). IT reduces transaction costs, generates user network economies and increases speed and scalability, which has an impact on firm internationalisation (Kotha, Rindova and Rothaermel, 2001; Singh and Kundu, 2002; Brouthers, Geisser and Rothlauf, 2016). Digitalisation affects the nature of firm specific advantages (FSAs) (Strange and Zucchella, 2017). These reductions of transaction costs, network economies, speed and scalability are firm specific advantages (FSAs) and depend on a set of complex and tacit knowledge that is embedded within the MNE's competitive advantage (Banalieva and Dhanaraj, 2019). These FSAs can take the form of intangible assets, learning capabilities or privileged relationships with outside actors (Rugman and Verbeke, 2003). Digitalisation allows firms to internationalise FSAs in a modular manner (Banalieva and Dhanaraj, 2019). Modularity here refers to the ease at which a firm's FSA can be bundled. Bundling means that the FSAs are integrated with the assets of other firms, creating a new type of competitive advantage that enhances competitiveness for firms that have undergone digitalisation (Collinson and Narula, 2014; Pitelis and Teece, 2018). A way for firms to achieve modular FSAs is by using application programming interfaces (APIs). APIs have flexible designs that can be adapted to service ends (Gawer, 2009). An API is a set of routines, protocols and tools that allows building software applications. The API specifies how software products interact (Gopal, Ramesh and Whinston, 2003) and serves as the foundation for other platforms. It also allows for generating new capabilities without having to code from scratch (Banalieva and Dhanaraj, 2019). The corporate focus on API use started in 2002, when Jeff Bezos of Amazon ordered his employees to define and use service interfaces for technologies and communication between teams. Services such as Amazon Marketplace Webservice and Amazon Web Services are based on their API, as well as many of the technologies that Amazon's partners use when interacting with Amazon's marketplace and Cloud (Beaulieu, Dascalu and Hand, 2022).

To sum up, technological innovations alone do not increase productivity gains. Companies won't benefit from the increase in productivity unless the work organisation is modified while new technology is acquired (Askenazy and Gianella, 2000). Traditional internalisation theory argues that hierarchy is the most effective governance choice to protect technology FSAs (Narula, 2001) but, for digital service MNEs, the digital network is a more efficient structure than relying on hierarchy when deploying technology FSAs because the digital network provides a network advantage for the firm (Teece, 2018).

2.8. Implications and contributions

Our research on this topic shows that many of the previous definitions provided for the digital economy were insufficient for the task that the BEPS initiative had set itself to accomplish, are obsolete, contradictory or were simply made ad hoc. In contrast, by defining the digital economy as the sector where the digital firms operate, and in turn identifying the digital firm with the production and sale of digital objects, we have provided a definition adaptable for future innovations and that can be implemented with industry classification codes. That should enable future researchers to perform quantitative research, providing a valuable tool for researchers and for policymakers. We have identified and described two ownership advantages that digital firms possess owing to their final product being a digital object, extending the use of IB frameworks and paradigms to tackle the issue of describing the digital economy. One of these advantages, malleability, is shared by all digital firms, and allows firms to expand, enhance and unlock new features for their products, even after delivering the product. The other advantage, scalability, belongs to firms producing intangible digital objects, and allows firms to grow, increase sales and generate value outside the formal boundaries of the firm. We have provided an implementation of our definition within NACE Rev.2 (2008). Then, we have critically analysed the existent literature on digital firms and the digital economy, identified five common themes across the literature: the use of computers and the computer as a GPT, the use of networks, engaging in e-commerce, the use of information and data and the reliance on intangibles. We have described these elements, their history and implications for the economy and management disciplines and finished by analysing the literature on the consequences of digitalisation in terms of IB scholarship and the implications of digitalisation in terms of productivity of firms and GDP.

2.9. Limitations

Despite Chapter 2 making substantial contributions to the literature on digital firms, there are a few limitations to highlight in this research. The first one, as highlighted by UNCTAD (2017) is the potential obsolescence of the industry classification codes in the firm databases. Our reliance on NACE codes to classify digital firms provides a practical means for large-scale classification. However, these codes are inherently static and may not fully capture the dynamic nature of digital transformation. For instance, legacy classifications may fail to account for hybrid or emerging business models that blur the lines between digital and traditional firms. The second limitation we acknowledge is that a firm might be performing several activities, some of which are digital and some of which are not, yet the firm might only have one primary code, and secondary codes might be absent from the classification. This is an issue that arises in absence of plant-level data as opposed to firm-level data. The final limitation arises from industrial classifications utilising obsolete codes (is the manufacture of magnetic storage digital or not?) or lumping together traditional and dematerialised objects (such as NACE Revision 2 (2008) code 58) or lumping together e-books and printed books.

2.10. Conclusions and avenues for future research

2.10.1. So, what is a digital firm?

This chapter pushes the concept of the digital firm as an enterprise that primarily produces or sells digital objects – products or services fundamentally constituted by bitstrings. Digital objects, whether intangible (software, algorithms, media) or tangible (computers, smartphones) rely on bitstrings as their defining component. Because of the bitstrings, digital objects inherently possess ownership advantages of scalability – the ability to replicate and deploy their products globally with little to no incremental cost; and malleability – the ability to adapt, update and innovate their offerings dynamically as the market demands. To put it in a concise manner:

1. A digital firm produces digital objects. Its primary economic activity involves the production, distribution, or sale of digital objects. This involves creating software, managing digital platforms, operating digital marketplaces, or manufacturing the devices required to access or interact with intangible digital objects.
2. Because digital objects are made of bitstrings, digital firms possess scalability (low marginal cost of replication) and malleability as their ownership advantages (ease of modification and enhancement).
3. Value chain integrated. Digital firms can integrate their value chains into a fully digital workflow, allowing them to operate seamlessly across the globe, lacking many of the physical constraints that non-digital firms suffer.
4. Use digital infrastructure. Digital firms leverage the power of digital systems, information, and sometimes networks, which are the foundation of their operations.

At the same time, a digital firm is not:

1. A user of digital tools. Merely using digital tools (IT, digital marketing) to enhance traditional operations without producing digital objects does not imply being a digital firm. The use of GPS to track a fleet of vehicles in a logistics firm does not make it a digital firm.
2. A firm that uses significant uses of digital technology in its processes but does not have a digital object as the final output. Car manufacturers, despite their use of electronics, AI, and robotics, are not digital firms.

3. A firm that does not have the production or distribution of digital objects as their core economic activity, such as firms undergoing digital transformation (going from brick and mortar to online retail, but still grounded in traditional operations).
4. A firm that does not depend on the digital object. If their product or service does not require or inherently depends on bitstrings to function, then it is not digital.

2.10.2. Theoretical Implications

The contributions of Chapter 2, and this thesis in general, enrich the conceptualisation of FSAs and ownership advantages, by explaining how digitalisation affects the way digital firms leverage resources to compete. We also bridge the gaps in existing definitions of digital firms. We have balanced them, highlighted their inconsistencies, extracted the common denominators, and then anchored the concept of digital firms to the production and manipulation of digital objects. This provides a theoretical framework that resolves prior ambiguities and extends the application of internalisation theory to the digital economy.

By incorporating the unique characteristics of digital firms, and scalability and malleability as ownership advantages, this Chapter advances the theoretical framework of internalisation theory. The ownership advantages we have identified align with the firm's ability to manage and exploit intangible digital assets. Scalability, defined as the potential to replicate and expand intangible resources with minimal cost, enables digital firms to transcend traditional limitations in physical infrastructure. Malleability, on the other hand, reflects the capacity of digital objects to be adapted, enhanced, and modified, providing firms with a dynamic advantage in responding to evolving market needs.

2.10.3. Managerial Implications

The findings of this chapter are critically important for managers. Managers must leverage the ownership advantages inherent to digital firms. Their scalability allows firms to expand rapidly across markets without significant investments in physical production facilities. Managers of these firms must prioritise the development of intangible resources that can be scaled globally with minimal friction, or at least regionally, such as algorithms, proprietary data, and platform ecosystems. Malleability of digital objects allows digital firms to stay competitive by quickly adapting to market demands. Software can be update, algorithms can be improved, and personalised user experience can be deployed seamlessly across customer bases, allowing for increased customer satisfaction and retention. Malleability possesses strategic value as it can foster innovation and agility in environments that are becoming increasingly volatile and competitive. At the same time, managers must remember that they do not have a monopoly on malleability or scalability. Scalability and malleability have potential drawbacks. competitors also possess these advantages, leading to vulnerability in imitation, low switching costs for consumers and rapid shifts in consumer preferences.

2.10.4. Policy Implications

We have provided a number of insights that have significant implications for policymakers aiming to regulate the digital economy. A critical issue with the current regulatory landscape is the inability to separate digital and non-digital firms. The proposed criterion, based on digital objects, offers a concrete method for identifying digital firms using NACE codes. Because this framework is compatible with existing taxonomies, policymakers can make more effectively target regulations, such as the ones addressing the Base Erosion and Profit Shifting initiative. The identification of scalability and malleability highlight the need for nuanced policy approaches that consider the unique operational dynamics of these firms. The goal of ensuring fair competition and equitable taxation needs to be balanced with promoting innovation. An example could be recognising the geographic limitations of scalability in certain sectors, informing region-specific regulatory strategies. Another example could be encouraging the responsible use of scalability while addressing challenges like market concentration and monopolistic tendencies.

2.10.5. Contributions

Chapter 2 makes several contributions to the academic discourse on the digital economy and international business. First, we provide a clear and operational definition of digital firms, address the inconsistencies and circularity found in prior definitions. Second, we identify scalability and malleability as essential ownership advantages, and link their use with enhancing firm competitiveness and adaptability in international markets. These findings extend the theoretical boundaries of internalisation theory and their applicability to digital firms. Third, Chapter 2 offers a practical framework for classifying digital firms using NACE codes, which bridges the gap between theoretical concepts and empirical research. This framework, adaptable to the needs of researchers and practitioners, offers a robust tool for identifying digital firms across industries and facilitates large-scale quantitative analyses. Finally, we contribute to policy discussions by offering actionable insights for addressing regulatory challenges in the digital economy. Third, this chapter offers a practical framework for classifying digital firms using NACE codes, bridging the gap between theoretical concepts and empirical research. This scalable and adaptable framework provides researchers and practitioners with a robust tool for identifying digital firms across industries, facilitating large-scale quantitative analyses. Lastly, it contributes to policy discussions by offering actionable insights for addressing regulatory challenges in the digital economy.

2.10.6. Avenues for Future Research

Many possibilities open from this point onwards. We believe that our contribution, the path to close Pillar One of the BEPS initiatives (the one related to the digital economy) has been opened. If so, then the BEPS initiative could be finally closed and fulfilled. Our contribution opens an avenue for quantitative research, using large datasets of firms, while being able to discriminate across firm databases as to which firms are digital and which are not is a requirement to measure the extent of the problem identified by the OECD in 2012.

Our findings presented here open several promising avenues for future research. One area of interest is the long-term impact of malleability on innovation cycles, particularly in industries characterised by rapid technological advancements. How do firms balance the need for continuous updates with the risks of overextending resources or diluting brand identity? Similarly, further exploration is needed to understand the geographic and sectoral limitations of scalability, particularly in regions or industries where digital infrastructure is less developed. Additionally, future research could investigate the interplay between ownership advantages and network effects, examining how firms can mitigate the risks associated with low switching costs and imitation. Panel data research could also shed light on how digital ownership advantages evolve over time and influence firm survival, market dominance, and competitive resilience. Lastly, expanding the framework to include hybrid firms—those transitioning from traditional to digital operations—would provide valuable insights into the dynamics of digital transformation.

With respect to this doctoral thesis, Chapters 4 and 5 in this doctoral thesis contain two contributions to the field of IB research utilising the digital firm definition proposed in this research. Chapter 4 analyses whether digital firms, thanks to the scalability and malleability enabled by their products, display higher total factor productivity than non-digital firms, both in the manufacturing and the industry sectors. Chapter 5 considers the implications of being oriented to the production and sale of digital objects when it comes to the risk of a firm having a presence in a tax haven, a useful tool for engaging in profit shifting and tax planning.

CHAPTER 3. DATA

This chapter provides an overview of the datasets used in Chapters 4 and 5 on empirical data. This thesis has been prepared with secondary data using the firm-level dataset from ORBIS, published by Bureau van Dijk. We provide an explanation on the variables of interest (digital firms vs non-digital firms), as well as the dependent variables of Chapter 4 (the total factor productivity variables) and the dependent variables on tax havens from Chapter 5 (the tax haven dummies). The are explained in the relevant sections. Finally, we provide an explanation on how the datasets were cleaned and prepared before running the regressions.

3.1. Data sources: ORBIS

The ORBIS database is a collection of firm-level variables from multiple countries, collated from national-base administrative data sources. The provider is Bureau van Dijk (BvD), a company that belongs to Moody's Analytics group. ORBIS is the largest cross-country firm-level database and combines both a firm's financial statements with data in terms of sales, employment, and investment. The database provides data on both public and private firms, their location, industry and crucially, subsidiaries. That means it provides a glimpse of the inner workings of MNEs and large business groups without the blurriness of consolidated financial statements (Kalemli-Ozcan et al., 2022). There are issues with using the ORBIS data: ORBIS tends to offer better cover of larger firms over smaller firms, the firms covered might not be representative, manufacturing is better covered than services (Bajgar et al., 2020), but even despite these flaws, the coverages has improved over time, and the data still has sufficient coverage and representativeness. With 200 million firms encompassed and the fact that it provides industry sector data at the 4-digit level, ORBIS is ideal for our endeavour (Bajgar et al., 2020).

The two empirical chapters in this thesis use subsets of the ORBIS dataset. Both datasets are similar and include data from 36 nations within the OECD, under the understanding that these nations have a direct stake in the BEPS initiative. The dataset from Chapter 4 on productivity is slightly smaller in number than that from Chapter 5: it does not include firms that are only one year old, in the understanding that productivity depends on a managerial function, and that cannot take place unless the manager reviews past performance and adjusts accordingly. Chapter 5 on tax havens uses a conventional definition of MNE as suggested by UNCTAD (2013), of owning at least 10% of the capital. That is how subsidiaries in tax havens are spotted: a controlling stake of at least 10% combined with a different jurisdiction identified as a tax haven and under the same parent firm code.

3.2. Determining which firms are digital

Our digital firm variable has been implemented using the criterion highlighted in Chapter 2: if a firm produces or retails a digital object (tangible or intangible) then this firm is a digital firm. The retail part may sound a stretch, but sometimes firms that produce computer parts opt to be registered under that industrial code (for example, NVIDIA, which produces graphics cards for computers and has now ventured into AI is classified as a retailer). The list of codes, using Revision 2 of NACE (2008) down to 4-digits is as follows:

Table 3.1: Firm classification under NACE Rev.2 (2008)

Digital manufacturers NACE codes 26, except 26.5, 26.6 and 26.7
Manufacture of electronic components and boards, computers and peripheral equipment, communication equipment, consumer electronics, equipment and magnetic and optical media.
Non-digital manufacturers NACE codes 10 to 35, and 26.5 and 2.6
Manufacture of food products, beverages, tobacco products, textiles, wearing apparel, leather and related products, products of wood and cork, articles of straw and plaiting materials, paper and paper products, printing and reproduction of recorded media, coke and refined petroleum products, chemicals and chemical products, basic pharmaceutical products and pharmaceutical preparations, rubber and plastic products, other non-metallic mineral products, basic metals, fabricated metal products, electrical equipment, machinery and equipment, motor vehicles, trailers and semi-trailers, other transport equipment, furniture, other manufacturing, repair and installation of machinery and equipment, manufacture of instruments and appliances for measuring, testing and navigation, watches and clocks and irradiation, electromedical and electrotherapeutic equipment, manufacture of optical instruments and photographic equipment, electricity, gas, steam and air conditioning supply.
Digital service firms NACE codes 46.5, 47.4, 47.63, 47.91, 58.2, 59.1, 59.2, 60.1, 60.2, 61, 62, 63, 71, 73, 77.4, 79, 82.2, 92, 95.1
Wholesale of information and communication equipment, retail sale of information and communication equipment in specialised stores, retail sale of music and video recordings in specialised stores, retail sale via mail order houses or via Internet, software publishing, motion picture, video and television programme activities, sound recording and music publishing activities, radio broadcasting, television programming and broadcasting activities, telecommunications, computer programming, consultancy and related activities, information service activities, advertising and market research, leasing of intellectual property and similar products (except copyrighted works), travel agency, tour operator and other reservation service and related activities, activities of call centres, gambling and betting activities, repair of computers and communication equipment.
Non-digital service firms NACE codes 45, 46 (except 46.5), 47 (except 47.4, 47.63 and 47.91), 49, 50, 51, 52, 53, 55, 56, 58.1, 68, 69, 70, 71, 72, 74, 75, 77, 78, 80, 81, 82 (except 82.2), 90, 91, 93, 94, 95 (except 95.1), 96
Wholesale and retail trade and repair of motor vehicles and motorcycles, wholesale trade (except information and communication equipment), retail trade, land transport and transport via pipelines, water transport, air transport, warehousing and support activities for transportation, postal and courier activities, accommodation, food and beverage service activities, publishing of books, periodicals and other publishing activities, real estate activities, legal and accounting activities, activities of head offices, management consultancy activities, architectural and engineering activities, technical testing and analysis, scientific research and development, other

professional, scientific and technical activities, veterinary activities, rental and leasing activities, employment activities, security and investigation activities, services to buildings and landscape activities, office administrative, office support, organisation of conventions and trade shows, business support activities, creative, arts and entertainment activities, libraries, archives, museums and other cultural activities, botanical and zoological gardens and nature reserves activities, sports activities and amusement and recreation activities, activities of membership organisations, repair of personal and household goods, other personal service activities.

Note: agriculture, mining, public sector, and the financial sector have been excluded from this classification.

A reference to what we called "false codes" in this section is in place: an inspection on the data will sometimes reveal codes that do not exist in the official classification; for example, the database might show a NACE 4-digit code referencing industry code 60.00, which does not officially exist. These are most likely administrative mistakes, when whoever had to register the company chose to input a correct 2-digit code and then, instead of searching for the right 4-digit code, simply added two zeroes behind the 2-digits. We have treated these rare cases as follows: if the entirety of the 2-digit codes belong to a single category, then the "false code" is assigned to that category as well.

3.3. Measuring total factor productivity

Chapter 4 measures firm productivity and compares the performance of digital and non-digital firms. Firm TFP can be estimated with many methods. All methods have been diagnosed with issues and rely on assumptions. Firm heterogeneity and data availability make it necessary for researchers to pick the right method or methods and provide the right motivation. The first issue is, TFP is an obscure concept. It implies that there are unobserved parts in production which cannot be explained by inputs, which poses a high risk of misspecification (Bournakis and Mallick, 2018). TFP calculation methods can be divided between non-parametric, parametric, and semi-parametric (Bournakis and Mallick, 2018). Non-parametric estimations often come in the form of index number approach and Törnqvist index approach. Index number approach estimation is convenient as it can accommodate many production functions and avoids econometric bias when estimating production input parameters. However, these approaches require strong assumptions such as perfect competition for product and input markets (Bournakis and Mallick, 2018). Solow (1957) used a version of this approach in his seminal article. Caves, Christensen and Diewert (1982) use an approach based on the Törnqvist index, which allows for translog production. However, the estimations of labour will be biased if the firm does not operate in perfect competition (Bournakis and Mallick, 2018).

Semi-parametric techniques can address simultaneity bias between unobserved productivity and selection of inputs with their two-stage estimation. The first model was formulated by Olley and Pakes (1996) (OP) and other methods are built upon the work of Olley and Pakes. OP has a two-stage implementation, first with an OLS that estimates the labour and capital coefficients, and then a regression to calculate the state input. The model uses a Cobb-Douglas equation and addresses the simultaneity bias of the OLS estimation by assuming that labour is perfectly flexible. Olley-Pakes also considers whether a firm will enter or leave the industry, depending on their productivity levels. A basic iteration of this model, without the investment measure that OP propose looks like:

$$\gamma_{it} = \alpha_0 + \alpha_k k_{it} + \alpha_l l_{it} + \omega_{it} + \varepsilon_{it}$$

In this mode, γ_{it} represents a measure of performance, $\alpha_k k_{it}$ represents capital, $\alpha_l l_{it}$ represents labour. Technical efficiency is represented by the parameters α_0, the mean efficiency across all firms, ε_{it}, the random noise that represents measuring error and ω_{it}, the unobserved factors that affect the output of firm i (Olley and Pakes, 1996). If ω_{it} is not included, then the model will have issues with simultaneity (Petrin, Poi and Levinsohn, 2004).

However, OP has two issues: monotonicity and the reliance on increasing levels of investment on the error term that represents the unobserved productivity (Bournakis and Mallick, 2018). This, investment data tends to be missing for the researcher. Or, given that constant yearly investments are required for computation, many firms might just not qualify for the research project (Bournakis and Mallick, 2018). Levinsohn and Petrin (2003) proposed a new estimation method (LP) that addresses the OP limitation by using intermediate inputs in the place of the investments.

$$\gamma_{it} = \alpha_0 + \alpha_k k_{it} + \alpha_l l_{it} + \alpha_m m_{it} + \omega_{it} + \varepsilon_{it}$$

Where $\alpha_m m_{it}$ represents an intermediate good, commonly called "materials." Assuming monotonicity in ω_{it} for every k_{it}, the demand function for intermediate inputs is then:

$$m_{it} = m\,(k_{it}, \omega_{it})$$

Investment is then replaced by the intermediate input $\varphi(k_{it}, m_{it})$, with $\varphi = \alpha_0 + \alpha_k k_{it} + \alpha_l l_{it} + m^{-1}(k_{it}, \omega_{it})$, with m^{-1} being the inverse of the intermediate inputs function. And the first equation becomes:

$$\gamma_{it} = \alpha_l l_{it} + \alpha_m m_{it} + \varphi(k_{it}, m_{it}) + \varepsilon_{it}$$

The second stage of the LP estimation uses the following specification:

$$\gamma_{it} - \hat{\alpha}_l l_{it} = \alpha_k k_{it} + \alpha_m m_{it} + f\left(\widehat{\Phi}_{it-1}(k_{it-1}, m_{it-1}) - \alpha_0 - \alpha_k k_{it-1} - \alpha_m m_{it-1} \right) + \theta_{it} + \varepsilon_{it}$$

This second stage is implemented with a generalised method of moments (GMM) framework that satisfies the moment conditions $E[k_{it}\theta_{it}] = 0$ and $E[m_{it-1}\theta_{it}] = 0$ (Bournakis and Mallick, 2018).

Parametric estimations of TFP start with a parametric log-linear form of the production function. These contain estimates for labour, capital and two error terms. One of these error terms is an unobserved factor that affects output, the other represents measurement error. TFP can then be determined using the ordinary least squares (OLS) method (Bournakis and Mallick, 2018). The problem for the econometrician then is what Eberhardt and Helmers (2010) called "transmission bias", which undermeasures the unobserved factors and exaggerates the importance of the labour coefficient. Because input choices are likely to be linked to productivity, estimating OLS on a firm-level production function can cause a simultaneity or endogeneity problem, and if firms are not allowed to enter or exit the market, then the model will suffer from selection bias (Van Beveren, 2012). To deal with this issue, endogenous variables can be instrumentalised with the generalised method of moments framework (GMM). GMM provides easy to use robust standard errors and uses the cross-equation correlation to enhance efficiency, and the optimal weighting matrix efficiently accounts for serial correlation and heteroskedasticity (Wooldridge, 2009).

The method used by Wooldridge (2009) starts from the Olley Pakes (1996) and Levinsohn and Petrin (2003) semi-parametric methods that are described above. Instead of the bootstrapping methods proposed by OP and LP, GMM is used in one stage instead of two (Wooldridge, 2009). This method is more efficient and avoids potential correlation errors between steps one and two which can produce robust standard errors instead of bootstrapped standard errors, but this gain in accuracy comes at a cost of computational intensity (Bournakis and Mallick, 2018). To deal with selection bias, *k* and *l* are instrumentalised using GMM and lagged to satisfy the requirement of correlation with endogenous regressors and being uncorrelated with the error term (Wooldridge, 2009; Bournakis and Mallick, 2018).

This article uses three estimations of TFP. One is calculated with the Wooldridge (2009) method, using Rovigatti and Mollisi (2018). The other two estimations use different variations of Levinsohn and Petrin (2003). We do not use the original Levinsohn and Petrin implementation with third-order polynomials to calculate k_t and m_t and then omega (ω) standard errors as established by Petrin, Poi and Levinsohn (2004). Instead, we use Mollisi and Rovigatti's (2018) preparation for the Levinsohn and Petrin estimator, which uses GMM in the first estimation stage instead of bootstrapping polynomials. We use two estimations of

TFP with the Mollisi and Rovigatti preparation, one that uses omega standard errors and another with residual standard errors from the log production function. We have found that this approach is significantly less taxing on computer resources.

Table 3.2: Comparison between TFP estimated with LP (2003) and Wooldridge (2009)

Criterion	Levinsohn and Petrin (2003)	Wooldridge (2009)
Rationale	Uses intermediate inputs (materials) as a proxy for productivity shocks.	One-step GMM approach that estimates production function in a single stage.
Advantages	- Addresses simultaneity bias by using intermediate inputs as proxies. - Reduces issues from missing or zero investment values (common in OP methodology). - Flexibly adjusts to datasets with significant heterogeneity in investment data.	- Simultaneously estimates all parameters, avoiding errors in multi-stage methods. - Provides robust standard errors. - Avoids potential biases caused by separate estimation stages in semi-parametric approaches.
Disadvantages	- Requires monotonicity between intermediate inputs and productivity, which may not hold in all datasets. - Sensitive to errors in intermediate input data. - Does not allow for dynamic input choices (e.g., labour).	- Computationally intensive due to the complexity of the GMM framework. - Performance depends heavily on instrument validity and proper identification.
Handling Labour Inputs	Assumes labour is perfectly flexible and not dynamic.	Allows for dynamic labour input choices, making it suitable for datasets where labour depends on past productivity shocks.
Simultaneity Bias	Addresses bias using materials as a proxy for productivity shocks.	Addresses bias using lagged variables and GMM instruments for endogenous regressors.
Error Handling	Relies on bootstrapped standard errors, which may be less robust.	Produces robust standard errors within the one-step framework.
Data Requirements	Requires intermediate input data (e.g., materials or energy).	Requires comprehensive panel data with valid instruments for inputs.
Applicability	Suitable for datasets with missing investment values or where intermediate inputs are reliable.	Suitable for datasets where dynamic input choices (e.g., labour) need to be considered and computational resources are sufficient.
Computational Efficiency	Faster due to fewer computations (multi-stage estimation).	Slower but more precise due to single-stage estimation.
Empirical Validation	Often produces biased labour coefficients due to simplistic labour assumptions.	Provides consistent and theoretically sound estimates under complex settings.

Our interest is in the results calculated with the omegas of the Levinsohn and Petrin (2003) and the Wooldridge (2009) methods as the dependent variable. However, to control for endogeneity, results are also calculated using the residuals methods for the Levinsohn and Petrin (2003) estimation.

Table 3.3: Comparison between Omega (TFP predicted value) and Residuals in LP (2003)

Criterion	Using Omegas	Using Residuals
Rationale	Omega represents the productivity shocks (unobserved TFP) derived as a control function from the LP estimation.	Residuals are the differences between actual and predicted output, capturing unexplained variance.
Advantages	- Provides a direct measure of TFP as predicted by the LP model. - Omega accounts for unobserved productivity shocks explicitly. - More theoretically consistent with the LP framework since TFP is modelled as a control function of inputs.	- Residuals are simpler to calculate and interpret as deviations from the predicted production function. - Can highlight specific mismatches in the model, useful for diagnostics.
Disadvantages	Omega relies on assumptions of the LP method, such as monotonicity and the validity of intermediate inputs as proxies. - Computationally more intensive, especially in larger datasets. - May be sensitive to misspecifications in the production function.	- Residuals include noise and measurement errors, making them less precise as TFP estimates. - Do not separate pure productivity shocks from random error, conflating both in the residual.
Interpretation	- Omega is interpreted as the firm's TFP, a component of output explained by unobserved factors like technology or efficiency.	- Residuals are deviations, which include productivity shocks, measurement errors, and other unexplained factors.
Robustness to Measurement Errors	- Omega incorporates productivity shocks as part of the model structure, reducing their effect on TFP estimates.	- Residuals are prone to errors in measurement or model misspecification, leading to potentially biased TFP estimates.
Uses	- Suitable for studies that require precise, theoretically grounded TFP estimates. - Often used in policy analyses or comparisons across firms and industries.	- Useful for diagnostic purposes or quick checks of model fit. - Suitable when simplicity or computational speed is a priority.
Impact of Data Quality	- Requires high-quality intermediate input data and compliance with LP assumptions (e.g., monotonicity).	- More forgiving of data quality issues but less precise and harder to interpret rigorously.
Consistency with LP Framework	- Fully consistent as it directly models unobserved productivity using the LP framework.	- Less consistent since residuals do not distinguish productivity from errors and shocks clearly.

Our estimations of TFP per sector are as follows:

Table 3.4: TFP distribution among economic sectors for the Wooldridge (2009) method

Industry Groups	Obs.	Mean	SD	Min	Max
Digital Manufacturers	1709	10.577	0.754	7.794	15.399
Digital Services	8097	10.658	0.811	7.517	16.649
Non-Digital Manufacturers	45799	10.438	0.662	5.945	17.098
Non-Digital Services	44186	10.585	0.923	2.47	17.835

Table 3.5: TFP distribution among economic sectors for the LP (2003) method (Omega)

Industry Groups	Obs.	Mean	SD	Min	Max
Digital Manufacturers	1709	-.052	0.694	-3.352	5.184
Digital Services	8097	.148	0.710	-3.005	5.451
Non-Digital Manufacturers	45799	-.127	0.537	-10.961	5.869
Non-Digital Services	44186	.018	0.838	-8.049	7.572

As explained earlier, the results between both TFP estimates differ because the methods have different assumptions and separate ways of calculation.

3.4. Determining tax haven jurisdictions

Determining whether a jurisdiction is a tax haven or not is a process filled with intellectual risks and moral perils: it casts a sort of judgement over the jurisdiction on whether it is a bad actor in the international scene or not (Palan, Murphy and Chavagneux, 2013). The point in this research for our Chapter 5 is not so much determining which jurisdiction is a tax haven as much as whether the criteria used to prepare the lists resonate with our own perceptions of tax havens. Table 3.2 provides a full overview of the four lists used in Chapter 5.

This research makes use of the tax haven lists created by Hines and Rice (1994) and Desai and Dharmapala (2006), who looked at the lists of tax havens compiled by the US Internal Revenue Service and other organisations. Then they divided the tax havens into two categories: the Big 7 and the dot tax havens. The Big 7 are large jurisdictions, with a considerable economic size and a population superior to one million. These jurisdictions are Hong Kong, Ireland, Lebanon, Liberia, Panama, Singapore, and Switzerland. The dot tax havens are considerably smaller in population and economy size, although further generalisations are amiss: they can range from remote locations such as Bermuda to locations in the core of Europe such as Luxembourg. Table 3.2 provides the list of jurisdictions.

Our research thus uses four lists of tax havens: the original one from Hines and Rice (1994) with both the dot and the Big 7 jurisdictions, a second list with only the Big 7, a third list with only the dot tax havens, the same one used by Jones and Temouri (2016). The fourth list comes from Jones, Temouri and Cobham (2018), using the Financial Secrecy Index (FSI) prepared by the Tax Justice Network. The FSI deals away with the division of tax haven vs non-tax haven, creating instead an index that measures items such as the weight of financial services to non-residents related to the rest of the economy, bank secrecy and transparency. This gives firms a score between 0 (full transparency) to 100 (complete secrecy). Jones, Temouri and Cobham (2018) use this index to put a cut at 60 points and identify 52 jurisdictions, and we have used their list as well. Finally, another set of lists comes from international organisations, such as the OECD or the IMF. Because many jurisdictions have the political leverage (often the larger ones) to avoid being categorised as a tax haven within these international fora, we refrain from using such lists.

Table 3.6: Four lists of tax havens

Hines and Rice (1994) - Big 7
Hong Kong, Ireland, Liberia, Lebanon, Panama, Singapore, and Switzerland
Jones & Temouri (2016) – dot tax haven
Andorra, Anguilla, Antigua, Barbados, Bahrain, Bermuda, Bahamas, Belize, British Virgin Islands, Cayman Islands, Cook Islands, Cyprus, Isle of Man, Jersey, Gibraltar, Grenada, Guernsey, Liechtenstein, Luxembourg, Macao, Malta, Monaco, Netherlands Antilles, Saint Kitts and Nevis, Saint Lucia, Saint Vincent, Seychelles and the Turks and Caicos Islands
Hines and Rice (1994) – Full list
Hong Kong, Ireland, Liberia, Lebanon, Panama, Singapore, Switzerland, Andorra, Anguilla, Antigua, Barbados, Bahrain, Bermuda, Bahamas, Belize, British Virgin Islands, Cayman Islands, Cook Islands, Cyprus, Isle of Man, Jersey, Gibraltar, Grenada, Guernsey, Liechtenstein, Luxembourg, Macao, Malta, Monaco, Netherlands Antilles, Saint Kitts and Nevis, Saint Lucia, Saint Vincent, Seychelles and the Turks and Caicos Islands
Jones, Temouri and Cobham (2018)
Andorra, Anguilla, Antigua, Aruba, Bahamas, Bahrain, Barbados, Barbuda, Belize, Bermuda, Botswana, British Virgin Islands, Brunei Darussalam, Cayman Islands, Cook Islands, Curacao, Cyprus, Dominica, Ghana, Gibraltar, Grenada, Guatemala, Guernsey, Hong Kong, Isle of Man, Jersey, Lebanon, Liberia, Liechtenstein, Luxembourg, Macao, Macedonia, Malaysia, Marshall Islands, Mauritius, Monaco, Montserrat, Nauru, Netherlands Antilles, Panama, Saint Kitts and Nevis, Saint Lucia, Saint Vincent, Samoa, San Marino, Seychelles, Singapore, Switzerland, Turks and Caicos Islands, UAE, Uruguay, and Vanuatu

3.5. Cleaning the data

Raw data from ORBIS needs to be thoroughly cleaned before being inputted into an econometric model. First, the data needs to be checked for incompleteness. Not every country asks for the same amount of data, and thus there are several observations that need to be dropped. That was a substantial problem when building an estimation of the intermediate input in chapter 4, and several variations had to be tested until settling on the creditors as the estimator. Outliers can pose a large problem, but not every outlier is necessarily wrong. Something different happens when spotting numbers that are clearly incorrect: a firm might have a loss or a profit, but a firm's assets quantity cannot be negative. The information has been double-checked extensively, to avoid the kind of incoherences that would make results impossible to interpret. We have controlled for those incoherences. All amounts by ORBIS are provided in units of US dollars. To adjust for inflation, all values have been deflated using the United States gross domestic product (GDP) Deflator (Trading Economics, 2022). Although there is availability of data, the research is bound to the years 2008 to 2019, to avoid the disruptions caused by the Covid pandemic.

3.6. Conclusions

This chapter has described the datasets that have been used in the three empirical chapters. It has provided an overview on ORBIS and its variables, the preparation of the variables of interest (digital and non-digital firms), and the dependent variables (total factor productivity for Chapter 4 and tax haven presence in Chapter 5). Due to limitations in the data, several potential avenues of research have not been explored. For example, had the data been more complete, we would have looked at the impact of more types of intangibles or R&D expenditure. Future research can look at these paths not traversed and build up from our contribution to look at expensed intangible asset intensiveness, local tax rates or alternatives to the NUTS-3 agglomeration criteria.

CHAPTER 4. THE PRODUCTIVITY OF THE DIGITAL FIRM

4.1. Introduction

In 2012, the OECD spearheaded a concerted effort to patch and overhaul the existing international tax system. The aim was for countries to improve their tax revenue base and identify the international taxation system as a source of inefficiencies (OECD, 2015b). Of these pressing issues, only one initiative stands today unsolved, namely "Pillar 1", related to taxation of the "digital economy". The OECD focused on a few firms that had little in common other than being perceived as "digital" and defined the "digital economy" as e-commerce (OECD, 2013). The initiative ended up creating an ad hoc definition for large Internet giants that would be targeted with specific regulation. Political issues immediately arose because the companies targeted by Pillar 1 were mostly from the United States. In 2018, the European Commission decided to step in and create their own Digital Tax, a provisional solution that tried to patch the problem and break the impasse the OECD was stuck in (European Commission, 2018). The initiative failed for the same reasons Pillar 1 is unresolved: these initiatives have not been able to determine which firms are digital and are posing a risk to the international taxation system, and both the Digital Tax and Pillar 1 have become stuck with accusations of wanting to focus excessively on a subset of highly successful US companies.

The literature on digital technology makes the reasonable assumption that investments in information technology (IT) should be linked to increases in productivity (Syverson, 2010; Brynjolfsson and McAfee, 2014), but the empirical evidence at industry and firm level does not always match this assumption (Acemoglu et al., 2014; De Stefano, Kneller and Timmis, 2014; Bartelsman, van Leeuwen and Polder, 2017; Cette, Lopez and Mairesse, 2017). There are differences between country: between 1995 and 2005, US productivity increased in sectors that relied heavily on ICT, especially the service industry and the manufacturing of computer parts. No such productivity growth was experimented in Europe (Gordon and Sayed, 2020).

Wholesale and retail led the TFP growth within the US between 1995 and 2000, with finance and business sectors leading TFP growth between 2000 and 2004 (Corrado et al., 2007). Since then, TFP growth has been low both in the US and Europe (Gordon and Sayed, 2020). Researchers are limited in their assessments because they cannot differentiate between digital firms and non-digital firms. This is because definitions contradict each other all the time and tend to overlap and become obsolete (Bukht and Heeks, 2017). There is a research gap when it comes to determining the productivity of digital firms, a topic relevant to the BEPS initiative.

This chapter argues that the questions motivating Pillar 1, whether these digital firms are really that profitable, productive and are not paying their fair share of taxes, remain unresolved. The phenomenon of profitability of firms operating on the digital economy is not well explored. We know that some firms operating in the digital economy have managed to grow into economic behemoths and assume that the processes of firms in the digital economy are more productive than those of non-digital firms. But this is not a settled question. This chapter utilises a definition of digital firms as those that produce and sell digital objects, following the digital object of Faulkner and Runde (2019). We calculate total factor productivity (TFP) using the Levinsohn and Petrin (2003) and Wooldridge (2009) methods to find a TFP estimate for a panel of 100,000 OECD firms between 2008 and 2019 and test a series of hypotheses regarding the application of international business theories to explain the competitive advantages that digital firms have compared to non-digital firms. We introduce the idea of scalability as an ownership advantage of the eclectic paradigm (Dunning and Lundan, 2008) exclusive of a certain number of digital firms, apply the firm specific advantage / country specific advantage (Rugman, 2010b) to the location preferences for firms in their home country, and then analyse whether the intangible assets contained in the balance sheets are a true source of sustainable competitive advantage.

Our research makes a series of contributions to the IB literature and in particular firm performance as measured by TFP. Conceptually, our first contribution extends the concept of scalability from the information systems discipline to highlight how scalability is a feature of intangible digital objects, and how firms oriented to the production and sale of these intangible digital objects benefit from it, as they can increase their total factor productivity without incurring extra production costs or consuming more resources. Our second contribution, theoretical, extends the concept of scalability, identifying it as an ownership advantage within the eclectic paradigm to explain why digital service firms are outperforming other firms in terms of total factor productivity. Empirically, our third contribution shows that digital service firms possess higher levels of total factor productivity than other firms. Our fourth contribution reveals that not all intangible assets are the same and more research is required to determine which intangible assets in particular are sustainable. At least for now, it appears that those appearing within the balance sheets are not providing a sustainable, competitive advantage. Firms wishing to increase productivity must invest instead in research and development, employee training and software developed in-house instead of purchasing externally. Finally, our fifth contribution shows that, for digital service firms, the main determinant of choice location within developed countries is the access to the labour located in metropolitan areas. Incidentally, we also show that for non-digital manufacturers there is an incentive to be in a metropolitan area, clustered with other firms, whereas this incentive does not seem to exist for digital manufacturers.

The rest of this chapter is as follows: we first overview the literature on total factor productivity and formulate our three hypotheses. We continue with our methodology and data description. Then we proceed with the results and discussion. Finally, we provide the conclusions, contributions, and suggest avenues for future research.

4.2. Literature and hypotheses

The concerns of the OECD countries on the "digital economy" crystalised during the Base Erosion and Profit Shifting (BEPS) initiative. The 2013 BEPS report (OECD, 2013) showed, among others, a concern regarding the delivery of “digital goods” and their taxation, and the risks associated with intangible assets and profit shifting in the context of global value chains (Self, 2013). The BEPS initiative assumed that firms operating within the digital economy were generating value and making profits in new ways that were not intended by the existing international taxation system (OECD, 2013).

This new digital economy was characterised "by an unparalleled reliance on intangible assets, the massive use of data (notably personal data), the widespread adoption of multi-sided business models capturing value from externalities generated by free products, and the difficulty of determining the jurisdiction in which value creation occurs" (OECD, 2013). The OECD also expressed interest in defining intangible assets under Action 8 and regulating these assets in terms of value creation and profit generation (OECD, 2013).

These and other measures to improve tax collection among member states should have been delivered in two years. The OECD addressed most actions from the BEPS initiative, but the challenges of the digital economy remain unsolved. The BEPS initiative was undermined by two issues. First was the focus on a series of large household firms, such as Amazon or eBay. The BEPS initiative did not make a large effort to distinguish between business to business (B2B) and business to consumer (B2C). The mediatic focus on the issue ignored that the B2B transactions dominate the digital economy and present the greatest BEPS challenges (Báez and Brauner, 2019). An example of this attitude can be seen in Boccia and Leonardi (2016) , when the authors explicitly say *“we are referring to large Web multinationals, such as Google, Facebook, Amazon, AirBnB, Apple, eBay, Baidu, JD.com, Alibaba, Netflix,* *Samsung and a few others that, under the current conditions, continue to enjoy tax privileges not available to others"*, then go on to mention how the digitalisation of the economy has created new value chains and dematerialised the generation of wealth, leading to unfair competition (Boccia and Leonardi, 2016, p. 2).

Describing several characteristics of the digital economy as the OECD did is not enough when it comes to legislation. This is why this effort eventually devolved into a series of uncoordinated national initiatives (Baez and Brauner, 2019). The objective of this research therefore is determining whether these firms deserve more attention, and whether "being digital" is something that truly makes a firm special. Whatever is making these firms special needs to reflect in statistics and metrics.

4.2.1. Measuring digital firm productivity

Measuring digital firm performance is difficult. It requires the availability of firm-level microdata as well as determining which firms qualify as digital. What previous researchers meant when they used the term 'digital' often obscures the discussion. In a context where digital definitions often overlap or contradict each other (Bukht and Heeks, 2017), academic reviews looking at productivity and performance will either focus on a small number of firms that can be clearly identified as digital (UNCTAD, 2017; Casella and Formenti, 2018), the impact of 'digitalisation' on existing businesses (Martinelli et al., 2020), or on a subset of highly profitable firms (Westberg, 2014).

From the very start, the incorporation of ICT into businesses created an expectation of "the biggest technological revolution men have known" (Snow, 1966). During the 1970s the United States felt they were lagging behind with the manufacturing revolution. The discussion took place as a severe economic crisis caused by the 1973 OPEC oil embargo highlighted the overreliance of prior productivity growth on fossil fuels (Smil, 2017, p.297). Measures of productivity were not reflecting the impact of ICT changes, and those arguing that digitalisation was improving the US economy could not provide any measurable evidence of that, prompting Robert Solow to say that "you can see the computer age everywhere but in the productivity statistics" (Solow, 1987). Meanwhile, Baumol warned that productivity laggard countries cannot specialise in the same industries as before and will have their competitive advantage swapped to that of a purveyor of cheap labour (Baumol, 1989, p.22). Now we know that IT investment was being hindered by inadequate managerial techniques. For example, corner-cutting in software development (which required paying salaries to programmers) meant that improvements in hardware (which was becoming cheaper and more powerful) were not being fully exploited (Wirth, 2008).

Technology has transformed how businesses operate, how workers do their jobs and the final products, but the effects on technology remain absent from the productivity statistics. Technological implementation is not plug-and-play and, in appearance we are stuck with a modern version of the 1987 Solow’s Paradox (Brynjolfsson, Rock and Syverson, 2017). The history of e-commerce expansion provides some examples. Despite being a promising technology that has altered how the public consumes and acquires goods and services, it was hindered by many issues that needed to be tackled. Customers lacked digital skills and general knowledge. Retailers faced several technical problems regarding the integration of different systems, such as the integration of fulfilling orders and payments (Brynjolfsson, Rock and Syverson, 2017). In any case, e-commerce business know-how did not even arise endogenously. The industry benefitted from developments in warehouse management and the expansion of warehouse stores and superstores, transformations that had occurred before the 1990s dot.com bubble (Hortaçsu and Syverson, 2015).

Historically, the US annual rate of growth of productivity was worryingly small between the 1970s and the mid-1990s. It experienced an increase between 1995 and 2005 but has been languishing ever since, with levels of increase that are even less than between 1970 and 1995 (Gordon and Sayed, 2020). Despite these shortcomings, even if productivity growth did not return to the pre-crisis levels after the recovery from the 1973 crisis, the growing contribution of ICT investment in businesses caused a decline in US output volatility between the 1950s to 2000. Economic activity stabilised during the 1980s, as the digitalisation of firms brought improvements in inventory management, better control of firm operations and better management of firms both during normal times and crises (Blanchard and Simon, 2001). For Western Europe, the rate of growth of productivity was higher than in the US prior to 1995. However, Western Europe did not experience an increase between 1995 and 2005. Rather, the rate of productivity slowed down in 1995 *and then again in 2005,* to rates even lower than the United States (Gordon and Sayed, 2020).

Having spotted the consequences, now, the issue at hand was determining why Western Europe did not benefit from the productivity surge that the US had experienced, and why the American growth of TFP did not sustain over time. Gordon (2014, 2015) argued that the IT-driven acceleration that happened between 1995 and 2004 had been a one-off anomaly. Stiroh (2002) looked at data between 1977 and 1995, and 1995 to 2000. The conclusion was that TFP growth was driven by ICT-intensive firms, not just the computer and software industries.

Non-ICT-intensive firms experienced zero TFP growth. Van Ark, O'Mahony and Timmer (2008) argued that the difference in productivity growth happened because, since the 1980s, European firms have invested less in ICT than the US. Castellani and Pieri (2016) argued that European countries were spending less on the kind of R&D that enables productivity gains. Also, the higher number of European firms (relative to the United States) stuck in medium or low-tech sectors meant they were weaker candidates to benefit from the growth in TFP.

Another potential take is that the differences in performance between industries and between European stagnation and US growth are not explained by ICT or digitalisation (Gordon and Sayed, 2020). Nordhaus (2021) argued that an acceleration of technology-driven growth fails a series of tests. It could be that the growth in productivity did not happen and the enthusiasm in reporting the end of two decades of stagnation could have distorted the causality of this growth (Gordon and Sayed, 2020). Jorgenson and Stiroh (2000) attribute labour productivity acceleration between 1990 and 1998 to the higher TFP growth of ICT-producing industries, with two thirds of the increase in TFP due to spillover effects. Thus, ICT-producing industries made it possible for other industries like wholesale and retail trade to invest in computers and electronic equipment.

Higher use of ICT can be linked to higher levels of productivity growth. Europe, having in general invested less in ICT hardware than the US, reaped less benefits in ICT hardware-intensive sectors. In the US, sectors linked to higher use of ICT experienced TFP growth, but the effects were not widespread. Commodity-producing industries (save for the kind of electric machinery that produces computer hardware) did not experience TFP growth. The growth manifested mostly in the service-producing industry, the most intensive users of ICT (Gordon and Sayed, 2020).

Corrado et al. (2007) argued that, over the ten-year moment of US TFP growth, wholesale and retail led the productivity growth between 1995 and 2000, with the finance and business sectors leading between 2000 and 2004. Acemoglu et al. (2014) acknowledge that labour productivity increased for manufacturing industries that use high-tech equipment but argue that ICT-intensiveness does not completely explain the increase of productivity in the US after 1995. In terms of ICT-intensiveness, information and communications, and electric machinery involved in the production of ICT hardware stood at the top, followed by finance, insurance, the professional and administrative industries, and then the wholesale and retail sector. In total, these industries represented 53% of the US market-sector added value. And their productivity grew more for the United States than for Europe (Gordon and Sayed, 2020).

Fernald (2014) argued that the impact of the ICT-revolution was not sustainable over time. Cette, Lopez and Mairesse (2017) explained that the expiration of the ten-year growth in TFP came from the exhaustion of the possibilities of electronic inventory management and role-reorganisation in service industries. Aggregate productivity statistics did not seem to be affected by technological advancements during the 2010s. In many developed countries labour productivity growth rates fell during the mid-2000 and remain low today (Storm, 2017). The productivity slowdown predates the 2008 recession (Cette, Fernald and Mojon, 2016). That does not necessarily mean that post-2005 innovations do not have the potential to enhance productivity. It could be instead that these historic lags in productivity are due to how firms implement these technological improvements, and how these technologies require complementary changes (Brynjolfsson and Hitt, 2003).

A series of optimistic authors argue that this productivity slowdown issue has not been addressed adequately. The R^2 of the productivity growth rate does not hold much explanatory power (Brynjolfsson, Rock and Syverson, 2017). It could just be that ICT and digital technologies can indeed drive productivity upwards. We might simply be enjoying the fruits of increased productivity already, but unaware of it as we use obsolete and inaccurate measures (Mokyr, Vickers and Ziebarth, 2015). Perhaps the improvements from new technologies do indeed have a transformative impact but only a few companies have benefitted from them (Andrews, Criscuolo and Gal, 2016). Maybe the optimism about the possibilities of technology created expectations that ended up not being fulfilled, as these technologies were not going to be as transformative as once thought (Brynjolfsson, Rock and Syverson, 2017). Or it could be a problem of implementation, with recent technologies having been implemented in an obsolescent manner, with inappropriate firm structures, a lack of scale or missing complementarities (Brynjolfsson, Rock and Syverson, 2017).

4.2.2 Scalability, the eclectic paradigm, the digital good and the ownership advantage

That last portion – inappropriate firm structures, a lack of scale or missing complementarities – from Brynjolfsson et al. (2017) allows us to link with a concept from the ICT discipline called 'scalability'. Scalability can be defined as the ability to operate efficiently and with an adequate range of services over multiple configurations. Systems that require scalability include web-based applications, e-commerce, multimedia news services, remote learning, remote medicine, ERP and networked management (Jogalekar and Woodside, 2000). More nuanced definitions of scalability refer to the ability of a system to accommodate growing numbers of elements, objects or processes without stoppages, its susceptibility of enlargement (Bondi,

2000) and “the ability to handle increased workloads by repeatedly applying a cost-effective strategy for extending a system’s capacity” (Weinstock and Goodenough, 2006). Unscalable systems are those that can withstand increased levels of traffic with increasing operation costs or cannot withstand it at all.

Scalability is a desirable trait in a system, process or network, and can come in four manners: local scalability (when a system works gracefully at any level of load with a good use of resources), space scalability (when costs remain within tolerable levels as the number of items within the system increases), space-time scalability (similar to system-scalability, but when the number of items increases by orders of magnitude) and structural scalability (when the system lends itself to improvements that allow for greater processing of items) (Bondi, 2000). The concept of scalability refers not just to the hardware and software, but also to the human element that administers the software and uses it as a tool (Weinstock and Goodenough, 2006).

The concept of ‘scalability’ can be brought into the business management umbrella by assimilating it to an ownership advantage from the eclectic paradigm, an international business theory that explains firm performance, and as such our research is nested in the string of literature stemming from the contributions of Buckley and Casson (1976, 2009), Hennart (1986, 1991, 2001) Casson (1987), Rugman and Verbeke (2003, 2008b) and Narula and Verbeke (2015). This research project affirms that firms possessing strong ownership, location and internalisation advantages prefer to internationalise by establishing foreign subsidiaries (Dunning, 2000). What motivated Dunning to formulate the eclectic paradigm, based on ownership, location and internalisation advantages, was the necessity to explain differences in firm productivity between British and US firms (Verbeke and Yuan, 2010). Dunning (1988) identified a series of advantages that he identified as ownership advantages, and that were a requirement for internationalisation. These ownership advantages have become harder to identify as firms have been turning over time into something that resembles a loose amalgamation of equity-based and contractual interfaces with suppliers and customers (Verbeke and Yuan, 2010). The surge of new types of networked MNEs also made it difficult to identify ownership advantages (Mathews, 2002), as well as the now common habit of devolving responsibilities from headquarters to subsidiaries (Cantwell and Mudambi, 2005).

What made international researchers identify ownership advantages was the realisation that efficient organisations are those that establish hierarchical incentives that increase employee commitment and maximise output (Casson, 2005), and that firms need to manage activities outside the firm’s formal boundary effectively. The need to coordinate the input of independent contractors while retaining firm effectiveness and efficiency puts a limit to how much a firm can grow (Verbeke and Yuan, 2010).

Dunning and Lundan (2008) and Lundan (2009) identified three types of organisational advantages: asset-based ownership advantages, economies of common governance advantages and institutional advantages. Scalability shows characteristics of asset-based advantages and common governance. The outcomes are efficiency and increased market power (as an asset-based advantage) and an increase in organisational effectiveness (as a common governance advantage). And with this realisation, we go full circle to the 2012 OECD BEPS initiative. The OECD did not provide empirical evidence on what was causing base erosion and profit shifting. Instead, the proponents insisted on structural issues, such as the separation of business activities and profit reporting and focused on Internet-based businesses and intangibles (Ross and Herrington, 2013). Even in 2018, the European Commission, as they proposed their Digital Tax, did not address the issue but went to say things like “user participation in value creation” (Gabbai and Ross, 2018).

So, the literature does not exactly know what makes the digital firm more productive, or if digital firms are more productive at all. Therefore, we propose that scalability makes digital firms more efficient. Provided that the system allows for the users to connect without excluding other users (that means, for example, that sufficient bandwidth has been allocated for all of them), it will be able to sell increasing upon increasing amounts of digital objects without incurring rising unitary costs, due to the peculiar value chains of these firms. It is a requirement for many of these firms and it is a quality of the intangible digital object, as described by Faulkner and Runde (2019), that they can be replicated at no extra cost. This scalability of the digital object is an ownership advantage, a firm specific advantage that digital firms possess, and this ownership advantage is the one driving up productivity and profit within digital firms, as firms can produce copies upon copies of intangible assets at no extra cost, allowing increased sales without the need for more production facilities or unitary cost increases as production grows. Table 3.1 (Chapter 3) contains a breakdown of the sectors we have identified as digital, using NACE Rev.2 (2008), and Table A2 (Appendix) is an enumeration of observations of digital firms and non-digital firms per country. To sum up our position in a sentence: digitality helps scale up the ownership advantages of the firm. Therefore, our first hypothesis is:

> H_1: Digital firms with superior processes and assets that allow for scalability and malleability, are more productive than non-digital firms.

Our next hypothesis tries to delve deeper into determining which, if any, are these ownership advantages.

4.2.3. Digital firms and intangibles

Intangible assets are a key feature of the digital economy (Zeng, Khan, and De Silva, 2019). While some intangibles, such as brand names, software, research and development, or patents, are straightforward to identify, others, such as digital platforms and data flows, are more challenging to quantify. Industries that rely heavily on intangible assets include high-technology, healthcare, telecommunications, and the production of non-durable goods (Orhangazi, 2019). Firms leverage intangible assets to enhance their market power and profitability (Haskell and Westlake, 2018). Balance sheets struggle to capture a considerable amount of digital assets, mostly of the intangible class. Assets such as IA capital, human capital, software produced in-house, and organisational capital possess the power to transform and upgrade an organisation but will be often missing from the enumeration of firm assets in the balance sheets or the entirety of the financial statements (Jones and Romer, 2010; Brynjolfsson, Rock and Syverson, 2017; Haskell and Westlake, 2018; Orhangazi, 2019). Moreover, free intangible assets – with copyright licenses that allow for multiple copies – can improve productivity but remain largely invisible to the broader economy (Nagle, 2014). In any case, users cannot access intangible assets straight ahead. These assets require the use of tangible digital assets such as computers and peripherals (Faulkner and Runde, 2019). A firm that wants to utilise intangible assets needs to have access to computer resources, servers for data processing and storage, and the real estate that houses those machines.

Intangible assets can be defined in multiple ways, such as "identifiable non-monetary assets without physical substance" (IASB, 2014), as rights to "certain privileges" (Orhangazi, 2019), or as the outcomes of investments in developing products, processes, or capabilities (Hulten, 2010; Haskell and Westlake, 2018). The scope of what qualifies as an "asset" varies. Some definitions made by scholars do not require the legal protection element, allowing knowledge or employee training to qualify as intangible assets. Conversely, other scholars, like Bryan, Rafferty, and Wigan (2017), argue that legal protection is a necessary characteristic.

Despite the technological advancements over the last half-a-century, Solow (1957) would have still recognised these types of investment, but productivity measures based on a Cobb-Douglas (1928) production function will be missing a considerable portion of the intangible assets that are contributing to the productivity of a firm. When it comes to ICT investment, the capital of the firm in the equation will only reflect the portion of the intangibles that are classified as assets and their complementary tangible assets. For example, many investments in intangibles tend to be merely expensed (Lev and Gu, 2016). Thus, quantifying the real impact of technological progress is complicated. Potentially, a great amount of the market value of IT capital derives from capitalised short-term quasi-rents earned by firms that have reorganised to extract service flows from new investments (Brynjolfsson, Rock and Syverson, 2017). These intangible assets play a crucial role in multinational enterprises (MNEs) and their internationalisation, making them highly relevant to the field of international business (IB). Intangible assets have made organisations and their policies more adaptable and fluid (Bryan, Rafferty, and Wigan, 2017). The use of intangible assets is facilitated by their mobility, which can be divided into components such as legal protections, tax jurisdictions, and the revenue streams they generate. However, this mobility is largely a legal construct rather than a physical reality; the legal frameworks for intangibles often do not align with their actual movement across time and space (Palan, Murphy, and Chavagneux, 2013; Bryan, Rafferty, and Wigan, 2017).

The literature affirms that intangible assets will boost the productivity of a firm (Chen and Dahlman, 2006; Crass and Peters, 2014; Calligaris et al., 2018). However, the expression lends itself to confusion by practitioners: these intangibles cited by the literature do not neatly match what accountancy rules list as an intangible asset. For example, Chen and Dahlman (2004, p.33) when speaking about intangibles are referring to 'knowledge'. We go a step beyond and affirm that the intangible assets within the balance sheets are not the determinant that boosts TFP. Even though the resource-based view (RBV) claims that intangible intangibles are those that create value for the firm (Rugman and Verbeke, 2003), these assets are hard to examine, observe or measure (Lev and Gu, 2016). In some cases, service MNEs operate with significant portions of their value-creation processes outside the formal boundaries of the firm, functioning instead as coordinators of interactions between external participants (Zeng, Khan, and De Silva, 2019). These flexible structures, combined with the reliance on intangible assets, distort trade flow measurements and are considered a risk to the international tax system (Bryan, Rafferty, and Wigan, 2017). Intangible assets are sensitive to taxation; higher corporate tax rates negatively affect patent application filings by MNE subsidiaries (Karkinsky and Riedel, 2012). Tax differentials and the intangibility of assets also influence decisions on whether to internalise activities or outsource them (Ma, 2017). But then the same logic that tangible assets cannot be the source of sustainable competitive advantage needs to apply to the most common, measurable, and recognised of all intangible assets: the ones contained in the balance sheet. We consider that these intangibles are not determinant when it comes to boosting TFP. These are so common they cannot make a real difference. It must be the other ones considered by the literature, such as training, in-house made software and the other unaccounted intangibles that are boosting TFP. Knowing all this, our second hypothesis establishes that:

> H_2: The positive impact of intangible assets on a digital firm's TFP is amplified for firms located in metropolitan areas.

4.2.4 The impact of location: metropolitan areas and offshoring

We consider that the study of the metropolitan area could shed relevant insights on productivity. As we are about to see, metropolitan areas in the 21st century have increasingly been conceptualised as hubs of innovation, creativity, and digital enterprise. Rather than existing solely as agglomerations of population and infrastructure, these regions operate as digital ecosystems, where human creativity, advanced technical infrastructure, and economic capital converge to support the rapid growth of information and communication technology (ICT) industries. These areas provide firms a unique combination of resources and opportunities that place them at the forefront of the digital economy.

The mobility of ICT businesses is subjected to what we refer to as centrifugal and centripetal forces. Centrifugal forces are those that encourage ICT businesses to diffuse their activities wherever they obtain location advantages, as described by Dunning (1988). There are three powerful reasons to do this. First, intangible digital objects can be delivered digitally with the help of telecommunication technology. Second, several activities can be bundled together to be performed remotely (Flecker, 2016). The ability to purchase airplane tickets is an example. Third, many digital technologies are standardised, such as software languages, which in turn means that employee training and qualifications are also standardised, making it easy to evaluate candidates and determine the right fit for a position (Huws, 2007). In contrast, centripetal forces are those that encourage the business to remain close to their home location. ICT businesses cannot be moved with as much ease as it first might seem. Digital work, the production of intangible digital objects, cannot be completely placeless. The teams that craft these digital objects need to exist and perform their work in a physical location, and the design of their work must take place within a physical location as well. Even if these teams are working remotely, then the design and shape of these firms must be done in a manner that allows for dispersing them geographically (Flecker, 2016, p.4). Achieving ‘placelessness’ requires a great deal of managerial effort (Flecker, 2016, p.11) because all information must be digitised so employees can access it remotely. The tacit knowledge that the task entails must be codified and accessible to the entire organisation – the lone employee working remotely does not get the chance to casually ask for things from their colleagues. Otherwise, the divided tasks cannot be fulfilled adequately. Keeping control and accountability without direct supervision is harder unless workflow systems are established (Schönauer, 2008). For a task to be divided and outsourced, offshored or handed to a subsidiary, it is crucial to check first if the task can be separated from other tasks, or if technology allows for the task to be divided at all. For example, modern telecommunications allow the offshoring of personal services. Delocalising software development and R&D of IT can be harder to delocalise due to the requirement of large degrees of spontaneous human interaction (Flecker, 2016, p.14).

In the global market, digital technologies enable firms to benefit from winner-takes-all, increasing their performance gap with laggard firms (Brynjolfsson and McAfee, 2014). These winner-takes-all dynamics have been observed in "ICT-intensive services" – such as computer programming, software engineering, data storage and other types of information service activities – with labour productivity rising at the global frontier and slowing down in the laggard firms (Andrews, Criscuolo and Gal, 2016). This hints at the existence of a firm specific advantage (FSA) that could potentially be linked to a location specific advantage. The absence of slowdown in global frontier firms is likely to reflect technological divergence in geographical areas. The problem at theorising this phenomenon is that, within Dunning's eclectic paradigm, ownership advantages are far too numerous. These include the firm's intangible assets (knowledge, brands, organisational structure, and management skills), natural factors endowments, the workforce, capital, and the environment where the firm operates. The same issue occurs with the location advantages, which are abundant and often hard to distinguish from ownership advantages (Rugman, 2010). Therefore, Rugman (1981) proposed the idea of 'country specific advantages', which originated from the availability in a country of natural resources, labour, and cultural factors. This bridges the ownership with the location advantages, which are not often easy to classify neatly via the firm specific advantage / country specific advantage (FSA/CSA) paradigm. This paradigm puts the researcher focus on the firm rather than the transaction costs, although it can be used as well to list the advantages at the home country and has the advantage of doing away with the overlap in the categories of the eclectic paradigm. The FSA/CSA paradigm considers all location and ownership internalisation advantages as firm specific advantages. The paradigm does not distinguish between asset-based ownership advantages and transaction-based ownership advantages, since FSAs are only visible at the firm level (Rugman, 2010).

A series of articles on qualitative and mixed-methods consider the 21^{st} century city as a place of innovation and creativity in the new knowledge economy (Chapain and Sagot-Duvauroux, 2020). This corpus of literature is based on three theoretical streams: the creative cluster (Porter, 1998), the creative city (Jacobs, 1961; Florida, 2019) and the information city (Castells, 2009). Metropolitan areas in the 20^{th} century can serve as agglomerations of people or talent. Florida (2019) noticed how a certain type of talented worker he identified as the "creative" class tends to flock to these locations. The creative class specialises in science, technology, arts, culture, media and entertainment, business management and the professional sector. These activities have in common the creative nature of their work, requiring knowledge of field-specific information, recognition of patterns and decision making. Thus, metropolitan areas serve as the nerve centres of the digital economy, providing critical infrastructure such as broadband networks, data centres, and cloud computing facilities. These infrastructural resources are as crucial to ICT industries as roads and railways were to traditional manufacturing economies. Their proximity to global communication networks, such as undersea cable landings and internet exchange points, further reinforces their importance in linking local innovation to international markets (Castells, 2009). By facilitating rapid digital exchanges and fostering cross-border collaboration, metropolitan areas have become the backbone of a globally interconnected value system, and while the theoretical placelessness of digital work allows it to be conducted from virtually any location, metropolitan areas remain dominant in hosting ICT industries due to several key factors.

Porter (1990) followed the trail established by Jacobs (1961) to raise awareness of the importance of industrial clusters, and Porter (2003) differentiated between "traded clusters" and "local industries". Traded clusters sell beyond their local region, provide higher wages for their workers, provide the primary source of productivity, innovation and generate spillover effects that boost the entire economy. Local industries do not produce these spillover effects and cater only to the adjacent areas. Both projects refer to the same phenomenon, and Florida, Mellander and Stolarick (2008) observed that areas with large percentages of creative workers also attracted industries with high-paying jobs, in particular technological industries. Metropolitan areas are magnets for talent, attracting highly skilled professionals from diverse cultural and technical backgrounds. These regions incubate talent through robust education systems, ongoing training programs, and a vibrant cultural milieu. Florida (2019) identifies this workforce as the "creative class," whose innovation and adaptability play a significant role in the success of digital industries. Also, high-quality healthcare, cultural attractions, and diverse social opportunities make metropolitan areas attractive to top-tier talent. This creates a feedback loop, as these regions continuously draw both firms and workers seeking dynamic, opportunity-rich environments (Florida, 2019; Chapain and Sagot-Duvauroux, 2020).

Castells (2009) emphasises the impact of globalisation and of digital technologies interconnecting metropolitan areas. Rather than the end of distance, digitalisation has encouraged urbanisation and concentration of human activities in major metropolitan areas, with the transport and digital communication infrastructure serving as the nerve system of the metropolis (Platt, 2006). The metropolis does not match the old city, the suburbs and the rural areas are also part of the metropolitan area. Sometimes an urban core can be identified (such as London or Paris) and sometimes there are several urban cores connected by railway, high-speed roads, and computer networks (such as the San Francisco Bay Area). The commonality to all metropolitan areas is the global functions these perform via their connections to global networks of value making, financial transactions, managerial functions, and such. These points of connection attract wealth, power, culture, innovation, and people to these places. Metropolitan areas grow as the infrastructure they rely on needs to be catered for by highly skilled personal workers (Castells, 2009). The exchange of tacit knowledge and spontaneous collaboration often require physical proximity, which metropolitan areas facilitate. Despite the rise of remote work, metropolitan areas provide the infrastructure and environment necessary for certain critical aspects of digital production, such as ideation and problem-solving, which thrive on in-person interaction (Flecker, 2016).

Therefore, what we have in front of us is a series of industries, all of which provide digital objects, and many of which (but not all) provide intangible digital objects, that can in theory be produced anywhere, but that are being attracted to certain areas that provide them with location advantages that boosts productivity in the form of specialised workers that belong to the “creative class” and the integration of global networks of value making, financial transactions, etc. In summary, we have a series of firms that could be located anywhere in the world, because their employees are standardised and can deliver their services anywhere, and yet they prefer to flock in certain metropolitan areas. Therefore, our second hypothesis assumes that:

> H_3: The positive influence of metropolitan location on a digital firm's TFP is stronger for firms with higher levels of intangible assets.

4.3. Methodology

4.3.1. Foundations of TFP

The earliest concerns about Total Factor Productivity (TFP) can be traced to 'Technical Change and the Aggregate Production Function', an article published by Solow (1957). Solow (1957) combined the econometric models of Douglas (1948) and the data from Abramovitz (1956) to identify "technical change" as the factor shifting the US production function upwards. This residual was driving the US economic growth and could not be explained by inputs in labour and capital. Kuznets (1971) drew international comparisons and found the same results, arguing that "the distinctive feature of modern economic growth […] is for the most part attributable to a high rate of growth in productivity".

Measuring the Solow residual is hard for an econometrician. The adjustments required to preserve firm competitiveness take place within the managerial sphere. Econometricians do not get to observe this process directly (Abramovitz, 1956). The best thing we can do is infer and interpret from the results we have obtained. Solow (1957) argued that the residual represented "technical change". Kuznets (1978) interpreted it as "exogenous technological innovation". In 'The Explanation of Productivity Change', Jorgenson and Griliches (1967) argued that Solow and Kuznets had overexaggerated the importance of the residual. Only 15% of the residual was actual productivity growth, the other 85% was made of improvements in labour quality and capital quality (Jorgenson, 2009).

4.3.2. Estimating the impact of being digital in terms of productivity

After calculating the TFP using the three methods explained earlier in Chapter 3.3, the two variants of Levinsohn and Petrin (2003) and the one from Wooldridge (2009) (all calculations performed using the method from Rovigatti and Mollisi (2018)), we find ourselves with roughly 100,000 estimates of firm TFP for companies within the OECD and the intuition that there is something driving up productivity for digital firms − hence driving these supernormal profits that the BEPS initiative seeks to tax. We use Fixed Effects (FE) to study this unobserved effect that is supposedly working for the digital firm, an effect that might be related to some component within the ω. In this case, we use a digital dummy variable – that takes values between 0 and 1 – as the variable that does not change over time. We also use FE estimation because it is compatible with attrition, which is important when dealing with an unbalanced panel like ours (Wooldridge, 2016). Thus, our basic model looks like this:

$$TFP_{i,t} = Digital_t + IATA_{i,t} + TotalAssets_{i,t-1} + Age_{i,t-1} + CashFlow_{i,t-1} + l/tDebt_{i,t-1} + v_{i,t}$$

Relevant variables are added for the other two hypotheses. Each specification for the model is run 3 times, one for each TFP estimation, and for hypothesis 2 and 3 it is run twice as well, once for service firms and another for digital manufacturers.

4.3.3. Data sources and descriptive analysis

For our models on firm productivity, the sample contains 100,000 firms from every country in the OECD, between 2009 and 2019, the year before the beginning of the Covid-19 pandemic. Table A1 (Appendix) contains a breakdown of the observations per year.

The firm data from this article comes from ORBIS, a firm-level dataset provided by Bureau van Dijk. Bureau van Dijk is an electronic publishing and consultancy firm that does not just provide consolidated data, but also collects firm data from parent firms as well as subsidiaries. The practice of using ORBIS data for the calculation of TFP is well established, and its complexities are laid out by Gal (2013). We test our hypothesis with the financial data provided by the database, as well as the geographic location and the sectors where these firms operate. We acknowledge that the coverage of the database is not uniform, and that some countries are underrepresented, or their data is incomplete. With the data on economic sectors provided by the NACE Rev.2 (2008) codes, we can plot the activities the firms are engaged in, and we can classify them between digital and non-digital. Table 3.1 (Chapter 3) provides a breakdown of which firms are digital. Table A3 (Appendix) provides a correlation matrix of the variables. We expect our controls for firm size, measured by total assets and cash flows to be positive and significant, matching what Castany, López-Bazo and Moreno (2005) found about digital firms, and we would not be surprised if firm age is negative, corroborating the findings of Ding, Guariglia and Harris (2016), although it is also possible that This is because firm age can go both ways. Older firms accumulate experience, resulting in increased assimilation of knowledge (Coad, 2018). On the one hand, firm age could enhance productivity, as firms learn by doing (Arrow, 1962, p.155), managers become more skilled, economies of scale are achieved and investments increase (Jensen, McGuckin and Stiroh, 2001). On the other hand, older firms can grow complacent and act by mere inertia, just repeating old patterns instead of adapting to new opportunities (Hannan and Freeman, 1984). Both forces can interact, and it could be expected that the heterogeneity across sectors and the economies of the countries within the sample also play a role.

The distribution of intangibles in our sample is as follows:

Table 4.1: Descriptive statistics for intangible assets over total assets within the sample

Variable	Obs	Mean	S.D.	Min	Max
Digital Manufacturer	1709	.09	0.139	0	.833
Digital Service Firms	8089	.127	0.178	0	.943
Non-Digital Manufacturer	45737	.043	0.095	0	.899
Non-Digital Service Firms	44085	.047	0.109	0	.942

For our metropolitan variable we use NUTS3 data obtained from Eurostat (2022) to construct a dummy variable where 1 means the firm is located in a metropolitan area identified by Eurostat and 0 if the area is rural. The reason why we have picked these variables is, these are variables that are easy to recognise and interpret, and keeping the model simple eases interpretation and avoids collinearity among variables.

With the financial data, as well as the number of employees, we can calculate our total factor productivity variables. The Levinsohn and Petrin method can be made using added value or gross revenue. We have chosen added value, estimated as the profit for the period plus depreciation and amortisation, due to data availability reasons. The labour requirement was estimated with the number of employees. Employee remuneration data could have been used, but we did not find it advisable due to the considerable number of countries in the database and the diversity in pay. Our regressions are stretching the possibilities of semi-parametric estimations of TFP, which were first conceived for firms that were manufacturing – Levinsohn and Petrin (2003) was first used to calculate the TFP of Chilean production plants. Our capital variable has been estimated with tangible fixed assets. We acknowledge a risk of bias in the TFP estimator since not every tangible asset a firm owns might be owned by the firm, thus the amounts of capital assets for firms in the creative industries might be significantly smaller than for other firms. For the estimation of the intermediate goods, we have used the creditors account, a liability. This deviates from the customary practice of using material costs – for example, in Temouri, Driffield and Higón (2008). Our justification follows this logic: attributing material costs to a specific intangible digital good is very hard, if not outright impossible, due to the ability of making multiple copies at no cost (Haskell and Westlake, 2018). At the same time, the creditors account is the reverse of the material costs account, as it includes a myriad of concepts that satisfy the intermediate good requirement for the LP estimation, and that match previous uses of the Levinsohn and Petrin (2003) method. For example, the creditors account includes the payment of utilities and electricity, and electricity was one of the parameters used by Levinsohn and Petrin (2003). The recurring payment of royalty fees and licenses (in particular, software licenses) will be included in the creditors, and those are relevant for all firms, but particularly for firms that produce digital objects. After all, software programs are tools a digital firm uses. Finally, creditors will also include payments for inputs and other goods that companies that deliver physical products will incur. Although we risk including some noise in the regression, this will allow for implementing the Levinsohn and Petrin method within the diversity of service firms, not just those that are digital service firms. Table A4 (appendix) provides the estimations for the employee, intermediate good and tangible capital used to calculate the TFP across the OECD, and table A5 (appendix) does the same for the European Union firms. Table 4.2 contains the measures and variables for Chapter 4 and Table 4.3 contains the descriptive statistics for Chapter 4.

Table 4.2: Variables and measures of Chapter 4

Variable name	Measures	Source
Log Added value	Natural log of profit for period plus depreciation and amortisation	ORBIS
Log Tangible Fixed Assets	Natural log of all tangible assets such as machinery, buildings, land etc.	ORBIS
Number of employees	Natural log of total number of employees on the company's payroll	ORBIS
Log Creditors	Natural log of trade payables to suppliers and contractors	ORBIS
TFP	Total factor productivity (firm performance).	ORBIS
Digital service firm	Dummy variable (1 if digital service firm, 0 otherwise).	ORBIS
Non-digital service firm	Dummy variable (0 if digital service firm, 1 otherwise).	ORBIS
Digital manufacturer	Dummy variable (1 if digital manufacturer, 0 otherwise).	ORBIS
Intangible Assets / Total Assets (IATA)	The natural log of IATA. Intangible assets are obtained from the balance sheet account. Total assets are the sum of all non-current assets and current assets.	ORBIS
Log Total Assets	The natural log of Total Assets. Total Assets are the sum of all balance sheet assets, non-current and current.	ORBIS
Age	Calculated since the year of incorporation.	ORBIS
Log Cash Flow	The natural log of Cash Flow. Cash Flow equals net amount of cash and cash flow. Obtained from the cash flow statement.	ORBIS
Log Long-term Debt	The natural log of long-term debt. Long term debts are loans and financial obligations owed for a period exceeding 12 months. Obtained from the balance sheet.	ORBIS
Year	Year of sample period: 2008-2019	ORBIS
Metropolitan	Dummy variable (1 if firm headquarters are in a NUTS3 metropolitan area, 0 otherwise).	Eurostat

Table 4.3: Descriptive statistics for sample data Chapter 4

Variable	Obs	Mean	S.D.	Min	Max
Log Added value	107014	16.01	2.012	6.522	25.118
Log Tangible Fixed Assets	107014	14.938	2.595	-.085	26.822
Number of employees	107014	4.587	1.994	0	14.648
Log Creditors	107014	14.847	2.267	-.106	24.641
Ln TFP Wooldridge	107014	10.5132	.8068	2.4696	17.8351
Ln TFP LevPet Residual	107014	11.9694	.9112	3.9427	19.4531
Ln TFP LevPet Omega	107014	-.0481	.7081	-10.9607	7.5718
Digital Manufacturer	107014	.016	.1254	0	1
Digital Service Firms	107014	.0757	.2645	0	1
Non-Digital Service Firms	107014	.4129	.4924	0	1
IATA	106832	.0505	.1119	0	.9428
Parent Age	107014	30.2416	24.6686	1	646
Ln Cash Flow	106543	14.5885	2.232	4.0361	24.8719
Ln Long Term Debt	99203	14.5617	2.6257	-.065	25.2156
Ln Total Assets	107014	17.2785	2.0189	8.0886	26.6177
Year	107014	2015.245	2.5905	2009	2019

Endogeneity refers to situations where an explanatory variable in a model is correlated with the error term. One of the key assumptions of many regression models is exogeneity, that means, that the explanatory variables should be uncorrelated with the error term. Endogeneity violates this assumption and, if unaddressed, endogeneity may produce biased and inconsistent parameter estimates, making the results of the analysis unreliable.

We have taken a series of steps to address endogeneity by mitigating potential biases such as simultaneity biases, omitted variable biases and reverse causality, ensuring that the analysis of productivity remain robust. First, two of our estimates of the TFP use the Levinsohn and Petrin (2003) method, a semi-parametric method that employs intermediate inputs as proxies for unobserved productivity shocks, which addresses simultaneity bias. By doing so, the model captures how firms' input choices (capital, labour) respond to these shocks without introducing bias. The use of the creditors' account is a novelty, since applying traditional input measures to digital and intangible firms is problematic, which means that our independent variable, the productivity estimates, should be well-suited to the characteristics of the dataset. We need to remember that the TFP estimate does already carry significant levels of information within the firm. Because of the way TFP is calculated, it is not advisable to use again variables related to numbers of employees, capital or the intermediate good in our controls.

The second stage model is intentionally designed to avoid multicollinearity by keeping the structure simple and focusing on essential variables. While multicollinearity is not the same as endogeneity, a parsimonious model ensures clearer estimates and reduces confounding effects between variables. Still, endogeneity can occur if too few control variables are added, since the effect of the unobserved variable will increase the coefficient of the remaining variables. We have chosen a comprehensive set of control variables, including firm size, age, cash flow, long-term debt, a metropolitan dummy, and year effects. These variables account for observable characteristics that could influence productivity, such as economies of scale, learning effects, financial resources, and geographic advantages. The inclusion of regional classifications based on NUTS3 data further mitigates omitted variable bias by accounting for unobserved regional factors such as infrastructure, labour market conditions, and policy environments.

Lagging explanatory variables, such as total assets and debt, by one period further addresses reverse causality concerns. By using past values, the model mitigates the risk that current productivity outcomes might influence these explanatory variables, thereby strengthening the causal interpretation of the results. Additionally, the analysis spans a decade, focusing on long-term trends rather than short-term fluctuations, which reduces the influence of transient shocks that might bias the results. Finally, the reverse causality issue with digitality and its potential impact on TFP is addressed by running a model that disaggregates the digital and non-digital industries through NACE 2-digit classifications, which captures sectoral heterogeneity, and would allow to disentangle productivity differences from broader industry dynamics. Instead of putting together the digital classification via NACE 4-digit, we look at the sectors using NACE 2-digit but presenting together the results following digital vs non-digital and manufacturing vs service for ease of readability. Within a two-digit, we still distinguish those that are digital and non-digital at a four-level categorisation.

4.4. Results and discussion

We have estimated three TFP specifications for hypothesis 1, on digital firms being more productive than non-digital firms. The reference category is non-digital manufacturers, as established in Chapter 3. Regardless of the method, the results shown in Table 4.2 are consistent, and support the initial hypothesis for digital service firms, though not so much for digital manufacturers. The coefficients of service firms, digital and not, are both positive and significant and, no matter the TFP measure, the digital service firm always appears more productive than the non-digital service firm. Taking, for example, the parameter calculated with the TFP from the Wooldridge method, we see that digital service firms are 29.51% more productive than the benchmark point, non-digital manufacturers, whereas non-digital service firms are 24.69% than the same reference. This difference remains positive for digital service firms no matter the TFP measure. Digital service firms consistently exhibit a significant productivity advantage over non-digital firms across all model specifications, as shown by their positive coefficients. This indicates that digital service firms, leveraging scalability and more efficient processes, are well-positioned to thrive in the diverse regulatory, economic, and technological environments of OECD countries. We must also consider that the 2008 to 2019 period, marked by significant technological advancements and the aftermath of the global financial crisis, likely accelerated the adoption of digital technologies, further benefiting digital service firms.

In contrast, digital manufacturers do not exhibit the same productivity advantage. The coefficients for these firms are either negative or insignificant across the models. The results show that these firms are less productive than non-digital manufacturers (which would represent 0, the baseline) with less significance. The highest significance shows when using the TFP calculated with the Wooldridge estimator with the residuals, where digital manufacturers have a negative 6.52% lower productivity. This suggests that digital manufacturers may face specific challenges, such as reliance on traditional production processes or varying levels of digital adoption across OECD countries. Additionally, global supply chain disruptions during the sample period may have disproportionately affected manufacturing firms compared to service-based counterparts.

Table 4.4: Results for Hypothesis 1

	Residual Wooldridge	Residual LevPet	Omega LevPet
Digital manufacturers	-.0652**	-.0749***	-.0246
	(.0302)	(.0281)	(.0333)
Digital service firms	.2951***	.2331***	.3256***
	(.0127)	(.0116)	(.0141)
Non-digital service firms	.2469***	.1784***	.2155***
	(.0082)	(.0072)	(.0087)
Log Intangible/Total assets	0***	.0001***	0***
	(0)	(0)	(0)
Parent firm age	-.0008***	-.0003**	-.0011***
	(.0002)	(.0001)	(.0002)
Log Cash Flow	.0721***	.0885***	.0674***
	(.0034)	(.0037)	(.0031)
Log Long Term Debt	-.0004	.0004	-.0049***
	(.0013)	(.0013)	(.0012)
Log Total Assets	.1531***	.2337***	.0382***
	(.0054)	(.0063)	(.0045)
Year	YES	YES	YES
Constant	6.8083***	6.6592***	-1.6513***
	(.0573)	(.0597)	(.0545)
Observations	107014	107014	107014
Pseudo R^2	0.4191	0.632	0.139

Note: Each column reports a random effects regression. The dependent variable is a TFP productivity measure calculated with three different methods. Coefficients are reported. Year impact is unreported for brevity. Controls are reported as their natural logarithm, and are all lagged, and deflated for inflation.
Standard errors are in parentheses.
**** p<.01, ** p<.05, * p<.1*

Establishing appropriate controls for TFP measures is hard. Because the TFP, the dependent variable calculated using Wooldridge (2009) and Levinsohn and Petrin (2003), already reflects tangible assets as capital, the number of employees as labour and a measure of material costs, the risks of collinearity are substantial.

That means, results for controls should be interpreted cautiously. The results on firm size measured by total assets and cash flows being positive and significant match what Castany, López-Bazo and Moreno (2005) found about larger firms being more productive, as they have more resources for R&D and more employees that are also likely to be more qualified. The results show firm age being significant, but with a small and negative coefficient. It matches the results of Ding, Guariglia and Harris (2016), who found a similar coefficient among Chinese industrial firms. Going a bit deeper, we believe the results are coherent with the literature, once one determines what 'age' it potentially measures, in this case, we assume that the newer firms benefit from higher levels of productivity. The insignificant effect of long-term debt suggests that leveraging debt did not play a key role in productivity growth during the study period, perhaps due to economic uncertainties following the global financial crisis. Overall, the analysis supports Hypothesis 1, particularly for digital service firms, which demonstrate a clear productivity advantage. However, digital manufacturers do not experience the same benefits, highlighting sector-specific constraints and cross-country differences.

Hypothesis 1.2 replaces, as explained earlier, the digital service and non-digital services firms with NACE 2-digit classifications. These have been grouped following their digital and non-digital classification of Hypothesis 1 for easier comparability. Non-digital manufacturing remains the reference category on which the others are calculated, and digital manufacturing, since it only refers to a few industries within NACE-26, remains the same.

Table 4.5: Results for Hypothesis 1.2

	Residual Wooldridge	Residual LevPet	Omega LevPet
Digital Manufacturers	-.0439	-.0555*	-.0116
	(.036)	(.0337)	(.0391)
Digital Wholesale	.0617	.0213	.0408
	(.0475)	(.0427)	(.0544)
Digital Retail	-.0086	-.0294	-.0194

	(.0659)	(.0603)	(.0753)
Digital Publishing	.3275***	.2362***	.4399***
	(.0587)	(.0552)	(.0667)
Digital Video, Film and Sound	.5572***	.4712***	.5072***
	(.0966)	(.0923)	(.0965)
Digital Broadcasting	.3969***	.324***	.2462**
	(.111)	(.0857)	(.1065)
Digital Telecommunications	.3529***	.3292***	.2311***
	(.0492)	(.0439)	(.0563)
Digital Computer Programming	.368***	.2942***	.4277***
	(.0212)	(.0195)	(.0234)
Digital Information Services	.313***	.2164***	.3389***
	(.0564)	(.0494)	(.0642)
Digital Advertising	.1881***	.1508***	.1628***
	(.0467)	(.0437)	(.0536)
Digital Rental and Leasing	.5137**	.3807**	.5991***
	(.2053)	(.1941)	(.1947)
Digital Travel Agency	-.0633	-.0796	-.1262**
	(.0565)	(.0496)	(.0633)
Digital Administrative services	.0158	.0204	.045
	(.1091)	(.1019)	(.0974)
Digital Gambling	.377	.2634	.3918
	(.3052)	(.2521)	(.3616)
Digital Computer Repair	.2921***	.2777***	.4081***
	(.0588)	(.0424)	(.1106)
Non-Digital Wholesale Vehicles	.0018	-.015	-.0066
	(.0362)	(.0324)	(.0395)
Non-Digital Wholesale	.0778***	.0383***	.0741***
	(.0115)	(.0103)	(.0122)
Non-Digital Retail	-.2376***	-.2218***	-.2713***
	(.0268)	(.0245)	(.0288)
Non-Digital Land Transport	-.0396*	-.0208	-.1207***
	(.0236)	(.0211)	(.0249)
Non-Digital Water Transport	.3184***	.2646***	.0784
	(.079)	(.0705)	(.084)
Non-Digital Air Transport	.2332***	.2571***	-.1235
	(.0866)	(.0745)	(.0763)
Non-Digital Warehousing	.1397***	.1285***	.0486*
	(.0281)	(.0249)	(.028)
Non-Digital Postal and Courier	-.0655	-.0265	-.1441*
	(.0587)	(.0447)	(.0821)
Non-Digital Hospitality	-.0813*	-.1556***	-.3492***
	(.0448)	(.0396)	(.0535)
Non-Digital Food and Beverage	-.2569***	-.2214***	-.2981***
	(.0574)	(.0531)	(.0613)
Non-Digital Publishing	.2618***	.1733***	.3409***
	(.0425)	(.0386)	(.0505)
Non-Digital Real Estate	.8542***	.6417***	.6287***
	(.0419)	(.0373)	(.0451)
Non-Digital Legal and Accounting	.5691***	.4413***	.5774***
	(.0542)	(.0482)	(.0636)
Non-Digital Consultancy	.5346***	.4059***	.5502***
	(.0261)	(.0222)	(.0293)
Digital Architecture and Engineering	.2301***	.17***	.2545***
	(.0194)	(.0177)	(.0218)
Non-Digital Scientific Research	.2035***	.1443***	.2411***
	(.0546)	(.0515)	(.062)
Non-Digital Advertising	.436***	.3378***	.4877***

	(.0874)	(.0805)	(.0857)
Non-Digital Other professional act	.2914***	.2141***	.2719***
	(.0447)	(.0385)	(.0489)
Non-Digital Veterinary	.8141	.7773	.9024
	(.6033)	(.5552)	(.6115)
Non-Digital Rental and Leasing	.4505***	.4226***	.2414***
	(.0551)	(.0503)	(.0482)
Non-Digital Employment	.5292***	.4421***	.7119***
	(.0759)	(.0716)	(.0829)
Non-Digital Security	-.029	-.0252	.0189
	(.1354)	(.1238)	(.1352)
Non-Digital Cleaning and Landscape	-.0846	-.0942	.0139
	(.0686)	(.0586)	(.069)
Non-Digital Office Support	.4421***	.3431***	.4793***
	(.0461)	(.0394)	(.0536)
Non-Digital Education	.0286	-.04	-.0259
	(.0631)	(.0606)	(.0715)
Non-Digital Healthcare	.0995*	.0581	.0274
	(.0599)	(.0526)	(.0657)
Non-Digital Residential Care	-.2337*	-.2361**	-.3407
	(.1259)	(.1182)	(.2214)
Non-Digital Social Work	.0865	.0741	.1955
	(.1616)	(.1383)	(.1724)
Non-Digital Creative Arts	.2302***	.1977***	.2623***
	(.0718)	(.0661)	(.0828)
Non-Digital Libraries and Museums	-.1528	-.1306	-.4348
	(.121)	(.1487)	(.3349)
Non-Digital Sports	.3492***	.2726***	.1825**
	(.0885)	(.0823)	(.093)
Non-Digital Repair household goods	.595***	.5135***	.5669***
	(.1026)	(.103)	(.1242)
Non-Digital Other personal service	.2076***	.17***	.1955***
	(.0607)	(.0537)	(.0698)
Log Intangible/Total assets	-.2009***	-.197***	-.0889**
	(.0392)	(.0342)	(.0439)
Parent firm age	-.0003**	0	-.0004**
	(.0002)	(.0001)	(.0002)
Log Cash Flow	.069***	.0861***	.0625***
	(.0039)	(.0038)	(.004)
Log Long Term Debt	-.003**	-.0023*	-.008***
	(.0014)	(.0014)	(.0015)
Log Total Assets	.1649***	.2464***	.0428***
	(.0052)	(.0049)	(.0055)
Year	YES	YES	YES
Constant	6.6366***	6.4726***	-1.6682***
	(.0527)	(.0475)	(.0577)
Observations	70806	70806	70806
Pseudo R2	0.6755	0.2015	0.4855

Note: Each column reports a random effects regression. The dependent variable is a TFP productivity measure calculated with three different methods. Coefficients are reported. Year impact is unreported for brevity. Controls are reported as their natural logarithm, and are all lagged, and deflated for inflation. Standard errors are in parentheses.

**** p<.01, ** p<.05, * p<.1*

The findings reveal substantial heterogeneity across digital sectors. Highly significant positive coefficients for subsectors such as digital publishing and digital computer programming indicate that these industries benefit significantly from the scalability and malleability of digital processes and assets. This supports the hypothesis that digital firms are more productive than their non-digital counterparts. similarly, other sectors, including digital telecommunications and digital information services, exhibit strong positive productivity advantages, suggesting that the ability to leverage digital infrastructure enhances efficiency and output. Not all subsectors uniformly benefit from being digital. Some digital subsectors, such as digital retail, display insignificant or negative coefficients, highlighting potential challenges in these industries. Such results may reflect sector-specific constraints, including competition, market volatility, or the inability to achieve sufficient economies of scale.

Non-digital sectors exhibit a more mixed pattern of productivity outcomes. Sectors such as non-digital real estate and non-digital consultancy demonstrate strong positive coefficients, suggesting these industries remain competitive and productive despite their non-digital nature. This may be attributed to their reliance on capital-intensive processes or the consistent demand for their services. Still, other non-digital subsectors display negative coefficients, indicating lower productivity. Maybe these differences stem from inefficiencies in traditional operations. Perhaps this is due to Baumol's cost disease. Such disparities reflect the diverse nature of non-digital sectors and the varying impacts of technological adoption and competition on productivity. The results of the model are robust and match those of Hypothesis 1. Whatever doubts we may have of the TFP estimators, the fact that all three estimations identify similar sectoral patterns affirms the validity of the findings.

Our second hypothesis aims to get a measure of the impact of the intangible assets over productivity. Hypothesis 2 looks at the specific intangible assets that the different four different categories of firms have, via interaction. For clarity, we have subdivided hypothesis 2 in services (with manufacturers serving as the baseline) and manufacturers (with services as the baseline). Hypothesis 2.1 repeats the same methodology of using three different estimations of TFP while focusing on service firms.

Table 4.6: Results for Hypothesis 2.1 (benchmark: all manufacturing firms)

	Residual Wooldridge	Residual LevPet	Omega LevPet
Digital Service firms	.3151***	.2557***	.3284***
	(.018)	(.0163)	(.0193)
Log Intangibles/Total assets	0***	.0001***	0***
	(0)	(0)	(0)
Digital service firms * Log Intangibles/Total assets	-.132	-.1494*	-.0142

	(.0967)	(.0874)	(.0995)
Non-digital services	.2493***	.1812***	.2164***
	(.0082)	(.0072)	(.0088)
Parent firm age	-.0008***	-.0003**	-.0011***
	(.0002)	(.0001)	(.0002)
Log Cash Flow	.0722***	.0886***	.0674***
	(.0034)	(.0037)	(.0031)
Log Long Term Debt	-.0004	.0005	-.0049***
	(.0013)	(.0013)	(.0012)
Log Total Assets	.1532***	.2339***	.0382***
	(.0054)	(.0063)	(.0045)
Year	YES	YES	YES
Constant	6.8018***	6.6518***	-1.652***
	(.0574)	(.0599)	(.0546)
Observations	107014	107014	107014
Pseudo R^2	0.4191	0.632	0.139

Note: Each column reports a random effects regression. The dependent variable is a TFP productivity measure calculated with three different methods. Coefficients are reported. Year impact is unreported for brevity. Controls are reported as their natural logarithm, and are all lagged, and deflated for inflation.

Standard errors are in parentheses.

**** p<.01, ** p<.05, * p<.1*

The results from Hypothesis 2.1 still corroborate what we knew about service firms being more productive than manufacturers, as seen in Hypothesis 1. Digital service firms exhibit a significant and positive effect on TFP, with coefficients of 0.3151 (Residual Wooldridge), 0.2557 (Residual LevPet), and 0.3284 (Omega LevPet). Non-digital service firms also show a significant positive TFP advantage over manufacturing firms, with coefficients of 0.2493 (Residual Wooldridge), 0.1812 (Residual LevPet), and 0.2164 (Omega LevPet). However, the magnitude of these coefficients is consistently lower than that of digital service firms, highlighting the inherent benefits provided by scalability and malleability as sustainable, competitive advantages.

The role of intangible assets is difficult to interpret. The variable "Log Intangibles/Total Assets" is highly significant and positive across all models, but the coefficient is small. It means intangible assets in the balance sheets contribute to firm productivity, but not to the degree that previous literature has highlighted. Such literature has explored the positive impact of ICT, and intangible assets such as patents or scientific publications in TFP growth (Chen and Dahlman, 2006). In recent studies, Crass and Peters (2014) looked at German firms from 2006 to 2010, and found that intangible assets (where they included intangible assets such as R&D, design, branding, organisational or human capital) contributed to productivity growth; while Calligaris et al. (2018) used intangible assets such as R&D, branding and marketing as a proxy for innovation, finding these to be a source of productivity growth.

Instead, our interaction term "Digital service firms * Log Intangibles/Total Assets" shows a negative coefficient of -0.1494 (Residual LevPet) and -0.132 (Residual Wooldridge). Therefore, while intangible assets have a positive impact, there is no incremental contribution to productivity as intangible asset use (of the type that is reflected by the balance sheet) increases. It could be that there are diminishing returns to the use of these assets, that their use is inefficient, or simply that these assets, past a threshold, are not that important in terms of productivity contribution. Probably, the intangible assets that matter most are outside the balance sheet (R&D, branding and marketing expenses), outside of accountancy (human capital) or are included in another variable (such as the physical parts of ICT that we have had to include in our TFP estimation and thus are reflected in the dependent variable).

Overall, these results support Hypothesis 2.1, demonstrating the positive impact of intangible assets on productivity of digital service firms.

Table 4.7: Results for Hypothesis 2.2 (benchmark: all service firms)

	Residual Wooldridge	Residual LevPet	Omega LevPet
Digital Manufacturers	-.302***	-.2473***	-.2437***
	(.0333)	(.0309)	(.0373)
Log Intangibles/Total assets	0***	.0001***	0***
	(0)	(0)	(0)
Digital manufacturers * Log Intangibles/Total assets	.0539	.0391	.0841
	(.1391)	(.1309)	(.1602)
Non-digital manufacturers	-.2393***	-.1714***	-.215***
	(.0073)	(.0065)	(.0079)
Parent age	-.0008***	-.0003**	-.0012***
	(.0002)	(.0001)	(.0002)
Log Cash Flow	.0735***	.0898***	.0688***
	(.0034)	(.0037)	(.0031)
Log Long Term Debt	-.0003	.0005	-.0049***
	(.0013)	(.0013)	(.0012)
Log Total Assets	.1519***	.2326***	.0371***
	(.0054)	(.0063)	(.0045)
Year	YES	YES	YES
Cons	7.04***	6.8294***	-1.4391***
	(.056)	(.0587)	(.0529)
Observations	107014	107014	107014
Pseudo R^2	0.4159	0.6303	0.1339

Note: Each column reports a random effects regression. The dependent variable is a TFP productivity measure calculated with three different methods. Coefficients are reported. Year impact is unreported for brevity. Controls are reported as their natural logarithm, and are all lagged, and deflated for inflation.

Standard errors are in parentheses.

**** p<.01, ** p<.05, * p<.1*

The model specifications for Hypothesis 2.2 allows us to observe the differences in productivity between digital and non-digital manufacturers, something that the constraints of Hypothesis 1 could not reflect. Digital manufacturers exhibit a significant negative TFP relative to service firms, with coefficients of -0.302 (Residual Wooldridge), -0.2473 (Residual LevPet), and -0.2437 (Omega LevPet). This indicates that, despite their digital classification and possession of malleability as an ownership advantage, manufacturing firms face challenges in realising the same productivity benefits as service firms, likely due to them not being able to benefit from scalability like digital service firms do, and operational models between manufacturing and services. Non-digital manufacturers also demonstrate significant negative TFP coefficients relative to service firms, with values of -0.2393 (Residual Wooldridge), -1.714 (Residual LevPet), and -0.215 (Omega LevPet). This reflects the broader structural productivity disadvantage of traditional manufacturing firms when compared to service industries. Service industries are better positioned to leverage digitalisation thanks to scalability. Malleability could explain, to a degree, the differences between digital and non-digital manufacturers.

Intangible assets still play a critical role in enhancing productivity, as indicated by the positive and significant coefficients for "Log Intangibles/Total Assets" across all models. However, the interaction term for "Digital Manufacturers * Log Intangibles/Total Assets" is insignificant across all models, suggesting that intangible assets do not provide additional productivity advantages for digital manufacturers beyond their baseline contribution.

These results do support Hypothesis 2.2 by confirming the positive impact of intangible assets on TFP across manufacturing firms.

Our third hypothesis aims to get a measure of the impact that productivity enjoys when a firm is within a metropolitan area, assuming that, as the literature says, firms in metropolitan areas enjoy superior resources, in the form of better infrastructure, access to skilled labour and such. Again, we subdivide between digital service firms and manufacturers. But we have only used firms within the European Union since we rely on NUTS 3 criteria. TFP estimates have been re-estimated for this subsample of countries. The results, reflected in Table 4.6, are as follows:

Table 4.8: Results for Hypothesis 3.1 (benchmark: manufacturing firms)

	Residual Wooldridge	Residual LevPet	Omega LevPet
Digital Service firms	.2832***	.2287***	.2871***
	(.0266)	(.0238)	(.0318)
Metropolitan dummy	.1039***	.0889***	.1025***

	(.0086)	(.0078)	(.0092)
Digital Service firms * Metropolitan dummy	.0088	.0102	.0406
	(.0298)	(.0266)	(.0351)
Non-Digital firms	.2206***	.1661***	.1665***
	(.0141)	(.0125)	(.0147)
Non-Digital Service firms * Metropolitan dummy	.009	-.0005	.0362**
	(.017)	(.015)	(.0179)
Log Intangibles/Total assets	0***	.0001***	0***
	(0)	(0)	(0)
Parent firm age	-.0013***	-.0008***	-.0017***
	(.0002)	(.0001)	(.0002)
Log Cash Flow	.0744***	.0911***	.0696***
	(.0034)	(.0038)	(.0031)
Log Long Term Debt	.0007	.0015	-.0039***
	(.0013)	(.0013)	(.0013)
Log Total Assets	.1642***	.2417***	.0473***
	(.0057)	(.0066)	(.0047)
Year	YES	YES	YES
Constant	6.5808***	6.4452***	-1.9044***
	(.0615)	(.0636)	(.0579)
Observations	103144	103144	103144
Pseudo R^2	0.441	0.6383	0.1654

Note: Each column reports a random effects regression. The dependent variable is a TFP productivity measure calculated with three different methods. Coefficients are reported. Year impact is unreported for brevity. Controls are reported as their natural logarithm, and are all lagged, and deflated for inflation.

Standard errors are in parentheses.

**** p<.01, ** p<.05, * p<.1*

Hypothesis 3 posits that a firm's headquarters being in a metropolitan area (defined as NUTS 3 regions) positively influences total factor productivity (TFP). The analysis focuses on service firms (both digital and non-digital) compared to manufacturing firms, using a sample of EU-based companies. A reminder here is in place that this ORBIS dataset provides data at firm-level, not plant-level. We must use the location of the HQ as a proxy for the actual location of the firm. Non-digital service firms also show a positive productivity advantage compared to manufacturing firms, with coefficients of 0.2206 (Residual Wooldridge), 0.1661 (Residual LevPet), and 0.1665 (Omega LevPet).

Coherent with the previous results, digital service firms exhibit a significant productivity advantage over manufacturing firms, with coefficients of 0.2832 (Residual Wooldridge), 0.2287 (Residual LevPet), and 0.2871 (Omega LevPet). Non-digital service firms also show a positive productivity advantage compared to manufacturing firms, with coefficients of 0.2206 (Residual Wooldridge), 0.1661 (Residual LevPet), and 0.1665 (Omega LevPet).

The presence of a metropolitan headquarters, represented by the "Metropolitan Dummy," significantly enhances TFP, with coefficients of 0.1039 (Residual Wooldridge), 0.0889 (Residual LevPet), and 0.1025 (Omega LevPet). This indicates that firms in metropolitan areas benefit from access to innovation hubs, skilled labour markets, and advanced infrastructure. However, the interaction term "Digital Service Firms * Metropolitan Dummy" is mostly insignificant (e.g., 0.0088 in Residual Wooldridge and 0.0102 in Residual LevPet) but becomes positive in the Omega LevPet model (0.0406), which suggests limited additional productivity gains for digital service firms beyond their inherent advantages. While the interaction term "Non-Digital Service Firms * Metropolitan Dummy" is insignificant in most models (e.g., -0.0005 in Residual LevPet), it is positive and significant in the Omega LevPet model (0.0362**), indicating some additional productivity benefits for non-digital service firms headquartered in metropolitan areas, although these are smaller than those observed for digital service firms.

The findings support Hypothesis 3. Metropolitan headquarters positively influence TFP for service firms, particularly digital service firms. Non-digital service firms also benefit from metropolitan locations, though to a lesser extent.

The second specification runs the model for manufacturers, digital or not, compared to non-digital manufacturers, and reflects interesting results for non-digital manufacturers.

Table 4.9: Results for Hypothesis 3.2 (benchmark: service firms)

	Residual Wooldridge	Residual LevPet	Omega LevPet
Digital Manufacturers	-.2058***	-.1655***	-.122**
	(.0466)	(.043)	(.0528)
Metropolitan dummy	.1268***	.1024***	.1532***
	(.0122)	(.0108)	(.0129)
Digital Manufacturer * Metropolitan dummy	.0697	.0748	.0625
	(.0572)	(.0526)	(.0648)
Non-Digital Manufacturer	-.2055***	-.152***	-.1595***
	(.0123)	(.011)	(.0129)
Non-Digital Manufacturer * Metropolitan dummy	-.0289*	-.0164	-.0573***
	(.0148)	(.0132)	(.0157)
Log Intangibles/Total assets	0***	.0001***	0***
	(0)	(0)	(0)
Parent firm age	-.0013***	-.0009***	-.0018***
	(.0002)	(.0001)	(.0002)
Log Cash Flow	.0757***	.0923***	.0709***
	(.0034)	(.0038)	(.0031)
Log Long Term Debt	.0008	.0016	-.0038***
	(.0013)	(.0013)	(.0012)
Log Total Assets	.1625***	.2401***	.0455***
	(.0057)	(.0066)	(.0047)
Year	YES	YES	YES
Constant	6.7881***	6.6046***	-1.7364***
	(.0605)	(.0626)	(.057)

Observations	103144	103144	103144
Pseudo R^2	0.4377	0.6365	0.1602

Note: Each column reports a random effects regression. The dependent variable is a TFP productivity measure calculated with three different methods. Coefficients are reported. Year impact is unreported for brevity. Controls are reported as their natural logarithm, and are all lagged, and deflated for inflation.

Standard errors are in parentheses.

**** p<.01, ** p<.05, * p<.1*

Compared to the previous specifications, digital manufacturers exhibit significantly lower TFP compared to service firms across all models, with coefficients of -0.2058 (Residual Wooldridge), -0.1655 (Residual LevPet), and -0.122 (Omega LevPet). Non-digital manufacturers also have significantly lower TFP compared to service firms, with coefficients of -0.2055 (Residual Wooldridge), -0.152 (Residual LevPet), and -0.1595 (Omega LevPet). This implies that manufacturers suffer from a productivity disadvantage relative to service firms, which can benefit from the scalability and knowledge-intensive nature of service operations.

Metropolitan headquarters have a positive and significant effect on TFP, as indicated by the "Metropolitan Dummy" variable, with coefficients of 0.1268 (Residual Wooldridge), 0.1024 (Residual LevPet), and 0.1532 (Omega LevPet). However, the interaction term "Digital Manufacturer * Metropolitan Dummy" is insignificant across all models (e.g., 0.0697 in Residual Wooldridge and 0.0748 in Residual LevPet), suggesting that metropolitan locations provide no additional productivity advantages for digital manufacturers beyond the general benefits of being in a metropolitan area. Furthermore, the interaction term "Non-Digital Manufacturer * Metropolitan Dummy" is negative and significant in some models, with coefficients of -0.0289 (Residual Wooldridge) and -0.0573 (Omega LevPet). This suggests that non-digital manufacturers headquartered in metropolitan areas experience even lower relative productivity compared to service firms in metropolitan areas. The result is concerning. It does not mean that metropolitan areas provide a lower productivity than rural areas for non-digital manufacturers. It means that, relative to service firms, non-digital manufacturers based in Europe have a lower ability to take advantage of the availability of knowledge-based resources and the infrastructure that metropolitan areas provide. The results seem to match what Harris and Moffat (2012) observed for UK industries. They measured city spillovers in a large city with a dummy variable for location. They found that, for the same regions, production plants located in cities will show higher TFP than those located outside. It could also be relevant to cite Pan and Zhang (2002) on Chinese firms, who showed that TFP grew with city growth, although this growth was stimulated by firm proximity to each other boosting transactions, and not so much with the actual city characteristics.

In conclusion, the results confirm that metropolitan headquarters positively influence TFP across firm types, but this effect is more general and not specific to digital manufacturers. Both digital and non-digital manufacturers experience significant productivity disadvantages relative to service firms, with limited additional benefits from metropolitan locations.

4.5. Conclusion

The 21st century has so far seen two large recessions, the 2008 financial crisis and the 2020 Covid recession. As nations want to tackle inefficiencies in the tax regime and increase their sources of taxation incomes, digital firms face scrutiny for their unusually large benefits and the oversized growth a few digital behemoths have experienced. Yet the story is not fully written. Lack of information regarding the smaller firms has caused generalisations that at best are not adequate and at worst could harm and stifle smaller firm growth and development. Larger firms are over researched, smaller firms are under researched, and there is not even a consensus on the breadth of the “digital firm” term.

However, our research shows that decent results on a panel can be obtained if we have a decent enough definition of a “digital firm.” We have shown that digital service firms within the OECD, the ones most often identified as “digital,” are indeed the most productive of all firms. We also reveal that digital manufacturers are underperforming in terms of TFP. We have shown that intangible assets within balance sheets are not particularly important in terms of productivity. It is the ones that go expensed or that exist completely outside accountancy and lack legal protection, the ones that go to increment the productivity of firms. Similarly, merely being present in a metropolitan area does not seem to be so important for digital firms, in the face of the standardisation of many tasks related to digital object production and delocalisation. It is likely that, save for a few clusters, most of these locations will not provide any specific advantage, despite the availability of quality labour and supporting infrastructure.

4.5.1. Theoretical implications

The findings from this Chapter offer important implications for theory and policy when it comes to our understanding of productivity dynamics across digital and non-digital firms in different geographic and industrial contexts.

The results for Hypothesis 1 confirm that digital firms, particularly digital service firms, have higher levels of productivity than non-digital firms due to their ability to leverage scalability, process efficiency, and intangible assets. However, digital manufacturers do not demonstrate the same productivity advantage, highlighting the variability of digitalisation's impact across sectors. This supports theories that emphasise the strategic role of digitalisation and intangible investments in driving firm competitiveness, while also underscoring the need to account for industry-specific factors. In terms of policy, governments should prioritise tailored support for digital transformation in manufacturing, including funding for advanced technologies and the integration of digital processes. Incentivising investment in intangible assets, such as R&D, workforce training, and intellectual property, can further enhance firm productivity, especially for sectors struggling to fully adopt digital strategies. Hypothesis 1.2, incidentally, shows that not all digital firms possess the same levels of productivity, reminding us that scalability and malleability are not magic tools but ownership advantages that need to be properly nurtured, developed and deployed for maximum effectiveness.

Hypothesis 2 shows that intangible assets have a significant positive effect on TFP across all firms, but their impact is less pronounced for digital manufacturers compared to service firms. Our findings add to the existing literature on the importance of intangible resources in driving productivity. Our findings also suggest that digital manufacturers may face diminishing returns or inefficiencies in leveraging these assets effectively. There is room for policymakers in this area, including the fact that some of the most relevant investments in intangibles, as seen in this chapter, are not even reflected in accountancy. This disparity between accountancy rules and the actual productivity of firms shows that there is room for improvement when it comes to assessing the value and actual capability of generating wealth of firms. Without recognition of what makes a firm valuable, while clinging on outdated methods, firms are being limited in their ability to raise debt, acquire funding, and grow.

The analysis of Hypothesis 3 confirms that metropolitan headquarters positively influence productivity, particularly for service firms. Metropolitan areas provide access to skilled labour, advanced infrastructure, and knowledge networks, which disproportionately benefit digital service firms. However, the productivity advantage for manufacturing firms in metropolitan areas is less pronounced, indicating that the benefits of urban agglomeration are sector specific. This supports theories of agglomeration economies and highlights the importance of spatial factors in productivity research. Policymakers should continue to invest in metropolitan areas as innovation hubs by improving digital infrastructure, fostering collaboration between firms and universities, and supporting regional clusters. Efforts should also be made to extend the benefits of metropolitan environments to non-metropolitan areas through investments in transport infrastructure, digital connectivity, and regional innovation initiatives.

A more general conclusion shows that more work is required to find further determinants of productivity for digital firms. Should the European Union want to go down the path of putting special taxes on digital firms while trying to avoid stifling their development. The work we have done here shows that the areas the legislators want to tread in are still uncharted. There is ample scope to look at more detailed data within countries or regional areas, as well as to try combining the incomplete data from the ORBIS database, such as the one on intangibles, with other datasets. Our research has not looked at research and development data due to lack of information, or at the role that foreign subsidiaries might play in boosting productivity. There is also the possibility of trying to find more determinants outside the ones highlighted by the OECD.

4.5.2. Managerial implications

The results show that digital service firms are indeed the most productive of all firms. Managers must focus on the practices that make these firms stand out from the rest, to keep embracing scalability to cater for growing numbers of customers and keep the added benefit of being able to increase sales without increasing operating costs, and to keep a constant use of technology, data/information, communications, and everything that makes a firm "digital". The results also show that digital manufacturers in the OECD countries from the sample are lacking sustainable competitive advantages and are underperforming when compared to the manufacturers of non-digital objects. Managers of digital firms need to carefully consider the distribution of assets and the investments done in order to increase productivity.

Location advantages are particularly important for digital firms, as cited in the previous section. Even if the tasks are near-decomposable and can be located anywhere or, the advantages of being located within a metropolitan area cannot be ignored,

Previous studies that have mentioned "intangible assets" need to be put within context: the expression does not simply refer to the assets in the balance, but to items that are not reflected by accountancy as expenses such as R&D or software generated in-house or are relational. An investment in employee training or research and development is likely to yield better results than in those items contained within the balance sheets.

4.5.3. Contributions

This research has revealed some interesting details and added new understanding to what makes digital firms more productive. Conceptually, we have explained how scalability is a feature of intangible digital objects, and an ownership advantage that allows digital service firms to increase their total factor productivity as opposed to digital manufacturers and other firms in general that lack this competitive advantage, requiring more resources and incurring extra production costs with increases in sales and production. Theoretically, we have extended the use of international business theories to describe how the eclectic paradigm can explain why digital service firms are outperforming other firms in terms of total factor productivity by identifying scalability as an ownership advantage. Empirically, we show that digital service firms possess higher levels of total factor productivity than other sectors of the economy, and we show as well that not all intangible assets are the same, and that more research is required to determine which intangible assets in particular are sustainable. At least for now, it appears that those appearing within the balance sheets are not providing a sustainable, competitive advantage. Firms wishing to increase productivity must invest instead in research and development, employee training and software developed in-house instead of purchased externally. Finally, we show that, for digital service firms, the main determinant of location within developed countries is the access to the labour within metropolitan areas. Incidentally, we also show that for manufacturers there is an incentive to be in a metropolitan area, clustered with other firms.

4.5.4. Limitations and future avenues of research

We acknowledge a series of limitations of our methodology: first is the objection to using NACE revision 2 (2008) codes. Firms listed in commercial databases such as ORBIS might have one single code and have parts of their business that produce digital objects (and thus are digital firms) and parts that are traditional. ORBIS provides a single NACE and does not consider situations where the firm might perform more than one activity. The codes in the businesses might be obsolete themselves if these have not been updated in the database as firms change activities. We are also bound (as every other study using industrial classifications) to a categorisation from 2008 which might have become obsolete. For example, book publishing (NACE code 58) does not distinguish between paper and e-books. We are bound to the limitations of Levinsohn and Petrin (2003) and Wooldridge (2009), especially to the assumption that the intermediate input's demand function is a monotonic function of productivity. Finally, our choice of using creditors as a proxy for the intermediate input might have generated some noise within the regression.

There is a lot to be done from this point onwards. There is room to improve the metropolitan and the location variables with more refined variables that look at geographical areas. Similarly, there is a research question that can be posed now: do digital firms that offshore parts of their production see an increase of productivity or are the productivity benefits offset by the costs of coordinating activities across different geographies?

CHAPTER 5: THE USE OF TAX HAVENS BY THE DIGITAL FIRM

5.1. Introduction

Tax havens play an important role in the financial system and the flows of foreign direct investment (FDI) (Eden and Kudrle, 2005; Dyreng, Hanlon and Maydew, 2008; Blanco and Rogers, 2014; Barker, Asare and Brickman, 2017) and a sizeable amount of this FDI is performed in a small number of specific tax havens and offshore financial centres (Zucman, 2015). This has become a matter of concern for scholars, governments, civil society, and the media. International organisations such as the Organisation for Economic Co-operation and Development (OECD) and the EU are trying to tackle this issue (Devereux and Vella, 2018). At the same time, the more firms increase their use of digital technologies the more necessary it is to explore how prone digital firms are to utilise tax havens compared to less digitalised firms (OECD, 2015a). Research in the international business (IB) literature has looked at the extent to which MNEs are using tax havens (Beugelsdijk et al., 2010; Henry, 2012; Jones and Temouri, 2016), showing that MNEs in higher-tech industries are more likely to use tax havens than in lower-tech industries. However, the risk of tax haven use has been linked to assumptions regarding reliance on intangible assets and e-businesses rather than characteristics linked to empirical evidence of tax shifting (Ross and Herrington, 2013).

The FSA/CSA Matrix (Rugman, 2010) explains that firms will establish a presence and perform FDI in a jurisdiction if they can obtain a location advantage. Internalisation theory (Rugman and Verbeke, 2008b) serves as a framework to explain how internal markets within a firm's structure allow firms to benefit from investments in tax havens. The heterogeneity of digital firms (Hennart, 2019) explains differences in tax haven use. Firms can perform FDI in tax havens to manipulate financial movements in jurisdictions with no correlative economic presence (Eden and Kudrle, 2005). The location characteristics of tax havens can be assimilated to country specific advantages (Jones, Temouri and Cobham, 2018). There are fears that digital firms are not contributing enough in terms of taxes due to these possibilities provided by tax havens to artificially increase expenses or shift profits to jurisdictions where little or no economic activity is taking place (OECD, 2015b), benefitting from the ability to shift profits and increase expenses from intangibles artificially located in tax havens (Palan, Murphy and Chavagneux, 2013), and since the OECD initiative remains unresolved, the European Union has tried to implement their own Digital Tax, with a specific tax for a small range of digital firms with little success (Cockfield, 2020). Action 1 was divided into Pillars 1 and 2. Pillar 1 searched for nexus solutions to re-allocate profits to the market jurisdiction and Pillar 2 was an anti-erosion measure: a global minimum tax on MNE controlled foreign income (Lips, 2020).

This chapter argues that the questions motivating Pillar 1 are still unanswered, and that whether these firms are paying less taxes than non-digital firms can only be solved via the use of quantitative data, calculated from large panels, to determine the amount of risk the digital economy poses for the international taxation system. In this pursuit, this chapter makes a series of contributions to the ongoing discussion on digital firms, tax haven use, and the international business discipline. We seek to answer several questions, involving the motivations for digital firms to establish subsidiaries in tax havens, the differences in tax haven use between service firms and manufacturers, the differences in tax haven choices, the links between tax haven use and assets such as intangibles and the validity of operating revenue turnover to determine tax risk. Ultimately, our ability to compare the results of different economic sectors also lets us see the impact of firm structure, and the differences between digital firms that have scalability and malleability (digital service firms) or only malleability (digital manufacturers) as ownership advantages in terms of tax haven use.

Our first conceptual contribution operationalises a definition of the digital economy based on digital firms that produce digital objects, following Faulkner and Runde's (2019) definition of the digital object as a technological object based on algorithmically organised computer components. We use this criterion to determine which firms are digital using the NACE Revision 2 (2008) industrial classification. With this, we connect to our contribution made in our theoretical chapter. Our second contribution, theoretical, expands on the international business theory to build on the identification of tax haven location advantages as advantages included inside the CSA/FSA matrix while looking at the characteristics of the digital economy. Our third contribution, empirical, reveals that tax haven use differs across economic sectors. Relative to our benchmark category (manufacturers of tangible, non-digital objects), manufacturers of tangible digital objects have a preference for performing FDI in tax havens with substantial amounts of population and economic activity (a 9.47% higher propensity), whereas non-digital service firms prefer subsidiaries in small tax havens (with a small population and economic base), their propensity being 3.46% higher than the reference. Digital service firms, the ones that are more often identified as the ones interacting in the digital economy stand in the middle, with a preference for smaller jurisdictions lower than regular service firms (2.13%), and a lower propensity to use larger tax haven jurisdictions than digital manufacturers (6.64%). Our fourth contribution, empirical, shows that the risk is not uniform across sectors. When it comes to distinguishing between sectors and risks (relative to owning subsidiaries in small tax haven jurisdictions with small economic bases), the video and motion industry pose a negative risk, the software and programming industry have a higher propensity of 2.23% than the benchmark and the digital retail sector a propensity of 4.55%. It is digital sectors that are not in the spotlight that represent the highest risk, such as the leasing of intangible digital objects with a propensity that is 14.1% less than the benchmark. Our fifth contribution, empirical, reveals the link between intangible asset ownership and the propensity and owning a subsidiary in a tax haven. Interestingly, it is the digital manufacturing sector with a 13.4% propensity of owning a subsidiary in a tax haven for a 1% increase in intangible assets over total assets, compared to the 2.48% of the digital service firms. Our sixth and final empirical contribution reveals that rising operating revenue turnover levels increase the likelihood of being present in tax havens for all firms but does not imply an inherently higher risk of tax haven use for digital firms.

The rest of this chapter is structured as follows: the next section offers a discussion on the state of the literature and hypothesis, which is followed by the methods section including information on data, the variables and empirical model. Our results are shown and discussed afterwards. We finish this chapter with our conclusions and policy implications, and an outline on implication for theory and practice as well as our contributions, limitations, and future avenues for research.

5.2. Literature review

5.2.1 International business and the use of tax havens

Our research is inserted in the string of literature stemming from the contributions of Buckley and Casson (1976, 2009), Casson, (1987), Hennart (1986, 1991, 2001), Rugman and Verbeke (2003, 2008) and Narula and Verbeke (2015). This research project – especially its *eclectic paradigm* version – proposes that those firms possessing strong ownership advantages, location advantages and internalisation advantages will internationalise by establishing foreign subsidiaries (Dunning, 2000). The eclectic (OLI) paradigm affirms that, firms will be more likely to engage in foreign production if the net benefits of internalising cross-border intermediate product markets increase (Narula and Dunning, 2010). The Firm Specific Advantage / Country Specific Advantage (FSA/CSA) paradigm focuses on the firm rather than the transaction costs but can be applied to the same situations and is often used as it deals with the overlapping categories of the OLI framework (Rugman, 2010). All location advantages are CSAs, and all ownership and internalisation advantages are FSAs. Since FSAs are only visible at a firm level, there is no difference between asset-based ownership advantages and transaction-based ownership advantages (Rugman, 2010b).

According to Alan Rugman, internalisation theory is the comprehensive framework that explains how firms organise international business transactions, emphasizing its ability to explain and predict patterns in governance choices. He advanced the concept that internalisation theory serves as the general theory of multinational enterprises (MNEs) and, by extension, firms in general (Narula and Verbeke, 2015). This theory also helps predict strategic governance regularities, such as the allocation of tasks, subsidiary directives (Rugman and Bennett, 2002), transfer pricing systems (Rugman and Eden, 1985), goal alignment mechanisms (Rugman and Verbeke, 2003; Verbeke and Kenworthy, 2008), and internal technology transfers (Rugman, 2010). In Rugman's FSA/CSA paradigm, MNEs use internalisation not only for internal operations but also to manage stakeholder networks outside the firm's formal boundaries (Rugman, D'Cruz, et al., 1995). This comprehensive approach provides insights into the decision-making processes of firms of all sizes, including de-internalisation strategies and entrepreneurial management practices (Rugman and Almodovar, 2011; Verbeke et al., 2014). To create a realistic model for MNE growth and international diversification, Rugman built on Coase's (1937) transaction cost economics (TCE) and Penrose's (1959) resource-based view (RBV), integrating elements of entrepreneurial judgment and institutional considerations (Rugman and Verbeke, 2002).

In the 1980s, Rugman also developed the FSA/CSA matrix to analyse how firms choose internationalisation strategies (Rugman, 1981, 1988; Rugman, Lecraw, and Booth, 1985). Firm-specific advantages (FSAs) represent competitive strengths arising from capabilities, while country-specific advantages (CSAs) reflect external factors like natural resources and institutional conditions (Collinson and Rugman, 2011). Internalisation theory guides MNEs when establishing governance mechanisms, allowing firms to decide whether to internalise activities or engage with external markets, determining interfaces with the external environment, and organising internal activities for efficiency (Grøgaard and Verbeke, 2012). Rugman's approach provides a reason for the MNE to exist. The MNE is an internal market, which exists to perform efficient governance mechanisms to develop, deploy, and enhance FSAs across borders. The FSAs enable survival, profitability, and growth, the CSAs guide firms' geographical and activity scope. MNEs arise naturally from coordination benefits within multi-plant systems. These organisations grow organically, and their conceptual designs are shaped by strategic evaluations of FSAs and governance structures (Rugman, 1981; Hennart, 2015).

MNEs suffer from liability of foreignness, where MNEs face higher costs due to differences between home and host countries. To counteract this, MNEs deploy FSAs, leveraging their home-country CSAs and internalisation advantages (Dunning, 1988; Rugman and Verbeke, 1992). FSAs extend beyond asset ownership to efficient organisational practices and internal market systems that optimise knowledge and resource flow across subsidiaries (Narula, 2014b). These FSAs include both basic resources and higher-order capabilities that combine and reconfigure assets for value creation (Hennart, 2009; Verbeke, 2013). Governance challenges stem from bounded rationality and imperfect information, prompting internalisation to protect FSAs and ensure efficient management of subsidiary networks (Narula and Verbeke, 2015). Rugman also highlighted the importance of regional strategies over global approaches, due to liabilities of outsidership and the complexities of cross-border FSA adjustments (Rugman and Verbeke, 2004; Flores, Aguilera, and Kim, 2015). Rugman's internalisation theory emphasizes leveraging both FSAs and CSAs for international expansion. Entrepreneurs generate FSAs domestically before deploying them abroad, with successful firms recombining resources and adjusting subsidiary roles during expansion (Grøgaard, Verbeke, and Zargarzadeh, 2011). This approach evolved from protecting existing FSAs to rejuvenating them through recombination, enabling firms to access novel resources and adapt to international contexts. Internalisation theory distinguishes between location-bound (LB) and non-location-bound (NLB) FSAs. Firms create new LB FSAs through resource recombination with host-country CSAs (Rugman and Verbeke, 1992). Successful internationalisation requires bundling NLB FSAs with host-country advantages for effective asset utilisation (Hennart, 2009; Verbeke and Hillemann, 2013).

At first glance, firms should not have any incentive to set up subsidiaries in locations where they perform little or no economic activity. It would be an exercise in futility, a way to complicate the internal structure of the MNE with an extra layer of transactions and opacity, as well as a source of extra costs to manage those transactions. Then why would these firms perform FDI in locations like this? Internalisation theory and transaction cost theory, two international business (IB) theories, explain why firms engage in this behaviour, why firms go through the effort of "complicating" their corporate structures and what firms get from setting up subsidiaries in jurisdictions known as "tax havens".

Businesses pay taxes, and these are often their largest annual expense. Managers do not treat taxes passively, but rather, taxation significantly influences investment decisions, including the scale, funding sources, and allocation of profits. MNEs adopt tax planning strategies to minimize their tax liabilities, underscoring the importance of understanding how taxation shapes corporate behaviour (Cooper and Nguyen, 2020). Internalisation implies performing activities across borders, as well as transferring resources, semi-finished goods, and intellectual property flow between affiliates; formalised through contracts that leave behind financial traces and legal implications. Transfer pricing, the cost assigned to these intra-group transactions, encompasses payments for trade, loans, or intellectual property (e.g., patents and trademarks) within an MNE’s network (Cooper and Nguyen, 2020).

From the early days of IB research, transfer pricing has been recognised for its role in enabling firms to internalise markets and become MNEs. Casson (1979) highlighted its advantages, and Rugman (1980) identified its use as an efficient response to market imperfections. Transfer pricing is fundamental for MNEs as it determines overall profitability and allocates profits among affiliates. By internalising, MNEs exploit differences in input costs, regulations, and tax rates across locations (Rugman and Eden, 1985). Buckley and Casson (1976) emphasised transfer pricing’s relevance to R&D-intensive and knowledge-based industries.

Lorraine Eden has made notable contributions to understanding the role of transfer pricing in MNE tax planning (e.g., Rugman and Eden, 1985; Eden, 1998, 2003, 2016). Particularly, the challenges. One challenge with transfer pricing is the lack of comparable market transactions to establish an "arm’s-length price standard," which represents the price an external market would charge. This opacity allows firms to manipulate transfer prices (Rugman and Eden, 1985). Moreover, internalisation itself complicates the estimation of an arm’s-length standard, as the unique benefits of internalisation (such as knowledge transfer) cannot be isolated from transfer prices, making them incomparable to external market prices (Eden, 2016). These issues hinder efforts to evaluate the risks transfer pricing poses to the international tax system.

Parallel to Alan Rugman’s efforts, John Dunning’s eclectic paradigm, or OLI framework, explores ownership, location, and internalization advantages of MNEs, alongside the motivations for foreign direct investment (FDI), such as market, efficiency, resource, and strategic asset seeking (Dunning, 1993, 2000; Eden and Dai, 2010). Dunning noted that tax-efficient profit shifting, moving profits to lower-tax jurisdictions, offers financial asset advantages for MNEs, reducing their tax burden (Samuelson, 1982; Zucman, 2014). Location-specific advantages (L) also play a key role in MNE behaviour. Countries with favourable tax policies or other benefits attract FDI, enabling firms to capitalise on these advantages (Markle and Shackelford, 2009; Hanlon and Heitzman, 2010). Dunning (1993) introduced additional FDI motivations, including escape, support, and passive investments, with tax avoidance identified as a driver of escape investments. High corporate taxes or restrictive regulations in home countries often prompt MNEs to seek alternative locations (Witt and Lewin, 2007). Oxelheim, Randøy, and Stonehill (2001) expanded this concept, emphasising the role of financial strategies like sourcing competitive capital, cross-listing, maintaining international banking relationships, and leveraging tax havens as internalisation advantages.

The international tax regime exists to address transaction cost challenges, particularly the issue of double taxation. It makes it easier doing business across different jurisdictions and avoids tax cost barriers that would deter many firms from engaging in global economic activities (Cockfield, 2013). At the core of the international tax system lie more than three-thousand bilateral tax treaties that allocate profits to activities generated by "permanent establishments" (Cockfield, 2020). These treaties keep taxation costs low by protecting firms from double taxation (Cockfield, 2013). The problems begin to arise when the accounting and financial movements related to the subsidiary in a tax haven are not related to economic activity taking place within said jurisdiction (Eden and Kudrle, 2005).

Tax havens, jurisdictions offering low or zero corporate taxes and high secrecy, facilitate profit shifting and tax avoidance, but investigating these practices is challenging due to limited disclosure requirements (Cooper and Nguyen, 2020). Rugman's FSA/CSA framework has been used to analyse how tax havens enable these practices, highlighting their role in MNE strategies (Jones and Temouri, 2016; Zucman, 2014).

This happens as the international tax regime also creates incentives for MNEs to establish their corporate structure in the most tax efficient form available. This way, firms can exploit the principles to avoid double taxation by setting up subsidiaries in tax haven jurisdictions, and shifting their profits or increasing their costs, (Bolwijn, Casella and Rigo, 2018). Then the problem is compounded when countries begin taking unilateral solutions in a context where MNEs have a near-unlimited ability to shift profits towards tax haven jurisdictions. Individual country efforts to counter this tendency tend to add further complexity into the system and create new opportunities for tax avoidance. Firms will just find a work-around by creating even more complex tax plans (Cockfield, 2013). After all, there's an entire infrastructure aimed at finding these mismatches between treaties and helping firms set up these infrastructures (Jones, Temouri and Cobham, 2018). Firms in developing countries or those whose home markets have weak financial markets can use their subsidiary in a TH to gain financial strength (Oxelheim, Randøy and Stonehill, 2001). And firm heterogeneity increases tax competition between jurisdictions (Krautheim and Schmidt-Eisenlohr, 2011).

A small stream of literature has measured the impact of tax haven use on misallocation of taxes. These articles give us a tentative idea on the value of tax lost to tax haven use. For example, Clausing (2016) measured that, for the U.S. government between 1983 and 2012, the tax revenue loss amounted to between $77 billion and $111 billion. Crivelli, Keen and de Mooij (2016) estimated a yearly global revenue loss of $650 billion. A third of that amount was related to developing countries and measured the misalignment between allocation of economic activity and declaration of profits within US-headquartered MNEs. The gap has increased from being very small by the 1990s to more than 20% of the total, although this phenomenon was slowed down by the 2008 financial crisis. Tørsløv, Wier and Zucman (2023) estimated that if shifted profits were allocated to their source countries, domestic profits would fall by 55% in tax havens and increase 5% in developing countries, 10% in the United States and 20% in the European Union countries with high taxes.

If the system that prevents double taxation creates incentives to reduce tax costs, then location characteristics of tax havens can be assimilated to other location advantages considered by IB theory (Jones, Temouri and Cobham, 2018). Thus, the determinants for "tax haven FDI" include the characteristics of the home and host economy and its development level, the proximity, the economic agreements, taxation levels and the institutions (Haberly and Wójcik, 2015). Internalisation theory explains how firms (digital and non-digital) have incentives to determine their corporate form in a manner that will reduce tax expenses.

We utilise tax haven use as our proxy for potential transfer price manipulation, due to the difficulties highlighted earlier about transfer pricing (unavailability of data, unavailability of comparable transactions). Following Rugman and Verbeke (2005), we assume that digital firms are under the same incentives to set up these structures as any other type of firm. A firm's scope of geographic expansion is determined by its ability to benefit from the link between FSAs and location advantages. It is successful when firms deploy existing FSAs instead of proprietary knowledge. The benefit of such linking is the creation of economies of scale within internal markets and the reduction of risk. The corporate headquarters' role is determined by geographical distance, the familiarity with the host region, the level of commitment and the degree of regional integration, among other parameters (Rugman and Verbeke, 2004). These deficiencies in the international tax regime allow firms to arrange their internal markets in a way that increases efficiency between the subsidiaries in tax havens and other parts of the firm. If the headquarters decide to perform nominal FDI in a tax haven jurisdiction, the organisation can achieve an exogenous source of competitive advantage (Hu, 1995) because tax havens can offer firms several enticing location advantages: low taxes, financial secrecy, political stability and easy incorporation (Jones and Temouri, 2016).

5.2.2 The digital economy and the BEPS initiative

Almost since its inception, the digital economy has displayed a series of elements that were identified as a source of tax risk: firms engaging in the digital economy enjoyed advantages in cross-border trade. These firms also faced high production costs to develop products, but almost non-existent costs at making copies of these goods (Shapiro and Varian, 1999). The 2008 financial crisis and the associated recession created the political impetus for the G8 and G20 to task the Organisation for Economic Co-operation and Development (OECD) with organising a coordinated effort towards tackling issues within the international taxation system (Picciotto et al., 2017). The result was the 2012 Base Erosion and Profit Shifting (BEPS) initiative. The spirit of the BEPS initiative was as follows: digitalisation was increasingly impacting the global economy, with e-commerce representing an ever-increasing proportion of global transactions. The tax authorities were alerted after seeing how a series of companies were growing in presence and firm value, thanks to intangible assets such as brands, trademarks, goodwill, patents, and copyrights. These Internet giants, such as Amazon, Apple, Facebook, Google, and Netflix were benefitting from their ability to be present in multiple geographical locations, with access to large consumer markets without committing physical resources to those geographies (Cockfield, 2020). In total, the OECD project included fifteen projects that were called "Actions," dealing with issues such as transfer pricing, treaty benefits, hybrid mismatch, disclosure rules, and interest deductions. The project also included an Inclusive Framework where participating countries (more than one-hundred and twenty) would commit to the BEPS rules and standards (OECD, 2015c). Of these fifteen Actions, only Action 1 remains unsolved (Cockfield, 2020).

Action 1 stated the goal of identifying the challenges that the traditional tax rules faced when dealing with the digital economy and providing alternatives to said rules. For the purpose of Action 1, the following features of the digital economy are challenges: mobility, reliance on data, network effects, the spread of multi-sided business models, a tendency towards the monopoly or oligopoly, and volatility. The kinds of businesses that posed risk included e-commerce, app stores, online advertising, cloud computing, participative networked platforms, high-speed trading and online payments (OECD, 2015a).

Our first hypothesis looks at the possibility that the firms operating within the digital economy are more likely to be using tax havens. There are reasons to think this could be true: the case of Apple taking advantage of the US tax credit system shows how large digital firms exploit these possibilities. However, the internal structure of the MNE must lend itself to the tax avoidance behaviour. For example, Apple could do this because they had set up two subsidiaries in Ireland where most non-US sales income was directed, resulting in large tax deductions (Tørsløv, Wier and Zucman, 2023). The other factor is the intangible assets located in these instrumental subsidiaries in tax havens, and Action 1 of the BEPS initiative considers that firms operating in the digital economy possess some of the most valuable intangible assets (OECD, 2015). Therefore, our first hypothesis is as follows:

H_1. Digital MNEs have a higher propensity to use tax havens than non-digital MNEs.

It will be interesting to learn which factor beats which and thus leads to higher amounts of tax haven use. In terms of complex internal structures lending themselves to be instrumentalised to perform diverse income and increase expenses, service firms lack structural flexibility compared to manufacturers, and larger MNEs (Rugman and Verbeke, 2008a). With simpler, more centralised structures, the internal markets within the service MNE that create the incentive for investing might just not be there. Many service firms face difficulties at adapting upstream-downstream activities in high-distance host environments, with higher human-asset specificity, and struggle at synchronising supply and demand of non-storage services across geographies. It is possible that firms like the retail, banking, legal utilities, and transportation sectors with little flexibility in their structures (Rugman and Verbeke, 2008a), choose not to utilise tax havens after internationalising, so as not to overcomplicate their internal structures and management costs even further; while other service sectors such as the IT and the media industries, with internal structures as complicated as those of the manufacturing sector (Rugman and Verbeke, 2008a), might be behaving differently. Therefore, acknowledging the heterogeneity of the service sector, our hypothesis 1.2 establishes that:

$H_{1.2.}$ Digital services MNEs operating in sectors considered at risk by the OECD and the Digital Tax initiative (e-commerce, computer software, digital advertising) have a higher propensity to use tax havens than non-digital MNEs.

5.2.3. The intangible asset

Intangible assets are one of the characteristics of the digital economy that the OECD linked with higher risk of tax avoidance (Zeng, Khan and De Silva, 2019). Some intangibles are easy to identify, such as brand names, software, research and development or patents. Others like digital platforms and data flows are harder to measure. The most intangible-reliant industries are high-technology, healthcare, telecommunications and manufacture of non-durables

(Orhangazi, 2019). Firms can increase their market power and profitability by using intangible assets (Haskell and Westlake, 2018).

Intangible assets can be defined in multiple ways, as 'identifiable non-monetary assets without physical substance' (IASB, 2014), as the right to ‘certain privileges’ (Orhangazi, 2019), as the result of intangible investment performed to develop products, processes or capabilities (Hulten, 2010; Haskell and Westlake, 2018). Where the extent of the “asset” term reaches depends. Some of these definitions do not require legal protection and allow for knowledge or employee training to be considered intangible assets. Other authors, such as Bryan, Rafferty and Wigan (2017) add the requisite of possessing some form of legal protection.

Intangible assets influence MNE internationalisation, which makes them relevant to the IB discipline. These assets have made organisations and their policies more fluid and flexible (Bryan, Rafferty and Wigan, 2017). For an MNE, higher levels of intangible asset ownership increase the likelihood of owning a subsidiary in a tax haven (Jones and Temouri, 2016). The increase is progressive: the more intensive the use of intangibles, the more likely a firm that fully owns their subsidiaries will have a presence in a tax haven (Gattai, 2010). This is enabled by the high mobility of intangible assets, which can be disaggregated in terms of legal protection, tax jurisdiction and the revenue streams that they generate. But this constitutes a legal fiction. Intangibles do not really flow through jurisdictions. Rather, their legal dimension does not match their real flow through time and space (Palan, Murphy and Chavagneux, 2013; Bryan, Rafferty and Wigan, 2017).

Profit-shifting trends can be explained by the intangible asset endowment of subsidiaries and the supply-chain complexity of the MNE (Beer and Loeprick, 2015). Some service MNEs have entire areas of their value-creation process outside the formal borders of the firm, with the firm acting as a channel and manager of the interactions between participants (Zeng, Khan and De Silva, 2019). These kind of flexible structures, combined with the reliance on intangibles, have distorted the amounts of trade flow and it is assumed these pose a risk for the international tax system (Bryan, Rafferty and Wigan, 2017). We know that intangible assets are sensitive to taxes: higher corporate rates have a negative effect on the number of patent applications filed by an MNE subsidiary (Karkinsky and Riedel, 2012) and tax differences and intangibility of assets play a role when deciding whether to internalise an activity or outsource it (Ma, 2017).

This discussion about digital assets makes it necessary to look at intangible assets *per se* to determine their actual relevance regarding tax haven use, for digital and non-digital firms.

Our suspicion is that intangible assets are being conflated in the discussion, assuming that in general all assets, whether they are in the balance sheets of the firms (such as brands or software acquired from external suppliers) or outside of the balance sheets (such as R&D, employee training or in-house produced software), pose the same risk for the integrity of the international taxation system. The definitions of intangibles assets (some of which require legal protection) lend themselves to this confusion: an intangible asset might be a source of sustainable competitive advantage for a firm (like employee training), and it might be enabling the impressive growth of a digital firm, but that specific intangible lacks legal recognition and thus that intangible does not lend itself to be shifted to a tax haven subsidiary for the purpose of tax avoidance. On the other hand, intangibles play a significant role in manufacturing. Our definition of digital firms allows us to identify a sector of the manufacturing industry as digital firms. These digital manufacturer firms also have incentives to manipulate the location and the amounts of value created. Internal processes of digital manufacturing firms are assumed to be more complex and more reliant on intangible assets than non-digital manufacturing firms (Beer and Loeprick, 2015), and the manufacturing sector has been more intangible-intensive since the 1990s (Haskell and Westlake, 2018). Therefore, this hypothesis analyses the relevance of intangible assets (only those with the highest degree of legal protection) in the risk of tax haven use. Our second hypothesis considers that:

> H_2: Digital manufacturing MNEs with higher levels of intangibles are more likely to own a subsidiary in a tax haven than non-digital MNEs.

5.2.4 The European Union and the Digital Tax

Action 1 produced some developments that were reflected in the 2017 iterations of the UN Model Tax Treaties. These were based on the concept of “significant economic presence” as a justification for taxation, moving away from the old concept of “permanent establishment” (UN, 2017) (OECD, 2019). But the main issue remained unsolved, so the European Union decided to break the political impasse. Hoping that a future framework would establish a single market for digital companies to do business while paying their due amount of taxes, the EU Commission decided to create an interim solution. A provisional Digital Tax would tax 3% of the profits from user data, connecting users and other digital services. These taxes would apply to businesses performing one of the activities described above and meeting one of these three criteria: revenue higher than €7 million from supplying digital services, providing services to more than 100,000 users and having more than 3,000 online business contracts (European Commission, 2018).

The intention of the EU Commission was probably to break the gridlock of the negotiations, but the repercussions of the Digital Tax were large. First, the OECD took the Commission's initiative as a challenge to its position as the overseer of the international tax rule coordinator (Cockfield, 2020). The second consideration was that few European companies would meet the thresholds established by the EU Commission. Rather, it would be large United States companies – such as Google, Amazon, Facebook, and Apple – liable to the new tax. This upset many negotiators: the United States were not pleased, certain EU countries were disappointed, and the regional EU solution was less adequate than an OECD-wide solution (Lips, 2020). As the EU Commission fell into discussions and lack of consensus, countries started stepping in, and the United Kingdom, Spain, France, Mexico, Turkey, South Korea, and Italy proposed their own digital taxes in a similar vein to the EU Digital Tax (Cockfield, 2020).

The EU Digital Tax proposal (European Commission, 2018) decided to set limits based on firm size. The EU looked, among another variables, at global turnover. We want to assess if that is an adequate measure to single out offenders of tax avoidance through tax havens. Therefore, our third hypothesis considers the impact of the parameters chosen by the EU:

> H_3: Digital MNEs with higher levels of turnover are more likely to use tax havens than non-digital service MNEs.

5.3. Data, variables, and empirical model

5.3.1. Data

This research has been conducted using secondary data from the commercial database ORBIS, operated by Bureau van Dijk. ORBIS provides relevant information when it comes to financial statements, location, and the subsidiaries of the firm at company level, which is useful for our research. This allows us to locate foreign subsidiaries of the MNE including those in tax havens. We can also classify firms by digital and non-digital and between manufacturing and services since ORBIS provides the sector where the parent firm operates. The dataset is unbalanced, with 242,736 observations of MNEs from a set of 36 OECD countries, with firms within the manufacturing and service industries. These have been chosen so no assumptions of political instability in the home country can determine the choice of subsidiaries and their location and hinder our conclusions. We have excluded the financial industry from our analysis to be coherent with the OECD decision of excluding it from Pillar 1 (Steel and Nair, 2021).

Table 5.1 contains the measures and variables for Chapter 5 and Table 5.2 contains the descriptive statistics for Chapter 5.

Table 5.1: Variables and measures of Chapter 5

Variable name	Measures	Source
Tax Haven	Dummy variable (1 if the firm owns a subsidiary in a tax haven jurisdiction, 0 otherwise).	ORBIS
Digital service firm	Dummy variable (1 if digital service firm, 0 otherwise).	ORBIS
Non-digital service firm	Dummy variable (0 if digital service firm, 1 otherwise).	ORBIS
Digital manufacturer	Dummy variable (1 if digital manufacturer, 0 otherwise).	ORBIS
Non-digital manufacturer	Dummy variable (0 if digital manufacturer, 1 otherwise).	ORBIS
Intangible Assets / Total Assets (IATA)	The natural log of IATA. Intangible assets are obtained from the balance sheet account. Total assets are the sum of all non-current assets and current assets.	ORBIS
Age	Calculated since the year of incorporation.	ORBIS
Log Cash Flow	The natural log of Cash Flow. Cash Flow equals net amount of cash and cash flow. Obtained from the cash flow statement.	ORBIS
Log Operating Revenue Turnover	The natural log of Operating Revenue Turnover. Operating Revenue Turnover equals total operating revenues, the sum of net sales, other operating revenues, and stock variations.	ORBIS

Table 5.2: Descriptive statistics for sample data Chapter 5

Variable	Obs	Mean	S.D.	Min	Max
TH Jones & Temouri (2016) Dot	243248	.078	.268	0	1
TH Jones & Temouri (2018)	243248	.174	.379	0	1
TH Hines & Rice (1994)	243248	.075	.264	0	1
TH Big 7	243248	.184	.387	0	1
Digital Service Firms	243248	.101	.302	0	1
Non-Digital Service Firms	243248	.476	.499	0	1
Digital Manufacturer	243248	.016	.125	0	1
Non-Digital Manufacturer	243248	.351	.477	0	1
IATA	238197	1.211	567.459	0	276950.7
Parent Age	243247	28.609	23.917	1	646
Ln Cash Flow	233200	14.608	2.471	-.106	24.872
Ln Operating Revenue Turnover	236178	17.071	2.479	-.106	26.883

5.3.2. Dependent variable: classifying tax havens

Our dependent variable is binary. It equals 1 if the firm has at least one subsidiary located in a tax haven, and 0 in the opposite case. Four lists of countries from the literature have been made to define which countries are tax havens and which ones are not (Hines and Rice, 1994; Jones and Temouri, 2016; Jones, Temouri and Cobham, 2018). These are quite complete and comprehensive lists, which include both smaller countries with little population or economy and nations that possess a larger economy and population. The full lists can be found in Table 3.2 (Chapter 3).

We obtain two of the four lists we have employed from Hines and Rice (1994), a Big 7 list and a 41 jurisdiction list that includes 'dot' and the Big 7. The Big 7 are jurisdictions that comprise large populations and economic size, sometimes leading to doubts on whether activities nominally performed on these jurisdictions correspond to real economic activity (Zucman, 2016). The dots are small jurisdictions, yet they comprise 60% of the assets, equity and net income in tax havens. Many of them lack natural or human resource endowments to sustain Developed world living standards (Palan, Murphy and Chavagneux, 2013). We also use the list Jones and Temouri (2016) provided, which removes the Big 7 from the dots to remove the issues that Big 7 firms may pose – such as having actual economic bases and real CSAs. Finally, to gauge and compare the evolving nature of tax havens, we have included Jones, Temouri and Cobham (2018), which brings back some of the Big 7 jurisdictions to avoid biases while providing a criteria that is updated compared to the earlier lists. Table 3.2 (in Chapter 3) provides the full breakdown of the tax haven jurisdictions.

Something that needs to be reiterated is that these four measures are not equivalent. When larger jurisdictions are added into the lists, there can be reasons to consider that these firms might be seeking other things than tax advantages. We will highlight this by comparing two of the jurisdictions we have included as tax havens (Ireland and Luxembourg) with other two jurisdictions that are not (Sweden and Denmark). All these countries have emerged in recent decades as significant European hubs for digital companies. However, these four countries have not offered the same location advantages to digital firms, and this motivates our decision to classify some as tax havens and not others.

Ireland's relatively low corporate tax rate has strongly appealed to multinational digital firms, many of which opt to position their European headquarters in Dublin (Dischinger and Riedel, 2011). Alongside this favourable tax regime, the Irish government provides targeted research and development tax credits that allow companies to reclaim a portion of their R&D expenditures (Griffith, Miller and O'Connell, 2014). Ireland has been for long integrated in the economies of the United Kingdom and the United States, is an English-speaking country, has been a manufacturing hub for a long time, and has chosen to specialise in sectors and imports where the disadvantage of the country as an island away from the European mainland can be minimised. Ireland, for example, exports pharmaceuticals (which are highly valuable with small mass) and especially IT, since these are immaterial (Barry, 2019). Luxembourg has a well-developed banking and transaction industry have made it an attractive base for fintech and other digital firms requiring sophisticated financial infrastructure (Miroudot and Cadestin, 2017). Geographically, Luxembourg is the opposite of Ireland, it has a strategic position in the heart of Europe, and a multilingual workforce. But Luxembourg inbound portfolio investment (that is, investment that is not FDI since it does not grant a controlling stake is larger than Japan, which has more than 250 times the population of Luxembourg (Hines, 2010), which begs the question on why there is so much interest to allocate funds in this small country.

Meanwhile, Sweden and Denmark have become regional hubs for digital firms, and provide firms with a robust digital infrastructure, an innovation-friendly policy environment and a highly skilled workforce. There has been significant public investment in broadband networks and supportive government policies (OECD, 2020). But there have been no incentives in form of tax or financial services as compared to Luxembourg and Ireland, and that makes the difference in our opinion. All these four countries are friendly to digital firms, but for some countries this friendliness comes with benefits.

5.3.3. Independent variable: digital firms

Digital firms have been identified using NACE Revision 2 from 2008, creating a series of digital dummies (digital services, digital manufacturers, non-digital services, and non-digital manufacturers). A categorisation of firms between service and manufacturing, and digital and non-digital has been provided in Table 3.1 (Chapter 3). We reiterate what we said in Chapter 2, that the reason Action 1 within the BEPS initiative failed is that the OECD did not know what the boundaries of the digital economy were, nor which firms were the ones posing a risk to the integrity of the international tax system. The literature does not give a simple answer on what the digital economy is and where its boundaries lie. Chapter 2 gives a longer, more appropriate explanation. As a refresher, we will reiterate that there are all kinds of definitions of digital firms and the digital economy. These definitions built heavily on what was new and promising at the time of their production – the Internet, smart devices, Big Data, the Cloud. Some of these definitions exclude each other and some do overlap (Bukht and Heeks, 2017).

We propose that digital firms are those that are oriented to the production and sale of digital objects. Tangible digital objects are those that we utilise to access intangible digital objects (Faulkner and Runde, 2019). Intangible digital objects are made of binary strings of zeroes and ones that are highly mutable and can acquire new functions by changing their underlying arrangement of information (Kallinikos, Aaltonen and Marton, 2013). We consider that this property, the malleability of the intangible digital object, is the one that the literature has linked to the unprecedented set of innovation through new and existing industries and sectors. The transformation of traditional objects into digital objects has changed the nature of sectors that already existed (Ahmad and Schreyer, 2016) and has also accelerated the creation and evolution of new products and services (Nambisan, Lyytinen and Yoo, 2020). The information systems discipline considers digital objects as the core of their discipline (Faulkner and Runde, 2019) and we build our contribution upon it. From here, it would make sense that it is these digital firms that comprise the digital economy and these firms should be the object of Action 1 of the BEPS initiative.

A plurality of definitions for "digital firms" or the "digital economy" mention at least one of these five elements: intangible assets, information (or data), computers (as a general-purpose technology), networks and e-commerce (or the Internet). Table 2.10 provides a full breakdown of the frequency of these elements across the literature.

5.3.4. Explanatory variables

Explanatory variables were obtained from the annual accounts compiled in ORBIS for every multinational. All monetary values are deflated using GDP deflators to take account of inflation over the 2008-2019 period. We have included cash flows, turnover, a ratio of intangible assets over total assets and the age of the parent firm (Jones and Temouri, 2016; Jones, Temouri and Cobham, 2018; Temouri, Nardella, Jones and Brammer, 2023). Turnover has been included both because it was selected by the EU Commission for their thresholds on the Digital Service Tax, as well as because it provides a measure of firm size. Following this literature, we expect (for small tax havens) turnover to be negative and insignificant, cash flows positive and significant, intangible ratio to be positive and significant and age to be positive and significant but with a small coefficient for each year. Our definition of MNE comes from UNCTAD (2019), where a firm is a multinational it if owns at least 10% of a subsidiary in a foreign country.

5.3.5. Empirical models

We have performed logit estimation, with two unbalanced panel models running through five specifications, one for each list of tax haven countries. Hypothesis 1 (Digital service MNEs have a higher propensity to use tax havens, relative to non-digital service MNEs) has been tested using the following equation:

$$TaxHaven_{it} = \beta_0 + \beta_1 DigitalService_i + \beta_2 Non - DigitalService_i + \beta_3 DigitalManufacturer_i + \beta_4 logIATA_{it} + \beta_5 logCashFlow_{it} + \beta_6 logTurnover_{it} + \beta_7 Age_{it} + \varepsilon_{it}$$

Where 'i' refers to the 'firm' and 't' to 'time'. Tax Haven, the dependent variable, is a binary proxy for the use of tax havens which equals one if the firm has a subsidiary in a country that has been identified as a tax haven in a tax haven list and 0 in the opposite case. A complete breakdown of tax havens has been provided in Table 3.1. *DigitalService, non-DigitalService and DigitalManufacturer* are dummy variables that equal one if the firm is a digital service/non-digital service/digital manufacturer firm and 0 otherwise. *IATA* is a continuous variable that measures the ratio of intangible assets over total assets, lagged for one period. *CashFlow* and *Turnover* are continuous variables that reflect the cash flows and turnover in USD, each one lagged for one period. *Age* is a continuous variable that measures how old the parent firm is. The models for hypotheses 2 and 3 are built on the first one, using relevant interaction variables.

5.3.6. Correlation matrix and endogeneity

Table B1 (appendix) reports the correlation matrix between all the variables used in our models. Not all the variables are present in each of the four models. The matrix shows that the correlations between our variables are weak, and multicollinearity is not a concern.

Endogeneity arises when an explanatory variable in a model is correlated with the error term. A fundamental assumption of many regression models is exogeneity, meaning that explanatory variables should not be correlated with the error term. Failing to address endogeneity can lead to biased and inconsistent parameter estimates, undermining the reliability of the analysis. To ensure the robustness of our productivity analysis, we implemented several strategies to mitigate endogeneity, addressing issues such as simultaneity bias, omitted variable bias, and reverse causality.

The second stage model is structured deliberately to avoid multicollinearity by maintaining simplicity and concentrating on essential variables. While multicollinearity differs from endogeneity, a parsimonious model enhances clarity and reduces confounding effects between variables. However, endogeneity risks remain if too few control variables are included, as unobserved variables can inflate the coefficients of the included variables. To address this, we selected a comprehensive set of control variables, including firm size, age, cash flow, and the use of intangible assets. These variables capture observable factors influencing productivity, such as economies of scale, learning effects, financial resources, and geographic advantages. To tackle reverse causality, we lag explanatory variables, such as total assets and debt, by one period. This approach reduces the risk of current productivity outcomes influencing explanatory variables, thereby reinforcing the causal interpretation of the results. Furthermore, our analysis spans a decade, focusing on long-term trends and minimising the impact of short-term shocks that might distort findings. This method reinforces causal interpretations and minimises the risk of reverse causality.

Reverse causality concerns specific to being digital and its potential effects on tax haven use are addressed by using a model that disaggregates digital and non-digital industries through NACE 2-digit classifications. This approach captures sectoral heterogeneity and helps disentangle productivity differences from broader industry dynamics. While the analysis follows the digital vs non-digital and manufacturing vs service categorisations for clarity, it also distinguishes between digital and non-digital sectors within each NACE 2-digit classification. This methodology avoids relying solely on NACE 4-digit classifications, ensuring more nuanced insights while maintaining readability. Another measure to prevent endogeneity is to check for potential deviations by using alternative tax haven lists (Hines and Rice, 1994; Jones and Temouri, 2018) to observe if the results hold. Our results have held across the different dependent variables and were consistent across varying classifications, implying that these do not depend on a single list.

5.4. Results and discussion

Table 5.3 reports the marginal coefficients for Hypothesis 1. Columns one to four contain the marginal effects for the model, using the tax haven lists from Jones and Temouri 2016 (J&T 16), Jones, Temouri and Cobham 2018 (J&T 18), Hines and Rice 1994 (H&R 94) and the Big Seven from Hines and Rice 1994 (Big 7). The models have been calculated to measure digital manufacturers, using non-digital manufacturers as a reference. The stars show significance at a 5% level. The logistic regression used to produce these marginal effects is reported as Table B2 in the Appendix.

Table 5.3: Hypothesis 1 results (logit marginal effects)

VARIABLES	J&T 16(Dot)	J&T 18	H&R 94	Big 7
Digital Services	0.0213***	0.0419***	0.0198***	0.0664***
	(0.00490)	(0.00639)	(0.00482)	(0.00701)
Non-Digital Services	0.0346***	0.0417***	0.0309***	0.0468***
	(0.00265)	(0.00356)	(0.00261)	(0.00378)
Digital Manufacturers	0.0120	0.104***	0.0126	0.0947***
	(0.00786)	(0.0132)	(0.00779)	(0.0141)
Intang. Assets/Total	-3.04e-06	-7.52e-06*	-3.26e-06*	-7.43e-06*
Assets (IATA)	(2.00e-06)	(3.86e-06)	(1.96e-06)	(3.99e-06)
Log Cash Flow	0.0309***	0.0490***	0.0297***	0.0452***
	(0.000864)	(0.00121)	(0.000855)	(0.00129)

Log Turnover	-0.00478***	0.00209*	-0.00513***	0.00717***
	(0.000815)	(0.00124)	(0.000800)	(0.00133)
Parent Age	9.95e-05***	0.000381***	0.000119***	0.000578***
	(3.70e-05)	(6.04e-05)	(3.66e-05)	(6.64e-05)
Observations	243,248	243,248	243,248	243,248
R^2	0.1459	0.1542	0.1378	0.1498

Notes: variables of interest grouped based on NACE Rev.2 (2008) as explained in Chapter 3. All monetary values are in USD and using GDP deflators. Clustered standard errors are at the MNE level. All explanatory variables are lagged one period. Robust standard errors are in parentheses.

** p < 0.1. ** p < 0.05. *** p < 0.01.*

Before entering in the variables of our interest, let us look first at our control variables. These tell a fascinating story. The difference between turnover and cash flows is compelling. Increasing levels of cash flows increases the likelihood of being present in a tax haven of any kind, the results being highly significant at 1% and positive. Turnover tells a more nuanced story: increasing levels of turnover are linked to performing FDI in tax havens within the Big 7, places that provide firms with tax advantages but that also possess functioning and larger economies than the dots, whereas lower levels of turnover increase the likelihood of being present in the dot tax havens, those where little effective economic activity takes place. Age also tells an interesting story. The results are positive and significant, with 0.0381% per year for the J&T 18 list of tax havens, the one with the greatest amount of jurisdictions. It might not look like a lot, but that is a yearly result. Let us imagine a 40-year-old parent firm, one that is arguably quite old, experienced and that has had the time to set up a sophisticated business structure. For that firm, the likelihood of owning a subsidiary in a tax haven rises to 1.524%. Increasing levels of intangible assets (the ones contemplated within the balance sheets, not the ones expensed like software developed in-house or more ‘ethereal’ like knowledge) show decreasing likelihood of owning a subsidiary in a tax haven, with intervals of confidence that range between 5 and 10%. The percentages are tiny, for a 1% increase in the amount of intangible assets over total assets, the odds of owning a subsidiary in a dot jurisdiction decrease by 0.000307%. This finding probably means that as firms grow larger, with increased use of intangibles, the incentive to manage these intangibles via a tax haven subsidiary decrease, as there might be increasing costs associated with managing a disaggregated and increasingly complex system of brands, patents and other intangibles across multiple jurisdictions.

Now, when it comes to firm classification, non-digital manufacturing firms are the benchmark (so they are zero percent). The results are quite revealing. Digital manufacturers show the lowest propensity of being in a dot, with a small and insignificant coefficient; but when it comes to the Big 7 jurisdictions, these skyrocket to the highest of all firms: 9.47% of having a subsidiary in one of the seven tax havens with the largest economic activity, with a one percent significance. Now, it is interesting that, for service firms, non-digital service firms have a higher propensity of having a presence in a dot tax haven (3.46%) over digital service firms (2.13%), but the tendency inverts for the larger jurisdictions. For the Big 7, being a digital service firm increases the risk of a tax haven by 6.64%, whereas for the non-digital service firms the risk is 4.68%, all relative to non-digital manufacturers. This indicates that these Big 7 jurisdictions are offering a competitive advantage to digital service firms, encouraging their use over the dot. Since we observe a higher propensity of tax haven use for digital firms (manufacturers and services) when it comes to larger jurisdictions, we cannot reject hypothesis 1.1.

This necessitates a comparison with existing literature. Janský (2020) looks at data from the United States Bureau of Economic Analysis and, for US-based MNEs, compared it with the declared profits within jurisdictions and the actual amounts of labour and investment in such jurisdictions to determine which are the favourite jurisdictions for shifting profits. Janský (2020) finds that different industries prefer different jurisdictions. The computers and electronic and information industry (which roughly overlap with our definition of digital firms) shows a particular preference for Ireland. However, Janský's (2020) methodology is limited by data availability – tax and gross profits are missing from the data for some jurisdictions. This means our results require further refining, hence motivating our hypothesis 1.2.

Table 5.4 reports selected results for the alternative specification of hypothesis 1, which we call hypothesis 1.2., where we distinguish NACE 2-digit codes between digital and non-digital. Table B3 (Appendix) reports the entire marginal effects and Table B4 the logistic regression.

Table 5.4: Hypothesis 1.2 results (marginal effects) – selection

VARIABLES	J&T 2016(Dots)	J&T 2018	H&R 1994	Big 7
Digital Wholesale	0.0235	0.0593***	0.0256	0.0846***
	(0.0161)	(0.0194)	(0.0162)	(0.0200)
Digital Retail	0.0455**	0.0252	0.0244	0.0582*
	(0.0219)	(0.0271)	(0.0195)	(0.0298)
Digital Publishing	0.0194*	0.0947***	0.0211*	0.137***
	(0.0117)	(0.0181)	(0.0116)	(0.0205)
Digital Video, Film and	-0.0172	-0.0564***	-0.0223	-0.0474**
Sound	(0.0166)	(0.0184)	(0.0160)	(0.0192)
Digital	0.0154	0.0351*	0.00944	-0.00211
Telecommunications	(0.0112)	(0.0198)	(0.0106)	(0.0196)

Digital Computer Programming	0.0223***	0.0524***	0.0229***	0.0836***
	(0.00769)	(0.00964)	(0.00762)	(0.0104)
Digital Information Services	0.0301	0.0606**	0.0224	0.117***
	(0.0213)	(0.0261)	(0.0195)	(0.0286)
Digital Advertising	0.00751	0.0296	0.00846	0.0708***
	(0.0162)	(0.0202)	(0.0160)	(0.0231)
Digital Rental and Leasing	0.141**	0.126**	0.132**	0.0789
	(0.0552)	(0.0586)	(0.0551)	(0.0575)
Digital Gambling	0.137*	-0.0121	0.127*	-0.0801*
	(0.0779)	(0.0648)	(0.0765)	(0.0411)
Digital Computer Repair	-0.0411	0.0152	-0.0184	-0.0533
	(0.0265)	(0.0521)	(0.0339)	(0.0463)
Non-Digital Wholesale	-0.00529	0.00198	-0.00385	0.0174***
	(0.00354)	(0.00514)	(0.00356)	(0.00550)
Non-Digital Retail	0.0458***	0.0331***	0.0345***	0.0271**
	(0.00900)	(0.0112)	(0.00855)	(0.0122)
Non-Digital Land Transport	0.00295	-0.0502***	0.00269	-0.0274**
	(0.00985)	(0.0112)	(0.00979)	(0.0136)
Non-Digital Water Transport	0.132***	0.155***	0.117***	0.0852***
	(0.0221)	(0.0267)	(0.0215)	(0.0249)
Non-Digital Warehousing	0.0370***	0.0609***	0.0437***	0.0614***
	(0.0103)	(0.0131)	(0.0105)	(0.0136)
Non-Digital Hospitality	0.0355**	-0.0252	0.0340**	-0.00612
	(0.0142)	(0.0165)	(0.0142)	(0.0225)
Non-Digital Food and Beverage	0.0937***	0.0735***	0.0802***	0.0373
	(0.0259)	(0.0278)	(0.0249)	(0.0279)
Non-Digital Publishing	0.0202	0.0377*	0.00884	0.0271
	(0.0148)	(0.0203)	(0.0140)	(0.0204)
Non-Digital Real Estate	0.0850***	0.0755***	0.0774***	0.0470***
	(0.00935)	(0.0110)	(0.00907)	(0.0116)
Non-Digital Legal and Accounting	0.117***	0.113***	0.104***	0.0791***
	(0.0203)	(0.0223)	(0.0201)	(0.0235)
Non-Digital Consultancy	0.0719***	0.111***	0.0661***	0.134***
	(0.00600)	(0.00773)	(0.00584)	(0.00804)
Non-Digital Advertising	0.0225	0.138***	0.0203	0.180***
	(0.0245)	(0.0360)	(0.0236)	(0.0394)
Observations	243,167	243,167	243,167	243,167
R^2	0.1592	0.1644	0.1491	0.1600

Notes: variables of interest grouped based on NACE Rev.2 (2008) as explained in Chapter 3. All monetary values are in USD and using GDP deflators. Clustered standard errors are at the MNE level. All explanatory variables are lagged one period. Robust standard errors are in parentheses.
** p < 0.1. ** p < 0.05. *** p < 0.01.*

The results are quite compelling. The digital service industry is not a monolith and does not seem to show a particular preference for using dot tax havens (the ones described by Jones and Temouri, 2016). Digital retail firms have a propensity for using dot tax havens, higher than non-digital manufacturers by 4.55%, a percentage that is significant. The software and computer programming industry show a propensity of 2.23%, relative to non-digital manufacturers, which is highly significant. But two sectors stand out: the leasing and rental of intellectual property shows a 14.1% propensity of being present in a dot tax haven, while their propensity of being in a Big 7, those jurisdictions that have a significant amount of economic base, is lower and non-significant, indicating that this business model obtains advantages from owning subsidiaries within dot jurisdictions. Another sector of the digital economy with an even more interesting pattern is the gambling industry. Although with lower significance than others, the gambling industry shows a propensity to own a subsidiary in a dot that is 13.7% higher than non-digital manufacturers, and a negative propensity to own a subsidiary in a Big 7 jurisdiction of 8.01%.

Now, there is clearly a preference for Big 7 jurisdictions for many sectors within the digital economy. The digital publishing, software and programming, and the advertising industry have a clear preference for the Big 7 jurisdictions, with 13.7%, 8.36% and 7.08% respectively. But, bearing in mind that these are jurisdictions with a large population and high levels of economic activity, it is very possible that these firms are obtaining location advantages that stem not from the ability to shift profits and manipulate expenses. The results of the digital retail and wholesale industry are also interesting. Wholesalers prefer performing FDI in the Big 7 (8.46%) whereas retailers are ambivalent (4.55% in the dot and 5.82% in the Big 7), relative to non-digital manufacturers. We cannot finish our review without highlighting the negative results for the video and picture industry when it comes to owning a subsidiary in a Big 7 tax haven, or the insignificant results of the telecommunications sector.

The risk posed by digital firms exists, but there are sectors among the non-digital sector that pose a similar risk but have not raised similar alarms for the OECD and the EU: the real estate, legal and accounting and the consultancy sectors show a preference for performing FDI in tax havens. Real estate shows a propensity of owning subsidiaries in dot jurisdictions at least 8.5% higher than non-digital manufacturers. Accounting and consultancy are ambivalent, with accounting showing a propensity of 11.7% of using dot jurisdictions and 7.91% of having a presence in a Big 7 location. For consultancy, the probabilities are inversed: 13.4% in a Big 7 and 7.19% in a dot. The part of the advertising business that cannot be linked to digital objects shows an 18% increased likelihood of performing investments in one of the Big 7 jurisdictions.

Table 5.5 reports the marginal effects for hypothesis 2. To determine the role that intangible assets (within the balance sheets) play for firms, related to propensity of being located in a tax haven jurisdiction, we have prepared four interaction variables between our intangible asset ratio (IATA) and four dummy variables for firms (digital service firm, non-digital service firm, digital manufacturer, non-digital manufacturer). Table B5 in the appendix contains the logistic regression that was used to prepare these marginal results.

Table 5.5: Hypothesis 2 results (marginal effects)

VARIABLES	J&T 2016(Dot)	J&T 2018	H&R 1994	Big 7
Digital Services	0.0248***	0.0488***	0.0234***	0.0792***
	(0.00644)	(0.00771)	(0.00637)	(0.00836)
Non-Digital Services	0.0426***	0.0526***	0.0385***	0.0595***
	(0.00289)	(0.00375)	(0.00286)	(0.00396)
Digital Manufacturers	0.00486	0.105***	0.00498	0.0994***
	(0.00944)	(0.0161)	(0.00926)	(0.0171)
Intang. Assets/Total	-6.72e-06***	-1.80e-05***	-6.64e-06***	-2.06e-05***
Assets (IATA)	(1.98e-06)	(3.80e-06)	(1.94e-06)	(4.30e-06)
IATA * Digital Services	0.0355**	0.0430*	0.0319**	0.0205
	(0.0157)	(0.0245)	(0.0158)	(0.0259)
IATA * non-Digital	-0.000107	1.82e-05***	-0.000813	2.09e-05***
Services	(0.000666)	(3.84e-06)	(0.00112)	(4.33e-06)
IATA * Digital	0.134***	0.134**	0.133***	0.131*
Manufacturers	(0.0386)	(0.0621)	(0.0377)	(0.0698)
IATA * non-Digital	0.108***	0.209***	0.103***	0.248***
Manufacturers	(0.0112)	(0.0196)	(0.0110)	(0.0210)
Log Cash Flow	0.0297***	0.0471***	0.0285***	0.0432***
	(0.000868)	(0.00122)	(0.000859)	(0.00130)
Log Turnover	-0.00486***	0.00187	-0.00520***	0.00686***
	(0.000811)	(0.00123)	(0.000797)	(0.00132)
Parent Age	0.000109***	0.000405***	0.000127***	0.000606***
	(3.68e-05)	(6.06e-05)	(3.64e-05)	(6.67e-05)
Observations	243,248	243,248	243,248	243,248
R^2	0.1489	0.1565	0.1408	0.1526

Notes: variables of interest grouped based on NACE Rev.2 (2008) as explained in Chapter 3. All monetary values are in USD and using GDP deflators. Clustered standard errors are at the MNE level. All explanatory variables are lagged one period. Robust standard errors are in parentheses.

** p < 0.1. ** p < 0.05. *** p < 0.01.*

The baseline of IATA (the ratio of intangible assets over total assets) is always significant in this specification (a different development from the result of Hypothesis 1). The coefficient is small and always negative for all the jurisdictions, though larger for the dot tax havens. This can be interpreted as, for all firms, increased levels of intangible assets over total assets are linked with lower propensity to be present in a tax haven, perhaps because as firms become larger there are less gains to be obtained from relocating these intangible assets in tax havens. Still, the results paint a vastly different picture between the four types of firms. For digital service firms, every 1% increase of their rate of intangible assets over total assets increases the propensity of owning a subsidiary in a dot tax haven by 3.55%, whereas the results for Big 7 jurisdictions are not significant. We need to remember here that our assumption of tax haven use is not the same for the dots and the Big 7, and the absence of a significant, positive correlation between intangible asset use and the Big 7, it reinforces the idea that the FDI performed by digital firms in these jurisdictions is done for actual economic performance and not tax avoidance. And again, these "intangible assets" in the balance sheets do not include intangibles that are expensed (such as in-house made software or R&D expenditure) or consist of knowledge or employee training. Intangibles that are not balance assets per accountancy rules cannot be relocated easily to a tax haven. There is no legal basis to transfer mere "knowledge" to a subsidiary in a tax haven, unlike a brand or patent that is backed by legal frameworks. The results invert for non-digital service firms. For these firms, increased percentage of intangibles over total assets cause a significant propensity for increasing their use of subsidiaries in the Big 7 jurisdictions, but the impact is small, a 0.0208% increase in likelihood for every 1% increase of intangibles over total assets, so it is practically nullified with the overall tendency of IATA that has a similar coefficient of the opposite sign.

These results contrast with the manufacturing sector. The manufacturing sector is the one where the intangible assets (within the balance sheets) increase the likelihood of having invested in a tax haven, both large and small. For digital manufacturers, it is quite linear: every 1% increase in intangible assets increases the propensity of having performed FDI within a tax haven by 13%, be it a dot, a Big 7 or a Jones, Temouri and Cobham (2018) tax haven. But the non-digital manufacturing sector has an even higher propensity of having a presence in a Big 7, with a 24.8% increase for every 1% increase in intangible assets over total assets, and the usage of dot jurisdictions still exceeds that of service firms, with each 1% increase in intangibles increasing the likelihood by 10.8%. Again, we must reiterate that tax haven use is a proxy for transfer price manipulation, and that this manipulation is easier to presume the smaller the economy where FDI is performed, but still, 13.4% for digital manufacturers and 10.8% for non-digital manufacturers are quite telling numbers. On the disparity of manufacturers and service firms, our findings concur with Haskell and Westlake (2018), who observed that manufacturing firms tend to possess more valuable intangible assets relative to service firms. These assets provide manufacturing firms with sustainable competitive advantages. With these results we cannot reject Hypothesis 2, but with the observation that digital service firms are not the ones posing the highest risk.

Hypothesis 3 deals with our final consideration. The EU Digital Tax uses a criterion based on global turnover. We want to observe if increasing levels of operating revenue turnover does increase the likelihood of owning a subsidiary in a tax haven jurisdiction, and if turnover is therefore a useful criterion to determine international taxation risk. Table 5.6 reports the marginal effects for hypothesis 3. To determine the role that operating revenue turnover plays for firms, related to propensity of having a presence in a tax haven jurisdiction, we have prepared four interaction variables between turnover and the four dummy variables for firms (digital service firm, non-digital service firm, digital manufacturer, non-digital manufacturer). Table B6 in the appendix contains the logit regression that was used to prepare these marginal results.

Table 5.6: Hypothesis 3 results (marginal effects)

VARIABLES	J&T 2016(Dot)	J&T 2018	H&R 1994	Big 7
Digital Services	0.278***	0.344***	0.259***	0.367***
	(0.0921)	(0.0718)	(0.0911)	(0.0703)
Non-Digital Services	0.340***	0.394***	0.338***	0.337***
	(0.0327)	(0.0193)	(0.0330)	(0.0252)
Digital Manufacturers	-0.0855***	-0.163***	-0.0829***	-0.119**
	(0.00434)	(0.0141)	(0.00413)	(0.0588)
Log Turnover (LTurn	0.00768***	0.0210***	0.00693***	0.0213***
	(0.00131)	(0.00184)	(0.00128)	(0.00193)
LTurn * Digital Services	-0.00953***	-0.0141***	-0.00887***	-0.0127***
	(0.00179)	(0.00255)	(0.00175)	(0.00265)
LTurn * non-Digital Services	-0.0144***	-0.0237***	-0.0140***	-0.0179***
	(0.00120)	(0.00168)	(0.00117)	(0.00179)
LTurn * Digital Manufacturers	0.0126**	0.0212***	0.0127**	0.0119*
	(0.00511)	(0.00640)	(0.00497)	(0.00692)
LTurn * non-Digital Manufacturers	-0.00328***	-0.00315***	-0.00301***	-0.00141***
	(0.000284)	(0.000423)	(0.000278)	(0.000454)
Intang. Assets/Total Assets (IATA)	-4.22e-06**	-8.60e-06**	-4.36e-06**	-7.82e-06*
	(1.97e-06)	(3.86e-06)	(1.93e-06)	(3.99e-06)
Log Cash Flow	0.0283***	0.0447***	0.0270***	0.0421***
	(0.000876)	(0.00120)	(0.000867)	(0.00128)
Parent Age	0.000102***	0.000371***	0.000120***	0.000561***
	(3.71e-05)	(6.04e-05)	(3.66e-05)	(6.67e-05)
Observations	243,248	243,248	243,248	243,248
R^2	0.1557	0.1601	0.1475	0.1526

*Notes: variables of interest grouped based on NACE Rev.2 (2008) as explained in Chapter 3. All monetary values are in USD and using GDP deflators. Clustered standard errors are at the MNE level. All explanatory variables are lagged one period. * p < 0.1. ** p < 0.05. *** p < 0.01.*

The results on increasing levels of operating revenue turnover are interesting. The overall effects are positive and significant, with a 2.17% percentage for the Big 7 tax havens and 0.768% for the dots. Now, interestingly, the results are negative and highly significant for three of these categories: the digital service firms, the non-digital service firms, and the non-digital manufacturers. For each of these industries, the likelihood of owning a subsidiary in a tax haven jurisdiction decreases. For digital manufacturing, the results are positive and significant, but only for one list of tax havens: the ones from Jones, Temouri and Cobham (2018). Regarding the European Commission's initiative to single out three digital business models, we can affirm that higher levels of turnover increase the likelihood for firms of all types to perform FDI in a tax haven jurisdiction, potentially with the intent of engaging in tax avoidance. This risk is systemic. Digital firms are not engaging in tax avoidance via tax haven use with a higher frequency than other types of firms, and with no ability to predict tax haven use based on turnover there is no economic reason why turnover should be used by the EU Digital Tax as the threshold to determine which firms should pay the digital tax. With this in mind, we must reject the null hypothesis.

5.5. Conclusions and policy implications

The digital economy does indeed pose many threats to the current taxation frameworks. Our research has indeed shed light over some of the tendencies. Our research has shown that the digital service industry is quite diverse and heterogeneous in tax haven use. It would be a mistake to exclusively target digital firms. Many service firms operating in traditional industries, such as the hospitality or the transport industry, are posing as much of a tax risk as the new digital firms.

This chapter has also highlighted that the efforts put into tackling the issue of tax avoidance in the digital economy have been pushing in the wrong direction. Digital firms are prone to using tax havens, and so are other types of firms. Intangible assets are linked to higher chances of using tax havens, but the manufacturing firms are the ones where intangibles play a more significant role – considering that some definitions of the digital firm do not even consider the possibility of a 'digital manufacturer', as seen in Chapter 2. Higher levels of operating revenue turnover are linked to higher likelihood of using tax havens, but these effects cannot be specifically linked to a category such as firms operating in the digital economy. Our research shows that intangible assets are a determinant of tax avoidance for all types of firms. These cannot be used to isolate certain industries.

5.5.1. Theoretical and policy implications

Our research shows that, once again, the frameworks that are often used by the international business (IB) discipline can be applied to the use of tax havens by firms who are seeking to reduce their tax expenses. Considering the differences of tax haven usage across firm classifications, with distinct patterns depending on whether the firms are digital or non-digital and among service and manufacturing firms, underscores the need for IB theories to account for industry-specific behaviour, firm size, and asset structures. The results of this chapter confirms that there is a sustainable competitive advantage enticing firms to perform FDI in tax haven jurisdictions and shows a positive correlation between being a firm identified as digital and performing FDI in a jurisdiction recognised as a tax haven. However, the negative association between intangible assets and tax haven use contradicts the traditional assumption that firms with high levels of intangible assets are more likely to exploit tax havens. Instead, the results suggest that as firms grow larger and more complex, the benefits of relocating intangible assets to tax havens diminish. This contrast in tax haven usage between digital and non-digital firms calls for sector-specific adaptations to IB frameworks. Wrapping up with the theme of these thesis, the same ownership advantage we have identified in the previous chapter (scalability), that has enabled this growth of the digital economy, does not seem linked to increased uses of tax havens, which are a crucial part of the tax avoidance toolkit. Despite their reliance on intangible assets, the results indicate that manufacturing firms, especially non-digital ones, may pose a greater risk for profit shifting. This insight necessitates a re-evaluation of the theoretical emphasis placed on digital firms in tax avoidance discourses. Furthermore, the findings that higher turnover decreases the likelihood of tax haven use for certain industries but increases it overall suggest that turnover may serve as a moderating factor rather than a direct predictor of international tax strategy.

Still, our results show once again that international business theories such as the eclectic paradigm are applicable when describing the usage of tax haven jurisdictions. Our research also extends international business to the study of the digital firm, combining the enquiries about their peculiar nature with the existing frameworks of the IB discipline.

5.5.2. Managerial implications

There are some implications for managers in this research. Of course, this chapter is not going to give advice on how to better perform tax avoidance. Rather, this chapter shows that digital firms are affected by similar incentives to engage in tax haven investment as any other type of firm (Jones and Temouri, 2016). It is their peculiarities that make them stand apart. Firms will set up their internal markets in such a manner that provides them with competitive advantage (Rugman and Verbeke, 2005) and saving on taxes is a way to cut costs within a corporation, a source of competitive advantage (Palan, Murphy and Chavagneux, 2013).

Our findings underscore the importance of strategic planning for tax compliance. Managers must evaluate the long-term costs and risks associated with tax haven use, particularly for firms with high intangible assets, where complex asset structures may reduce the profitability and effectiveness of such strategies. For digital firms, focusing on legitimate economic activities in Big 7 jurisdictions offers a path to mitigate reputational risks and avoid regulatory scrutiny. These firms can benefit from the advantages of the economies of such jurisdictions, while also enjoying the lower taxation and availability of financial services. Sector-specific strategies are equally crucial. Managers in manufacturing sectors should prioritise regulatory compliance given their higher propensity for tax haven use. Developing robust internal protocols aligned with emerging international tax policies is essential to navigating these risks. Similarly, service firms, particularly those in consultancy and advertising, should consider how their relatively lower tax haven usage aligns with their competitive strategies and regulatory requirements. It should be clear for digital firms (both services and manufacturers) that their intangible assets do indeed hold great value, and that managerial practices must be oriented to increase and enhance that value. When it comes to scrutiny from tax authorities, firm managers must make clear that the digital economy, as shown by this research, is not a monolithic block, and that some sectors within the digital economy show fewer use of tax haven jurisdictions compared to others. The manufacturing sector, both digital and non-digital, risk facing extra scrutiny from the tax authorities if they notice the links between increasing levels of intangibles. This is a time of global tax reforms, and firms will need to adapt to new standards. Firms will need to build strong reporting and compliance mechanisms will not only ensure adherence to these reforms but also provide a competitive edge in navigating the evolving tax landscape.

5.5.3. Contributions

This chapter makes several valuable contributions to both research and practice. By analysing panel data from OECD firms, spanning 2008–2019, we provide a longitudinal perspective that captures trends and sector-specific behaviours over an extended period, without the potential taint that the Covid-19 pandemic might bring in. The distinction between dot and Big 7 tax havens offers a nuanced understanding of jurisdictional preferences, enriching the existing literature on tax avoidance.

Our research has revealed some interesting findings. Our first hypothesis adds to the literature of tax haven use within the international business frameworks, as we have shown once again how the eclectic paradigm, and the FSA/CSA paradigm can explain the determinants of digital firm investment in tax havens. We have shown that there is diversity across the industries, and that firms operating in the digital economy show variation and behave differently depending on the industry, with some firms showing higher risk than others. We have shown how intangibles play a role in setting up a presence in a tax haven, highlighting differences between digital service firms and digital manufacturers, while also revealing that it is manufacturing firms, digital and non-digital, where higher levels of intangible asset ownership increase the likelihood of owning a subsidiary in a tax haven. Finally, our third hypothesis reveals that establishing a threshold for a series of firms based on operating revenue turnover cannot be justified with the evidence at hand, as there are no more risk levels associated with increased levels of turnover when moderating for firm classification.

From a theoretical standpoint, the integration of variables such as intangible assets and turnover into tax haven analysis enriches our understanding of IB theory. These findings illuminate the interplay of organisational structure and sector-specific dynamics in tax avoidance strategies, offering a framework for future research. By highlighting the complexity of tax haven use, the study bridges theoretical, policy, and managerial perspectives, advancing the discourse on international business and tax compliance.

Our findings have direct relevance for policy and managerial decision-making. They inform international tax policy debates and challenge existing assumptions about the behaviour of digital firms and the appropriateness of turnover thresholds. Managers can use these insights to craft more informed and compliant international business strategies, while policymakers can refine tax frameworks to address systemic risks across industries effectively.

5.5.4. Limitations

The first limitation that arises from this study comes from identifying some of the sectors. Further research is necessary to re-classify and re-categorise some of the firms within our four categories (digital vs non-digital and service vs manufacturers). The use of NACE codes from 2008 also poses issues. Some codes do not distinguish between activities conducted over digital or traditional objects. Despite these issues, this remains a major contribution; the limitations are to be expected due to the novelty of the topic. We acknowledge a second limitation, arising from the fact that we have only utilised firms from developed countries. Results from developing countries might not corroborate this approach. A third limitation to our approach is the bias regarding hierarchical decision making, where knowledge flows strictly downwards from the headquarters into the foreign subsidiaries (Da Silva Lopes, Casson and Jones, 2019).

This translates in our case to the assumption that most subsidiaries in dot tax havens are being used as “puppets” in the hands of the corporate headquarters and little to no economic activity takes place within these jurisdictions. We use a remedy for it by comparing the use of subsidiaries in small jurisdictions with minuscule economic basis and population with the use of subsidiaries in jurisdictions recognised as tax havens that have larger levels of economic activity and population.

5.5.5 Avenues of future research

This chapter opens several avenues of research. There are opportunities to provide further contributions with further subdivisions between varieties of capitalism, comparisons between countries, verifying whether these predictions hold for developing countries, utilising refined categorisations between digital manufacturers provided in Chapter 2, and finally, the chance that more modern NACE or other industrial classifications will remove some of the issues from NACE Rev.2. Other potential avenues of future research include checking how digital firms choose the tax havens they perform FDI in: are there sub-sectorial preferences? Are there other determinants not yet described or theorised? Does the nationality of the home country where the parent firm is located influence the choice?

CHAPTER 6: CONCLUSIONS

This doctoral thesis has sought to provide a thorough exploration of the intricate nature of digital firms, shedding light on their defining characteristics, operational dynamics, and interactions with regulatory and economic frameworks. We have sought to integrate theoretical perspectives with empirical analysis, literature reviews with panel data analysis, to bridge the gap in the existing literature while providing a deeper understanding on the implications of the ownership advantages that digital firms possess when it comes to productivity and tax avoidance. This doctoral thesis bridges gaps in existing literature and provided a deeper understanding of the role that digital firms play within the global business landscape.

With the backdrop of the Base Erosion and Profit Shifting (BEPS) initiative sponsored by the OECD, the practical purpose of this thesis is to shed light on the assumptions and concerns of this initiative, and on the assumptions of the Digital Tax sponsored by the European Union. Within the thesis, we report several novel empirical texts concerning the theoretical models we have proposed regarding the characteristics of the digital firms, their productivity, and their use of tax havens. This chapter provides a summary of the main findings of this thesis, the implications for policy makers and managers and the limitations of our studies, theoretical and empirical. But the conclusions do not stop at the Digital Tax or the BEPS initiative. Rather, these extend across several domains, providing critical insights for theory, policy, and practice, while also highlighting the limitations of the study and paving the way for future research.

6.1. Summary of key findings

This doctoral thesis examines eight research questions: (1) What are the defining elements of the digital firm? (2) What are the ownership advantages / firm specific advantages of the digital firm? (3) How do these ownership advantages affect digital firm productivity? (4) What role do intangible assets that are accounted for play in digital firm productivity? (5) Do digital firms benefit from their location in metropolitan areas? More or less than other types of firms? (6) Are digital firms more prone to using tax havens than traditional firms? (7) What role do intangible assets play when it comes to tax haven choice? (8) Is operating revenue turnover a good determinant to determine tax avoidance risk?

We have reviewed the current state of internalisation theory under the IB research project and extends its use to digital firms. We establish a clear and operational definition of digital firms, an area of ambiguity in existing scholarship. This doctoral thesis determines that a digital firm is not merely a user of digital tools or technologies but is fundamentally characterised by its primary activity of producing, distributing, or selling digital objects. These digital objects can intangible, such as software and algorithms, or tangible, such as smartphones and computers. Digital objects are constituted by bitstrings and derive their unique characteristics from this digital composition. Our definition distinguishes digital firms from traditional enterprises or those in the process of digital transformation, whose activities remain rooted in conventional outputs despite the adoption of digital tools. This approach solves question one: which firms are to be included under Action 1 (taxing the digital economy) of the BEPS initiative? The firms providing consumers and other firms with digital objects. We link there with the IT discipline, which defines the digital object as objects made of bitstrings (Faulkner and Runde, 2011, 2019; Hui, 2012; Kallinikos, Aaltonen and Marton, 2013). And because digital objects can be identified individually, they lend themselves to be classified into industrial categories such as NACE or SIC.

The identification of digital objects being made of or incorporating bitstrings allows for our second contribution, theoretical. We identify two ownership advantages predicable of digital firms: scalability and malleability. Scalability refers to the ability to replicate and distribute digital objects globally at minimal marginal cost, enabling exponential growth without commensurate increases in resource expenditure. Malleability, on the other hand, highlights the ease with which digital products can be adapted, modified, and innovated to meet evolving market demands. Malleability is predicated for all digital firms. Scalability is exclusive of digital service firms. Together, these advantages provide digital firms with unparalleled opportunities for efficiency and adaptability, setting them apart from traditional enterprises. These two ownership advantages have allowed firms to perform those extraordinary levels of growth identified by the literature (Casella and Formenti, 2018; Nambisan, Lyytinen and Yoo, 2020).

Scalability and malleability have implications for digital firms that go beyond the theoretical. Our empirical findings reveal significant sectoral disparities in how these advantages translate into productivity. Before we could even begin looking at the digital firms, we needed a measure of intermediate goods that could be applied to firms producing intangible goods. Our third contribution, theoretical, takes place in the field of productivity estimation, where we argue and show that the creditors account is a valid proxy for the intermediate good required by the Levinsohn and Petrin (2003) and the Wooldridge (2009) total factor productivity (TFP) estimation methods. This is because many service firms are not going to utilise intermediate tangible goods but need to pay periodical payments of software licenses, and as all firms will also have to pay for utilities and rent.

Digital service firms emerge as the most productive among all sectors, leveraging scalability and process efficiency to achieve superior total factor productivity. In contrast, digital manufacturers face unique challenges and underperform relative to their service-oriented counterparts and even traditional manufacturers. These findings underscore the variability in the impact of digitalisation across different industries, highlighting that being digital does not just make a firm more productive or profitable. Careful sector-specific consideration must be performed when making assumptions. Our research also examines the role of metropolitan locations in enhancing firm productivity. Metropolitan areas provide firms with skilled labour, advanced infrastructure, and knowledge networks, and for digital service firms this availability enhances and contributes to their competitive edge. For manufacturing firms, these advantages are less pronounced. Again, the benefits of operating in an urban environment cannot be generalised across sectors.

Finally, this doctoral thesis addresses tax avoidance in the digital economy. Our fourth theoretical contribution delves further into the field of foreign direct investment (FDI) under the FSA/CSA paradigm (Rugman, 2010), and elaborates further on the determinants of digital firms' FDI in tax havens, their preferences for destinations and their particularities regarding their intangible assets. Contrary to popular narratives, the study finds that digital firms are not uniquely predisposed to tax haven use. Traditional firms, particularly manufacturers, also engage significantly in tax avoidance strategies. While intangible assets play a critical role in enabling tax avoidance, their impact varies by sector, with manufacturing firms, both digital and non-digital, showing a higher propensity for such behaviour. This finding challenges the assumption that digital firms pose an outsized risk in tax avoidance and calls for a more nuanced approach to regulatory oversight.

Empirically, this thesis makes a series of contributions to the literature on digital firms. The results show that being a firm engaged in the digital economy (a digital firm) influences productivity and tax haven use and preference. Our fifth contribution shows that the firms we have identified as digital firms are the most productive of all. Relative to the baseline (non-digital manufacturers), digital firms are between 29.51% and 32.56% more productive – depending on our measure for productivity, Levinsohn and Petrin (2003) or Wooldridge (2009). Then come non-digital service firms, with a productivity higher than the reference by 24.69% to 21.55%. Digital manufacturers are less productive than their non-digital relatives, with a productivity that is between negative 6.52% and 2.46%. All these results are obtained while controlling for intangible assets over total assets, the age of the parent firm, cash flows, long term debt, total assets, and the year effects. When looking at sub-sectors, we can observe that digital service firms are not a monolith. Productivity within digital firms is not uniform, and a few such as digital retail (a code that includes many firms that design tangible digital objects but do not produce them themselves) have a TFP lower than digital manufacturing. Still, a few digital service firms are among the most productive within the OECD, such as digital publishing, video film and sound, broadcasting, computer programming, information services rental and leasing services, showing that these industries are at the lead of productivity in developed countries.

Our sixth empirical contribution shows that there is correlation between intangible assets within the balance sheets and improved productivity, but not specifically for digital firms. Rather, the general coefficient is significant, but close to zero, and once the intangible measure is interacted with the digital service or the digital manufacturer, it becomes insignificant. This does not mean that intangible assets are not enhancing digital firm TFP. There is evidence that they do from past research (Chen and Dahlman, 2006; Crass and Peters, 2014; Calligaris et al., 2018). However, the intangibles in the balance sheets are not much of a factor in TFP, suggesting that items such as brands do not boost TFP, whereas investments that do not appear in the balance sheets such as intangibles that are expensed or employee training are the ones making the difference. Still, intangible assets play a significant role in firms, digital and non-digital, as we will see in our eighth contribution.

Our seventh empirical contribution reveals that being in a metropolitan area boosts productivity between 0.1025 and 0.1039 for service firms, but the interaction for service firms and presence in a metropolitan area has a positive, yet small and insignificant coefficient. The fact that this interaction is not significant means that yes, being able to access the resources and skilled workforce of a metropolitan area is useful for digital service firms, but not in a manner that is inherently different to other service firms. For the manufacturing sector, the productivity boost ratios are even larger, between 0.1268 and 0.1532, but for digital manufacturers the interaction between being digital and metropolitan is negative and significant for the Levinsohn and Petrin (2003) estimation, a negative 0.0573. This should concern policymakers, as digital manufacturers within the OECD are not as skilled at taking advantage of the resources provided by metropolitan areas as much as digital service firms.

Our eighth empirical contribution reveals that, non-digital manufacturers being the benchmark again, digital firms are more prone to perform FDI in tax haven locations, but the preferences are not uniform. Being the reference category the non-digital manufacturers, digital manufacturers have a small preference for small tax havens (1.2%, and insignificant) while they much prefer tax havens with large economies (9.47% with high significance). When it comes to the service sector, digital service firms show preference for owning subsidiaries in a tax haven with a large economic and population base (6.64% vs 2.13% for the small dots). This hints that digital service firms FDI in jurisdictions considered as tax havens might not be so motivated by taxes as much as the other location advantages present in those jurisdictions. Non-digital service firms have a higher propensity of being present in a dot tax haven (3.46%) than digital service firms and show a lower amount of use of large tax havens (4.68%) than digital service firms. This divergence warrants a deeper look, and thus our ninth empirical contribution reveals stark differences across the industry: sectors like software and computer programming show a propensity for having a presence a small tax haven, only 2.23% higher than non-digital manufacturers, while for the large jurisdictions the percentage rises to 8.36%. For digital retailers, the propensity of owning a subsidiary in a dot is 4.55% and in a Big 7 is 5.82%. For the leasing and rental of intellectual property, that percentage grows to a staggering 14.1%. These numbers may look concerning, but they are not worse than the numbers of several non-digital service sectors, including water transport (13.2% for dots and 8.52% for Big 7, probably boosted because of the inclusion of Panama, a convenience flag, among the Big 7), legal and accounting (8.5% for dots, 4.7% for Big 7) or real estate (11.7% for dots, 7.91% for Big 7) that did not get so much attention from the BEPS initiative. Some digital industries, such as the video, film, and sound industries with a significant and negative propensity of having a presence in a tax haven of 4.74% deserve a special mention. On intangible assets, our tenth contribution reveals that, for the tax havens that pose the highest risk towards the international tax system, the small jurisdiction, a 1% increase in tax haven use increases the likelihood of digital service firms to be present a small tax haven jurisdiction by 3.55%, but the risk is insignificant for the Big 7 tax havens. This implies that digital service firms who are present in Big 7 tax havens (particularly, for our interest, Switzerland, and Ireland) are not attracted so much to the tax advantage as the other advantages these large jurisdictions provide. But the percentage is dwarfed by the manufacturing sector: a digital manufacturer will have their propensity of being present in a dot tax haven increased by 13.4% for a one percent increase in intangible over total assets (for the Big 7, it is 13.1%). Finally, our eleventh contribution reveals that one of the criteria chosen by the European Union regarding the digital tax (operating revenue turnover) does not seem to indicate a particular predisposition of digital service firms to use tax havens as turnover increases. Operating revenue turnover is positive for all firms, as an increase in 1% increases the chances of firms being users of tax havens by 2.17% for the Big 7 and 0.768% for the dots. This makes sense since turnover is a proxy for size. What is interesting for policy is that, when looking at what turnover implies for specific sectors, the results are all negative and significant, in a way that nullifies to an extent the tendency. Except for digital manufacturers, which show increased use of tax havens of all types as turnover increases, hinting that these, not the digital service firms targeted by the EU Commission, pose the highest taxation risk.

6.1.1 Why this topic matters

Beyond scholarly considerations of the digital object, the obsolete definitions, scalability, malleability, internalisation theory, intangible assets, metropolitan areas, productivity, tax havens, the overarching topic of this thesis, going back to the start is: digital technology is the future. Digital service firms are, as the results of this research shows, the most productive of all; these firms have strong capabilities that their managers are good at making use of, they are not particularly prone to using tax havens, hinting that they are not grave offenders when it comes to tax haven use. These are companies able of performing large economic feats in terms of growth and profitability. These dynamics matter when it comes to countries possessing a healthy and well-developed industrial ecosystem.

Digital service firms exhibit superior productivity compared to their non-digital counterparts. This improved efficiency bolsters host countries' GDP and global competitiveness, creating opportunities for sustained economic growth. Although these companies can, to a large degree, achieve placelessness, these prefer to be in urban areas. Although this can intensify regional inequality, with rural areas lagging in economic dynamism and job creation, it can also create clusters where other firms benefit in the form of spillovers. The current focus on regulating the digital economy, focusing on the perceived slights by the firms operating in the digital economy risks harming significantly a part of the economy that is currently thriving, and that risks being curtailed or harmed if public policies are enacted based on external characteristics and guesses.

6.2. Implications for theory

As established in the previous section, this doctoral thesis makes substantial contributions to theoretical discourses on digitalisation and international business, addressing long-standing gaps and inconsistencies in the literature. By providing a clear and operational definition of digital firms, it resolves ambiguities and circular reasoning prevalent in prior definitions. The anchoring of digital firms' identity in the production and manipulation of digital objects, alongside their unique ownership advantages of scalability and malleability, offers a robust conceptual framework that can be applied across disciplines.

This thesis both extends the application of internalisation theory on the digital firm, as well as extends a bridge with the information technology discipline. The findings also advance internalisation theory by incorporating the distinctive characteristics of digital firms. Scalability and malleability are presented as ownership advantages that fundamentally alter how digital firms manage resources, compete in global markets, and respond to dynamic environments. These insights extend the applicability of internalisation theory to the digital economy, enriching its explanatory power and relevance in contemporary contexts.

Additionally, the study underscores the importance of sectoral nuances in understanding digitalisation. The variability in productivity between digital service firms and digital manufacturers highlights the need for industry-specific adaptations of international business frameworks. By demonstrating that digitalisation's impact is neither uniform nor universally positive, the research calls for a more nuanced theoretical approach that accounts for these differences.

6.3. Policy and managerial implications

The findings in this thesis regarding digital firms contain relevant information for policy makers and managers.

6.3.1. Implications for policy makers

For policymakers, the findings of this thesis carry significant implications, particularly in the realms of regulation, taxation, and economic development. One of the most pressing issues highlighted is the inadequacy of existing industrial classification systems. Frameworks such as NACE Rev.2, which have not been updated since 2008, fail to capture the dynamic realities of digital transformation. This should be the time to get a new industrial classification for the digital economy. Policymakers must prioritise the modernisation of these systems to ensure accurate categorisation of firms, distinguishing between traditional and digital outputs. For example, distinguishing between e-books and printed books in publishing or digital and physical distribution in retail would significantly enhance regulatory precision.

Policymakers must also balance the promotion of innovation with the need to ensure fair competition. The scalability of digital firms allows them to dominate markets quickly, raising concerns about monopolistic tendencies and market concentration. Regulatory frameworks must be adapted to foster competition, reduce barriers to entry for smaller firms, and prevent anti-competitive practices. At the same time, policies should encourage responsible use of scalability and malleability, ensuring that these advantages benefit consumers and the broader economy. It needs to be noted that many of the leviathans that raised the alarms of the OECD and different governments might not be so strong as it first appeared: digital firms, especially service ones, are vulnerable to imitation and lack of customer loyalty. At the same time, malleability allows firms to re-invent themselves constantly, faster than a regulator can keep up.

In the realm of taxation, this doctoral thesis provides a nuanced perspective on the use of tax havens by digital firms. We must caution against generalised assumptions that digital firms are uniquely culpable in tax avoidance. Policymakers should develop sector-specific strategies that address the underlying drivers of tax haven use across industries. This includes recognising the role of intangible assets in facilitating tax avoidance and designing targeted measures to regulate their management. Attitudes towards digital firms must be very carefully considered. The results from this thesis show that digital service firms are the most productive of all firms, but beyond the Internet giants, digital service are not the most avid users of tax havens, nor are their intangible assets the ones posing the largest threat to the international taxation system. That corresponds to digital manufacturers. At the same time, in terms of productivity, the digital manufacturers do not seem to be doing so well and have lagged behind other sectors. For example, the scope of the BEPS project is limited: on the one hand, the productivity of digital firms is the highest, but their use of tax havens is not such a matter of public concern. Regulations must thread finely when it comes to balancing the needs to raise taxation income across OECD nations with the necessity of avoiding stifling the growth of this competitive sector.

Addressing regional disparities is another critical policy area. The findings suggest that metropolitan areas offer significant advantages for digital service firms, but these benefits are less accessible to firms in non-metropolitan regions. Policymakers should invest in digital infrastructure and innovation hubs in rural and underdeveloped areas, extending the benefits of digital transformation to a broader population. This includes initiatives to enhance digital connectivity, support regional clusters, and foster collaboration between firms and academic institutions. As mentioned earlier, digital manufacturers are showing limitations at taking advantages at the resources and workforce available at metropolitan areas.

This section cannot end without mentioning the European Commission's Digital Tax and the use of operating revenue turnover as a threshold to determine tax haven risk. Our results show that increases in turnover increase predisposition of tax haven usage for all firms. Turnover is a determinant of tax haven usage, but in general, not of a specific type of firms. Merely, large ones, and this should cast doubts on the wisdom of using operative revenue turnover as a determinant for taxation risk.

6.3.2. Implications for practitioners

For business leaders and managers of digital firms, the findings of this doctoral thesis offer actionable insights that should help them leverage the inherent advantages of their firms while addressing the challenges. Digital firms must prioritise investments in scalability-enabling resources, such as proprietary algorithms, platform ecosystems, and research and development. These investments not only enhance productivity but also provide a foundation for sustained competitive advantage. Malleability, another defining characteristic of digital firms, should be harnessed to foster continuous innovation and adaptability. By regularly updating and enhancing digital products, firms can respond effectively to evolving market demands, ensuring customer satisfaction and loyalty. Managers must also be vigilant in balancing the benefits of scalability and malleability with the risks of imitation, low switching costs, and rapid shifts in consumer preferences.

Tax compliance is another critical area for practitioners. Firms must adopt robust strategies that balance the cost-saving benefits of tax haven use with the reputational and regulatory risks involved. For digital firms, focusing on legitimate economic activities in jurisdictions with favourable tax policies can mitigate risks while maintaining competitive advantage. Sector-specific strategies are essential. Digital manufacturers must address the productivity challenges highlighted in this study. This includes integrating advanced digital technologies, optimising asset allocation, and exploring novel approaches to enhance efficiency. Service firms, on the other hand, should continue to leverage their inherent advantages, focusing on personalised customer experiences and scalable digital solutions.

6.4. Limitations of our study and future avenues of research

As far as we are concerned, this is the first time that research of this kind, in a quantitative manner, has been conducted on digital firms, and as such, despite the significant contributions, this doctoral thesis is not without limitations. One major limitation is the reliance on outdated industrial classification systems, such as NACE Rev.2. These systems fail to capture the nuances of hybrid and emerging business models, leading to potential misclassifications. Future research should prioritise the development of updated classification frameworks that reflect the realities of digital transformation. NACE, as an industrial classification, was not invented for this purpose of studying the digital economy. An example of that is how NACE does not distinguish between e-books and paper books. If a firm performs several activities, it may have multiple NACE codes, yet ORBIS will only reflect one. Then, there is the issue that commercial databases such as ORBIS provide data at firm-level, not plant-level. This reliance on firm-level data limits the ability to analyse plant-level dynamics and the interplay between digital and traditional activities within firms. Future studies could address this limitation by incorporating more granular data, offering deeper insights into the internal operations of digital firms. Right now, as it stands, the firm might very well operate different business, but be registered under just one code. Finally, a firm might be classified using an activity that is obsolete, raising questions on whether this company is still performing this activity (such as the manufacture of magnetic storage tape), and how it should be classified.

Additionally, the empirical chapters suffer, as it happens when doing quantitative data, from the availability of data, which has forced us to rely on proxies from ORBIS were available. Regarding Chapter 4, estimations that are performed on determinants of TFP can be prone to issues regarding collinearity: the TFP estimator already contains a measure of labour and assets. Finding good controls is not an easy task. The use of creditors, although creative, may have added some noise into the models. In Chapter 5, our research on tax haven use suffers from bias in decision making, as we assume that subsidiaries in tax havens are being mostly used as instruments and we cannot consider the actual economic activity that might be taking place in these locations without being able to look at the firm's operations. This issue is remedied by comparing jurisdictions in the dot tax havens to compensate for the potential issues on the larger jurisdictions.

A common limitation for Chapters 4 and 5 is that these models have been run for firms in the OECD, which are developed countries, and might not hold for developing nations. While it provides valuable insights into the dynamics of digital firms in these contexts, the findings may not be directly applicable to developing countries with different digital infrastructure and market conditions. Expanding the scope of research to include developing economies would provide a more comprehensive understanding of digitalisation's global impact.

Finally, our analysis of intangible assets, while thorough, does not fully explore certain critical factors, such as employee training and in-house software development. We do not have that data, and these areas warrant further investigation to understand their role in enhancing productivity and competitiveness.

Now, building on the findings and limitations of this study, several promising avenues for future research emerge. One area of interest is the dynamics of hybrid firms – those transitioning from traditional to digital operations. Understanding the challenges and opportunities these firms face would provide valuable insights into the process of digital transformation. The role of digital firms in developing economies is another critical area for exploration. Future research should examine how these firms operate in contexts with limited digital infrastructure and different regulatory environments, identifying the unique challenges and opportunities they encounter. From a pure IB perspective, the geographic and sectoral limitations of scalability warrant deeper investigation. Is scalability constant? Or are there lower returns as the firm leaves the region it comes from? What are the limits of scalability? What if the firm can scale up their platforms, but not at the pace that any physical infrastructure that relies for said platform? (for example, the case of Uber having to build a network of drivers every time it enters a city). Understanding the constraints of scalability in regions with underdeveloped infrastructure or industries with physical dependencies would provide a more nuanced understanding of digital firms' ownership advantages. And then there is malleability. What are the interrelations between the devices and the software running on the device? For complementary good, who has the upper hand in the de-facto partner dynamics? How do customer expectations affect malleable products? Who takes the blame if something goes wrong? Panel data analyses of productivity dynamics may offer valuable insights into how ownership advantages evolve over time and influence firm survival, market dominance, and competitive resilience. Expanding the framework to include the interplay between ownership advantages and network effects would also enhance our understanding of digital firms' competitive strategies. Then there is the possibility of looking at individual countries. How do these compare? How does performing FDI affect productivity of digital firms? How sensitive are digital firms to local taxes? Is there a "digital firm pathway" of FDI in tax havens or do digital firms simply copy what other firms in their environment are doing? And then, of course, there are the two final questions that we may have gotten a bit closer to answer: do we need a Digital Service Tax as the European Commission wanted? And can Action 1 of the BEPS initiative be completed in a way that leaves all nations involved satisfied?

REFERENCES

Abramovitz, M. (1956) ‘Resource and Output Trends in the United States Since 1870’, *The American Economic Review*, 46(2), pp. 5–23.

Acemoglu, D. *et al.* (2014) ‘Return of the Solow Paradox? IT, Productivity, and Employment in US Manufacturing’, *American Economic Review*, 104(5), pp. 394–399. Available at: https://doi.org/10.1257/aer.104.5.394.

Acquisti, A., Brandimarte, L. and Loewenstein, G. (2015) ‘Privacy and human behavior in the age of information’, *Science*, 347(6221), pp. 509–514. Available at: https://doi.org/10.1126/science.aaa1465.

Adner, R., Puranam, P. and Zhu, F. (2019) ‘What is Different About Digital Strategy? From Quantitative to Qualitative Change’, *Strategy Science*, 4(4), pp. 253–261. Available at: https://doi.org/10.1287/stsc.2019.0099.

Ahmad, N. and Schreyer, P. (2016) ‘Are GDP and productivity up to the challenges of the Digital Economy?’, *International Productivity Monitor*, 30, pp. 4–27.

Ambos, B. *et al.* (2019) ‘Unravelling agency relations inside the MNC : The roles of socialization , goal conflicts and second principals in headquarters-subsidiary relationships’, *Journal of World Business*, 54(2), pp. 67–81. Available at: https://doi.org/10.1016/j.jwb.2018.10.001.

Andrews, D., Criscuolo, C. and Gal, P.N. (2016) ‘The Best vs. the Rest: the Global Productivity Slowdown, Divergence across Firms, and the Role of Policy’, *OECD productivity working papers*, (5), pp. 1–76. Available at: http://dx.doi.org/10.1787/63629cc9-en.

Van Ark, B., O’Mahony, M. and Timmer, M.P. (2008) ‘The productivity gap between Europe and the United States: Trends and causes’, *Journal of Economic Perspectives*, 22(1), pp. 25–44. Available at: https://doi.org/10.1257/jep.22.1.25.

Arrow, K.J. (1962) ‘The Economic Implications of Learning by Doing’, *The Review of Economic Studies*, 29(3), p. 155. Available at: https://doi.org/10.2307/2295952.

Arrow, K.J. (1969) ‘The Organization of Economic Activity’, *The Analysis and Evaluation of Public Expending: The PPB System*. Washington, DC: U.S. Governement Printing Office.

Askenazy, P. and Gianella, C. (2000) ‘Le paradoxe de productivité : les changements organisationnels, facteur complémentaire à l’informatisation’, *Economie et statistique*, 339(1), pp. 219–241. Available at: https://doi.org/10.3406/estat.2000.7486.

Asmussen, C.G. and Foss, N.J. (2014) ‘Competitive Advantage and the Existence of the Multinational Corporation: Earlier Research and the Role of Frictions’, *Global Strategy Journal*, 4(1), pp. 49–54. Available at: https://doi.org/10.1111/j.2042-5805.2013.01068.x.

Asmussen, C.G., Larsen, M.M. and Pedersen, T. (2016) ‘Organizational Adaptation in Offshoring: The Relative Performance of Home- and Host-Based Learning Strategies’, *Organization Science*, 27(4), pp. 911–928. Available at: https://doi.org/10.1287/orsc.2016.1060.

Asmussen, C.G., Pedersen, T. and Dhanaraj, C. (2009) ‘Host-country environment and subsidiary competence : Extending the diamond network model', *Journal of International Business Studies*, 40(1), pp. 42–57. Available at: https://doi.org/10.1057/palgrave.jibs.8400420.

Avgerinou, M., Bertoldi, P. and Castellazzi, L. (2017) 'Trends in Data Centre Energy Consumption under the European Code of Conduct for Data Centre Energy Efficiency', *Energies*, 10(10), p. 1470. Available at: https://doi.org/10.3390/en10101470.

Báez, A. and Brauner, Y. (2019) 'Taxing the Digital Economy Post BEPS ... Seriously', *SSRN Electronic Journal*, 6–7(19), pp. 462–465. Available at: https://ssrn.com/abstract=3347503.

Bajgar, M. *et al.* (2020) *Coverage and representativeness of Orbis data*, *OECD Science, Technology and Industry Working Papers*. Available at: https://doi.org/10.1787/c7bdaa03-en.

Banalieva, E.R. and Dhanaraj, C. (2019) 'Internalization theory for the digital economy', *Journal of International Business Studies*, 50(8), pp. 1372–1387. Available at: https://doi.org/10.1057/s41267-019-00243-7.

Barker, J., Asare, K. and Brickman, S. (2017) 'Transfer pricing as a vehicle in corporate tax avoidance', *Journal of Applied Business Research*, 33(1), pp. 9–16. Available at: https://doi.org/10.19030/jabr.v33i1.9863.

Barry, F. (2019) 'Ireland and the changing global foreign direct investment landscape', *Journal of the Institute of Public Administration of Ireland*, 67(3), pp. 93–110. Available at: https://doi.org/10.2478/admin-2019-0022.

Bartelsman, E., van Leeuwen, G. and Polder, M. (2017) 'CDM using a cross-country micro moments database†', *Economics of Innovation and New Technology*, 26(1–2), pp. 168–182. Available at: https://doi.org/10.1080/10438599.2016.1202517.

Basker, E. (2012) 'Raising the barcode scanner: Technology and productivity in the retail sector', *American Economic Journal: Applied Economics*, 4(3), pp. 1–27. Available at: https://doi.org/10.1257/app.4.3.1.

Baumol, W.J., Blackman, S.A.B. and Wolff, E.N. (1989) *Productivity and American leadership: the long view*. Cambridge, MA: MIT Press.

Beaulieu, N., Dascalu, S.M. and Hand, E. (2022) 'API-First Design: A Survey of the State of Academia and Industry', in, pp. 73–79. Available at: https://doi.org/10.1007/978-3-030-97652-1_10.

Becker, G.S. (1964) *Human Capital*. New York: Columbia University Press.

Beer, S. and Loeprick, J. (2015) 'Profit shifting: drivers of transfer (mis)pricing and the potential of countermeasures', *International Tax and Public Finance*, 22(3), pp. 426–451. Available at: https://doi.org/10.1007/s10797-014-9323-2.

Bell, D. (1999) *The Coming of Post-Industrial society*. 2nd Ed. Basic Books.

Beugelsdijk, S. *et al.* (2010) 'Why and how FDI stocks are a biased measure of MNE affiliate activity', *Journal of International Business Studies*, 41(9), pp. 1444–1459. Available at: https://doi.org/10.1057/jibs.2010.29.

Van Beveren, I. (2012) 'TOTAL FACTOR PRODUCTIVITY ESTIMATION: A PRACTICAL REVIEW', *Journal of Economic Surveys*, 26(1), pp. 98–128. Available at: https://doi.org/10.1111/j.1467-6419.2010.00631.x.

Bharadwaj, A. *et al.* (2013) 'Digital Business Strategy: Toward a Next Generation of Insights', *MIS Quarterly: Management Information Systems*, 37(2), pp. 471–482.

Blanchard, O. and Simon, J. (2001) 'The Long and Large Decline in U.S. Output Volatility', *Brookings Papers on Economic Activity, The Johns Hopkins University Press*, 1, pp. 135–174. Available at: https://www.jstor.org/stable/1209161 (Accessed: 4 October 2023).

Blanco, L.R. and Rogers, C.L. (2014) 'Are Tax Havens Good Neighbours? FDI Spillovers and Developing Countries', *Journal of Development Studies*, 50(4), pp. 530–540. Available at: https://doi.org/10.1080/00220388.2013.874557.

Boccia, F. and Leonardi, R. (2016) *The Challenge of the Digital Economy*. Edited by F. Boccia and R. Leonardi. Cham: Springer International Publishing. Available at: https://doi.org/10.1007/978-3-319-43690-6.

Bogner, E. *et al.* (2016) 'Study Based Analysis on the Current Digitalization Degree in the Manufacturing Industry in Germany', *Procedia CIRP*, 57, pp. 14–19. Available at: https://doi.org/10.1016/j.procir.2016.11.004.

Bolwijn, R., Casella, B. and Rigo, D. (2018) 'An FDI-driven approach to measuring the scale and economic impact of BEPS', *Transnational Corporations*, 25(2), pp. 107–143. Available at: https://doi.org/10.18356/c4f9fd3c-en.

Bondi, A.B. (2000) 'Characteristics of scalability and their impact on performance', *Proceedings Second International Workshop on Software and Performance WOSP 2000*, pp. 195–203. Available at: https://doi.org/10.1145/350391.350432.

Bournakis, I. and Mallick, S. (2018) 'TFP estimation at firm level: The fiscal aspect of productivity convergence in the UK', *Economic Modelling*, 70(2018), pp. 579–590. Available at: https://doi.org/10.1016/j.econmod.2017.11.021.

British Computer Society (2014) *The Digital Economy*. Available at: https://policy.bcs.org/sites/policy.bcs.org/files/digital economy Final version_0.pdf (Accessed: 29 November 2019).

British House of Commons (2016) *The Digital Economy*, *House of Commons Business, Innovation and Skills Committee*. Available at: https://publications.parliament.uk/pa/cm201617/cmselect/cmbis/87/87.pdf (Accessed: 7 January 2024).

Brouthers, K.D., Geisser, K.D. and Rothlauf, F. (2016) 'Explaining the internationalization of ibusiness firms', *Journal of International Business Studies*, 47(5), pp. 513–534. Available at: https://doi.org/10.1057/jibs.2015.20.

Bryan, D., Rafferty, M. and Wigan, D. (2017) 'Capital unchained: finance, intangible assets and the double life of capital in the offshore world', *Review of International Political Economy*, 24(1), pp. 56–86. Available at: https://doi.org/10.1080/09692290.2016.1262446.

Brynjolfsson, E. and Hitt, L.M. (2003) 'Computing Productivity: Firm-Level Evidence', *MIT*

Sloan Working Paper, Brynjolfss(June). Available at: https://doi.org/10.2139/ssrn.290325.

Brynjolfsson, E. and Kahin, B. (2000) 'Understanding the Digital Economy: Data, Tools, and Research', in. Cambridge, MA: The MIT Press, pp. 1–10.

Brynjolfsson, E. and McAfee, A. (2014) *The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies*. 1st edn. New York: W. W. Norton. Available at: https://doi.org/10.1177/1946756714541404.

Brynjolfsson, E., Rock, D. and Syverson, C. (2017) 'Artificial intellegience and the modern productivty paradox', *NBER WORKING PAPER SERIES*, 24001, pp. 1–44. Available at: http://www.nber.org/papers/w24001.

Buckley, P. and Casson, M.C. (2019) 'Decision-making in international business', *Journal of International Business Studies*, 50(8), pp. 1424–1439. Available at: https://doi.org/10.1057/s41267-019-00244-6.

Buckley, P.J. (2006) 'Stephen Hymer: Three phases, one approach?', *International Business Review*, 15(2 SPEC. ISS.), pp. 140–147. Available at: https://doi.org/10.1016/j.ibusrev.2005.03.008.

Buckley, P.J. and Casson, M.C. (1976) *The Future of the Multinational Enterprise*. 1st edn. London: Palgrave Macmillan UK. Available at: https://doi.org/10.1007/978-1-349-02899-3.

Buckley, P.J. and Casson, M.C. (1998) 'Models of the Multinational Enterprise', *Journal of International Business Studies*, 29(1), pp. 21–44. Available at: https://doi.org/10.1057/palgrave.jibs.8490023.

Buckley, P.J. and Casson, M.C. (2009) 'The internalisation theory of the multinational enterprise: A review of the progress of a research agenda after 30 years', *Journal of International Business Studies*, 40(9), pp. 1563–1580. Available at: https://search.ebscohost.com/login.aspx?direct=true&db=edsbl&AN=RN261202977&site=eds-live&authtype=ip,shib&custid=s9815128.

Buckley, P.J. and Strange, R. (2011) 'The Governance of the Multinational Enterprise: Insights from Internalization Theory', *Journal of Management Studies*, 48(2), pp. 460–470. Available at: https://doi.org/10.1111/j.1467-6486.2010.00920.x.

Bukht, R. and Heeks, R. (2017) 'Defining, conceptualising and measuring the digital economy', *International Organisations Research Journal*, 13(2), pp. 143–172. Available at: https://doi.org/10.17323/1996-7845-2018-02-07.

Calligaris, S. *et al.* (2018) 'The productivity puzzle and misallocation: an Italian perspective', *Economic Policy*, 33(96), pp. 635–684. Available at: https://doi.org/10.1093/EPOLIC/EIY014.

Cannas, F. (2015) 'The last developments of the digital economy and bitcoins as a "stress test" for the EU VAT system', *World Journal of VAT/GST Law*, 4(2), pp. 69–87. Available at: https://doi.org/10.1080/20488432.2015.1096631.

Cantwell, J. (2015) *The eclectic paradigm a framework for synthesizing and comparing theories of international business from different disciplines or perspectives*. London. Palgrave Macmillan.

Cantwell, J. and Mudambi, R. (2005) 'MNE competence-creating subsidiary mandates', *Strategic Management Journal*, 26(12), pp. 1109–1128. Available at: https://doi.org/0.1002/smj.497.

Cantwell, J. and Narula, R. (2001) 'The Eclectic Paradigm in the Global Economy', *International Journal of the Economics of Business*, 8(2), pp. 155–172. Available at: https://doi.org/10.1080/13571510110051504.

Casella, B. and Formenti, L. (2018) 'UNCTAD insights: FDI in the digital economy: A shift to asset-light international footprints', *Transnational Corporations*, 25(1), pp. 101–130. Available at: https://doi.org/10.18356/cb688e94-en.

Casson, M. (2015) 'Coase and International Business: The Origin and Development of Internalisation Theory', *Managerial and Decision Economics*, 36(1), pp. 55–66. Available at: https://doi.org/10.1002/mde.2706.

Casson, M.C. (1979) *Alternatives to the multinational enterprise*. New York: Holmes & Meier.

Casson, M.C. (1987) *The firm and the market: Studies on multinational enterprise and the scope of the firm*. Cambridge, Mass.: Available at: https://search.ebscohost.com/login.aspx?direct=true&db=eoh&AN=0041114&site=eds-live&authtype=ip,shib&custid=s9815128.

Casson, M.C. (2005) 'Entrepreneurship and the theory of the firm', *Journal of Economic Behavior and Organization*, 58(2), pp. 327–348. Available at: https://doi.org/10.1016/j.jebo.2004.05.007.

Castany, L., López-Bazo, E. and Moreno, R. (2005) 'Differences in total factor productivity across firm size. A distributional analysis', in *45th Congress of the European Regional Science Association: "Land Use and Water Management in a Sustainable Network Society*, pp. 1–35.

Castellani, D. and Pieri, F. (2016) 'Outward Investments and Productivity: Evidence from European Regions', *Regional Studies*, 50(12), pp. 1945–1964. Available at: https://doi.org/10.1080/00343404.2014.981149.

Castells, M. (2009) *The Rise of the Network Society*. 2nd editio. Wiley. Available at: https://doi.org/10.1002/9781444319514.

Caves, D.W., Christensen, L.R. and Diewert, W.E. (1982) 'The Economic Theory of Index Numbers and the Measurement of Input, Output, and Productivity', *Econometrica*, 50(6), p. 1393. Available at: https://doi.org/10.2307/1913388.

Cette, G., Fernald, J. and Mojon, B. (2016) 'The pre-Great Recession slowdown in productivity', *European Economic Review*, 88, pp. 3–20. Available at: https://doi.org/10.1016/j.euroecorev.2016.03.012.

Cette, G., Lopez, J. and Mairesse, J. (2017) 'Upstream Product Market Regulations, ICT, R&D and Productivity', *Review of Income and Wealth*, 63(February), pp. S68–S89. Available at: https://doi.org/10.1111/roiw.12252.

Chapain, C. and Sagot-Duvauroux, D. (2020) 'Cultural and creative clusters–a systematic literature review and a renewed research agenda', *Urban Research and Practice*, 13(3), pp.

300–329. Available at: https://doi.org/10.1080/17535069.2018.1545141.

Chen, D.H.C. and Dahlman, C.J. (2006) ‘the Knowledge Economy, the Kam Methodology and World Bank Operations’, *The International Bank for Reconstruction and Development/The World Bank*, (35867), p. 42.

Chen, L. *et al.* (2019) ‘The international penetration of ibusiness firms: Network effects, liabilities of outsidership and country clout’, *Journal of International Business Studies*, 50(2), pp. 172–192. Available at: https://doi.org/10.1057/s41267-018-0176-2.

Chi, T. (1994) ‘Trading in Strategic Resources: Necessary Conditions, Transaction Cost Problems, and Choice of Exchange Structure’, *Strategic Management Journal*, 15(4), pp. 271–290. Available at: https://doi.org/https://www.jstor.org/stable/2486886.

Chi, T. (2015) ‘Commentary: Internalization theory and its relation to RBV and TCE’, *Journal of World Business*, 50(4), pp. 634–636. Available at: https://doi.org/10.1016/j.jwb.2015.08.003.

Clausing, K.A. (2016) ‘The Effect of Profit Shifting on the Corporate Tax Base in the United States and Beyond’, *National Tax Journal*, 69(4), pp. 905–934. Available at: https://doi.org/10.17310/ntj.2016.4.09.

Coad, A. (2018) ‘Firm age: a survey’, *Journal of Evolutionary Economics*, 28(1), pp. 13–43. Available at: https://doi.org/10.1007/s00191-016-0486-0.

Coase, R.H. (1937) ‘The Nature of the Firm’, *Economica*, 4(16), pp. 386–405. Available at: https://doi.org/10.1111/j.1468-0335.1937.tb00002.x.

Coase, R.H. (1960) ‘The Problem of Social Cost’, *The Journal of Law & Economics*, 3, pp. 1–44.

Cockfield, A.J. (2013) ‘The Limits of the International Tax Regime as a Commitment Projector’, *Virginia Tax Review*, 33(59), pp. 59–113.

Cockfield, A.J. (2020) ‘Tax Wars: How to End the Conflict Over Taxing Global Digital Commerce’, *Berkeley Business Law Journal*, 17(2), pp. 347–390. Available at: https://lawcat.berkeley.edu/record/1181505%0Ahttps://doi.org/10.15779/Z38H70815H.

Coff, R. and Kryscynski, D. (2011) ‘Drilling for micro-foundations of human capital-based competitive advantages’, *Journal of Management*, 37(5), pp. 1429–1443. Available at: https://doi.org/10.1177/0149206310397772.

Cohen, D. (2008) *Three Lectures on Post-Industrial Society*. Cambridge, MA: The MIT Press.

Collinson, S. and Rugman, A.M. (2008) ‘The regional nature of Japanese multinational business’, *Journal of International Business Studies*, 39(2), pp. 215–230. Available at: https://doi.org/10.1057/palgrave.jibs.8400347.

Collinson, S.C. and Narula, R. (2014) ‘Asset recombination in international partnerships as a source of improved innovation capabilities in China’, *The Multinational Business Review*, 22(4), pp. 394–417. Available at: https://doi.org/10.1108/MBR-09-2014-0046.

Collinson, S.C. and Rugman, A.M. (2011) ‘Relevance and rigor in international business teaching: Using the CSA-FSA matrix', *Journal of Teaching in International Business*, 22(1), pp. 29–37. Available at: https://doi.org/10.1080/08975930.2011.585910.

Cooper, M. and Nguyen, Q.T.K. (2020) 'Multinational enterprises and corporate tax planning : A review of literature and suggestions for a future research agenda', *International Business Review*, 29(3), pp. 1–20. Available at: https://doi.org/10.1016/j.ibusrev.2020.101692.

Corrado, C. *et al.* (2007) 'Sectoral Productivity in the United States: Recent Developments and the Role of IT', *German Economic Review*, 8(2), pp. 188–210. Available at: https://doi.org/10.1111/j.1468-0475.2007.00404.x.

Corrado, C.A. and Hulten, C.R. (2010) 'How Do You Measure a "Technological Revolution"?', *American Economic Review*, 100(2), pp. 99–104. Available at: https://doi.org/10.1257/aer.100.2.99.

Crass, D. and Peters, B. (2014) 'Intangible Assets and Firm-Level Productivity', *ZEW - Centre for European Economic Research Discussion Paper*, (14–120), pp. 1–40. Available at: https://doi.org/10.2139/ssrn.2562302.

Crivelli, E., Keen, M. and de Mooij, R. (2016) 'Base Erosion, Profit Shifting and Developing Countries', *FinanzArchiv*, 72(3), p. 268. Available at: https://doi.org/10.1628/001522116X14646834385460.

Cuervo-Cazurra, A. and Narula, R. (2015) 'A set of motives to unite them all? Revisiting the principles and typology of internationalization motives', *Multinational Business Review*, 23, pp. 2–14.

Cuervo-Cazurra, A., Narula, R. and Un, C.A. (2015) 'Internationalization motives: sell more, buy better, upgrade and escape', *The Multinational Business Review*. Edited by P. Alvaro Cuervo-Cazzura, 23(1), pp. 25–35. Available at: https://doi.org/10.1108/MBR-02-2015-0009.

Dahlman, C., Mealy, S. and Wermelinger, M. (2016) *Harnessing the digital economy for developing countries*. Available at: http://www.oecd-ilibrary.org/docserver/download/4adffb24-en.pdf (Accessed: 7 January 2024).

Desai, M.A. and Dharmapala, D. (2006) *Corporate Tax Avoidance and High Powered Incentives*, *NBER WORKING PAPER SERIES*.

Devereux, M.P. and Vella, J. (2018) 'Implications of digitalization for international corporate Tax Reform', *Intertax*, 46(6–7), pp. 550–559.

Dharmapala, D. and Riedel, N. (2013) 'Earnings shocks and tax-motivated income-shifting: Evidence from European multinationals', *Journal of Public Economics*, 97(1), pp. 95–107. Available at: https://doi.org/10.1016/j.jpubeco.2012.08.004.

Ding, S., Guariglia, A. and Harris, R. (2016) 'The determinants of productivity in Chinese large and medium-sized industrial firms, 1998–2007', *Journal of Productivity Analysis*, 45(2), pp. 131–155. Available at: https://doi.org/10.1007/s11123-015-0460-0.

Dischinger, M. and Riedel, N. (2011) 'Corporate taxes and the location of intangible assets within multinational firms', *Journal of Public Economics*, 95(7–8), pp. 691–707. Available at: https://doi.org/10.1016/j.jpubeco.2010.12.002.

Douglas, P.H. (1948) 'Are There Laws of Production?', *The American Economic Review*, 38(1), pp. 1–41. Available at: https://www.jstor.org/stable/1801936?seq=1&cid=pdf-reference#references_tab_contents.

Dunning, J.H. (1977) 'Trade, location of economic activity and the MNE: A search for an eclectic approach', in B. Ohlin, P.O. Hesselborn, and P.M. Wijkman (eds) *The international allocation of economic activity*. London: Palgrave Macmillan, pp. 395–418.

Dunning, J.H. (1980) 'Toward an Eclectic Theory of International Production : Some Empirical Tests Author (s): John H . Dunning Source : Journal of International Business Studies , Vol . 11 , No . 1 (Spring - Summer , 1980), Published by : Palgrave Macmillan Journals Stabl', *Journal of International Business Studies*, 11(1), pp. 9–31.

Dunning, J.H. (1988) 'The Eclectic Paradigm of International Production: A Restatement and Some Possible Extensions', *Journal of International Business Studies*, 19(1), pp. 1–31. Available at: https://doi.org/10.1057/palgrave.jibs.8490372.

Dunning, J.H. (1993a) 'Internationalizing Porter's Diamond', *Management International Review*, 33(2–1), pp. 7–15.

Dunning, J.H. (1993b) *Multinational enterprises and the global economy*. Wokingham: Addison-Wesley Publishing Co.

Dunning, J.H. (2000) 'The eclectic paradigm as an envelope for economic and business theories of MNE activity', *International Business Review*, 9(2), pp. 163–190. Available at: https://doi.org/10.1016/S0969-5931(99)00035-9.

Dunning, J.H. and Lundan, S.M. (2008) *Multinational Enterprises and the Global Economy, Second Edition*. Edited by Cheltenham. Edward Elgar Publishing.

Dunning, J.H. and Rugman, A.M. (1985) 'The influence of Hymer's Dissertation on the theory of Foreign Direct Investment', *American Economic Review*, 75(2), pp. 228–232.

Dyreng, S.D., Hanlon, M. and Maydew, E.L. (2008) 'Long-Run Corporate Tax Avoidance', *The Accounting Review*, 83(1), pp. 61–82. Available at: https://doi.org/10.2308/accr.2008.83.1.61.

Eberhardt, M. and Helmers, C. (2010) *Untested Assumptions and Data Slicing: A Critical Review of Firm-Level Production Function Estimators*. 513.

Eden, L. (1998) *Taxing Multinationals*. University of Toronto Press. Available at: https://doi.org/10.3138/9781442680371.

Eden, L. (2016a) 'Multinationals and Foreign Investment Policies in a Digital World', *International Centre for Trade and Sustainable Development (ICTSD)* [Preprint], (January). Available at: www.ictsd.org.

Eden, L. (2016b) 'The Arm's Length Standard: Making It Work in a 21st-Century World of Multinationals and Nation States', in T. Pogge and K. Mehta (eds) *Global Tax Fairness*. Oxford University Press, pp. 153–172. Available at: https://doi.org/10.1093/acprof:oso/9780198725343.003.0007.

Eden, L. and Dai, L. (2010) 'Rethinking the O in Dunning's OLI/Eclectic Paradigm', *Multinational Business Review*, 18(2), pp. 13–34. Available at: https://doi.org/10.1108/1525383X201000008.

Eden, L., Juarez Valdez, L.F. and Li, D. (2005) 'Talk softly but carry a big stick: Transfer pricing penalties and the market valuation of Japanese multinationals in the United States', *Journal of International Business Studies*, 36(4), pp. 398–414. Available at: https://doi.org/10.1057/palgrave.jibs.8400141.

Eden, L. and Kudrle, R.T. (2005) 'Tax havens: Renegade states in the international tax regime?', *Law and Policy*, 27(1), pp. 100–127. Available at: https://doi.org/10.1111/j.1467-9930.2004.00193.x.

Elmasry, T. *et al.* (2016) *Digital Middle East: Transforming the region into a leading digital economy*, *McKinsey & Company*. Available at: http://www.mckinsey.com/global-themes/middle-east- and-africa/digital-middle-east-transforming-the-region-into-a-leading-digital-economy (Accessed: 7 January 2024).

European Commission (2013) *Expert Group on Taxation of the Digital Economy*. Available at: https://taxation-customs.ec.europa.eu/expert-group-taxation-digital-economy_en (Accessed: 7 January 2024).

European Commission (2018) *Proposal for a council directive laying down rules relating to the corporate taxation of a significant digital presence*. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52018PC0147 (Accessed: 9 November 2023).

European Parliament (2015) *Challenges for Competition Policy in a Digitalised Economy*. Available at: https://www.europarl.europa.eu/RegData/etudes/STUD/2015/542235/IPOL_STU(2015)542235_EN.pdf (Accessed: 7 January 2024).

Eurostat (2022) *Statistical Regions in the European Union and Partner Countries. NUTS and statistical regions 2021*. Available at: https://ec.europa.eu/eurostat/documents/3859598/10967554/KS-GQ-20-092-EN-N.pdf/9d57ae79-3ee7-3c14-da3e-34726da385cf.

Faulkner, P. and Runde, J. (2011) 'The social, the material, and the ontology of non-material technological objects', *European Group for Organizational Studies (EGOS) Colloquium, Gothenburg.* [Preprint], (July 2016).

Faulkner, P. and Runde, J. (2019) 'Theorizing the digital object', *MIS Quarterly: Management Information Systems*, 43(4), pp. 1278–1302. Available at: https://doi.org/10.25300/MISQ/2019/13136.

Fernald, J. (2014) *Productivity and Potential Output Before, During, and After the Great Recession*, *NBER Macroeconomics Annual*. Cambridge, MA. Available at: https://doi.org/10.3386/w20248.

Fidler, B. (2017) 'Eternal October and the End of Cyberspace', *IEEE Annals of the History of Computing*, 39(1), pp. 6–7. Available at: https://doi.org/10.1109/MAHC.2017.9.

Flecker, J. (2016) 'Space, Place and Global Digital Work', *Space, Place and Global Digital Work* [Preprint]. Available at: https://doi.org/10.1057/978-1-137-48087-3.

Florida, R. (2019) *The Rise of the Creative Class*. Hachette UK.

Florida, R., Mellander, C. and Stolarick, K. (2008) 'Inside the black box of regional development - Human capital, the creative class and tolerance', *Journal of Economic Geography*, 8(5), pp. 615–649. Available at: https://doi.org/10.1093/jeg/lbn023.

Friedman, M. (1953) *Essays in Positive Economics*. Chicago: University of Chicago Press.

Fuest, C. *et al.* (2013) 'Profit Shifting and "Aggressive" Tax Planning by Multinational Firms: Issues and Options for Reform', *World Tax Journal*, 5(3), p. 307. Available at: https://doi.org/10.59403/wv8q3.

Fujimoto, T. (1999) *The Evolution of a Manufacturing System at Toyota*. New York, NY: Oxford University Press. Available at: https://doi.org/10.1093/oso/9780195123203.001.0001.

G20 DETF (2016) *G20 Digital Economy Development and Cooperation Initiative*. Available at: http://www.g20.utoronto.ca/2016/g20-digital-economy-development-and-cooperation.pdf (Accessed: 7 January 2024).

Gabbai, S. and Ross, J. (2018) *A closer look at the EC's proposed digital services tax*, *Tax Journal*. Available at: https://www.taxjournal.com/articles/closer-look-ec-s-proposed-digital-services-tax-17052018 (Accessed: 21 July 2020).

Gal, P.N. (2013) 'Measuring Total Factor Productivity at the Firm Level using OECD-ORBIS', *OECD Paris*, (1049), p. 59. Available at: https://www.oecd-ilibrary.org/economics/measuring-total-factor-productivity-at-the-firm-level-using-oecd-orbis_5k46dsb25ls6-en.

Gärdin, O. (2002) 'The New Economy New challenges for the statistical system', in *The International Association for Official Statisticians Conference*. London, pp. 1–15.

Gattai, V. (2010) 'Firm's intangible assets and multinational activity: Full versus shared ownership', *Journal of International Trade and Economic Development*, 19(4), pp. 553–589. Available at: https://doi.org/10.1080/09638199.2010.506335.

Gawer, A. (2009) *Platforms, Markets and Innovation*, *Platforms, Markets and Innovation*. Cheltenham: Edward Elgar Publishing. Available at: https://doi.org/10.4337/9781849803311.

Gopal, R.D., Ramesh, R. and Whinston, A.B. (2003) 'Microproducts in a digital economy: Trading small, gaining large', *International Journal of Electronic Commerce*, 8(2), pp. 9–30. Available at: https://doi.org/10.1080/10864415.2003.11044292.

Gordon, R.J. (2014) 'Secular Stagnation: Facts, Causes and Cures', in C. Teulings and R. Baldwin (eds) *Geneva Reports on the World Economy*. Paris & London: CEPR Press, p. 164. Available at: https://cepr.org/publications/books-and-reports/secular-stagnation-facts-causes-and-cures.

Gordon, R.J. (2015) 'Secular Stagnation: A Supply-Side View', *American Economic Review*, 105(5), pp. 54–59. Available at: https://doi.org/10.1257/aer.p20151102.

Gordon, R.J. and Sayed, H. (2020) 'Transatlantic Technologies: the Role of ICT in the Evolution of U.S. And European Productivity Growth', *NBER WORKING PAPER SERIES* [Preprint], (27425). Available at: https://doi.org/10.2139/ssrn.3637726.

Gorry, G.A. and Scott-Morton, M. (1971) 'A Framework for Management Information

Systems', *Sloan Management Review*, 13(1), pp. 55–70.

Grad, B. and Bergin, T.J. (2009) 'History of Database Management Systems', *IEEE Annals of the History of Computing*, 31(4), pp. 3–5.

Griffith, R., Miller, H. and O'Connell, M. (2014) 'Ownership of intellectual property and corporate taxation', *Journal of Public Economics*, 112, pp. 12–23. Available at: https://doi.org/10.1016/j.jpubeco.2014.01.009.

Grøgaard, B. and Verbeke, A. (2012) 'Twenty key hypotheses that make internalization theory the general theory of international strategic management', in A. Verbeke and H. Merchant (eds) *Handbook of Research in International Strategic Management*. Cheltenham: Edward Elgar Publishing, pp. 7–30.

Grøgaard, B., Verbeke, A. and Amin Zargarzadeh, M. (2011) 'Chapter 6 Entrepreneurial Deficits in the Global Firm', in *Entrepreneurship in the global firm*. Bingley: Emerald Group Publishing Ltd., pp. 117–137. Available at: https://doi.org/10.1108/S1745-8862(2011)0000006009.

Haberly, D. and Wójcik, D. (2015) 'Tax havens and the production of offshore FDI: An empirical analysis', *Journal of Economic Geography*, 15(1), pp. 75–101. Available at: https://doi.org/10.1093/jeg/lbu003.

Hanlon, M. and Heitzman, S. (2010) 'A review of Tax Research', *Journal of Accounting and Economics*, 50(2–3), pp. 127–178. Available at: https://doi.org/10.1016/j.jacceco.2010.09.002.

Hannan, M.T. and Freeman, J. (1984) 'Structural Inertia and Organizational Change', *American Sociological Review*, 49(2), p. 149. Available at: https://doi.org/10.2307/2095567.

Haskell, J. and Westlake, S. (2018) *Capitalism without capital: the rise of the intangible economy*. 1st Editio, *Discourse*. 1st Editio. Princeton University Press.

Hayek, F.A. (1945) 'The Use of Knowledge in Society', *The American Economic Review*, 35(4), pp. 519–530.

Heeks, R. (2008) *Researching ICT-based enterprise in developing countries : analytical tools and models*. University of Manchester, Institute for Development Policy and Management.

Hennart, J.-F. (1977) *A theory of foreign direct investment*. University of Maryland.

Hennart, J.-F. (1982) *A theory of multinational enterprise*. Ann Arbor, MI: University of Michigan.

Hennart, J.-F. (1986) 'Internalization in Practice: Early Foreign Direct Investments in Malaysian Tin Mining', *Journal of International Business Studies*, 17(2), pp. 131–143. Available at: http://www.jstor.org/stable/154587.

Hennart, J.-F. (1988) 'Upstream vertical integration in the aluminum and tin industries', *Journal of Economic Behavior & Organization*, 9(3), pp. 281–299. Available at: https://doi.org/10.1016/0167-2681(88)90038-8.

Hennart, J.-F. (1989) 'Transaction costs theory and the multinational enterprise', in C.N. Pitelis and R. Sugden (eds) *The nature of the transnational firm*. London: Routledge, pp. 81–

116.

Hennart, J.-F. (1991) ‘The Transaction Cost Theory of the Multinational Enterprise’, in C.N. Pitelis and R. Sugden (eds) *The nature of the transnational firm*. U IL: London and New York:, pp. 81–116. Available at: https://search.ebscohost.com/login.aspx?direct=true&db=eoh&AN=0340110&site=eds-live&authtype=ip,shib&custid=s9815128.

Hennart, J.-F. (2001) ‘Theories of the multinational enterprise’, in O.U. Press (ed.) *The Oxford Handbook of International Business*. Oxford, pp. 127–149.

Hennart, J.-F. (2009a) ‘Down with MNE-centric theories! market entry and expansion as the bundling of MNE and local assets’, *Journal of International Business Studies*, 40(9), pp. 1432–1454. Available at: https://doi.org/10.1057/jibs.2009.42.

Hennart, J.-F. (2009b) ‘Theories of the Multinational Enterprise’, in A.M. Rugman (ed.) *The Oxford Handbook of International Business*. Tilburg U: Second edition. Oxford and New York: Oxford University Press, pp. 125–145. Available at: https://search.ebscohost.com/login.aspx?direct=true&db=eoh&AN=1104571&site=eds-live&authtype=ip,shib&custid=s9815128.

Hennart, J.-F. (2010) ‘Transaction Cost Theory and International Business’, *Journal of Retailing*, 86(3), pp. 257–269. Available at: https://doi.org/10.1016/j.jretai.2010.07.009.

Hennart, J.-F. (2012) ‘Emerging market multinationals and the theory of the multinational enterprise’, *Global Strategy Journal*, 2(3), pp. 168–187. Available at: https://doi.org/10.1111/j.2042-5805.2012.01038.x.

Hennart, J.-F. (2015) ‘Commentary: Why and how can Multinational Enterprises be value-creating organizations?’, *Journal of World Business*, 50(4), pp. 623–626. Available at: https://doi.org/10.1016/j.jwb.2015.08.004.

Hennart, J.-F. (2019) ‘Digitalized service multinationals and international business theory’, *Journal of International Business Studies*, 50(8), pp. 1388–1400. Available at: https://doi.org/10.1057/s41267-019-00256-2.

Henry, J. (2012) ‘The price of Offshore Revisited’, *Tax Justice Network*, pp. 1–46. Available at: http://www.taxjustice.net/cms/upload/pdf/Price_of_Offshore_Revisited_120722.pdf.

Hines, J.R. (2010) ‘Treasure islands’, *Journal of Economic Perspectives*, 24(4), pp. 103–126. Available at: https://doi.org/10.1257/jep.24.4.103.

Hines, J.R. and Rice, E.M. (1994) ‘Fiscal Paradise: Foreign Tax Havens and American Business’, *The Quarterly Journal of Economics*, 109(1), pp. 149–182. Available at: https://doi.org/10.2307/2118431.

Hortaçsu, A. and Syverson, C. (2015) ‘The ongoing evolution of US retail: A format tug-of-war’, *Journal of Economic Perspectives*, 29(4), pp. 89–112. Available at: https://doi.org/10.1257/jep.29.4.89.

Hu, Y.S. (1995) ‘The International Transferability of the Firm’s Advantages’, *California Management Review*, 37(4), pp. 73–88. Available at: https://doi.org/10.2307/41165811.

Hui, Y. (2012) ‘What is a digital object?’, *Metaphilosophy*, 43(4), pp. 380–395. Available at: https://doi.org/10.1111/j.1467-9973.2012.01761.x.

Hulten, C. (2010a) *Decoding Microsoft: Intangible Capital as a Source of Company Growth*, *NBER WORKING PAPER SERIES*. Available at: http://www.nber.org/papers/w15799.

Hulten, C. (2010b) *Decoding Microsoft: Intangible Capital as a Source of Company Growth*, *Nber Working Paper Series*. Cambridge, MA. Available at: https://doi.org/10.3386/w15799.

Huws, U. (2007) ‘The spark in the engine: creative workers in a global economy’, *Work Organisation, Labour and Globalisation*, 1(1), pp. 1–12. Available at: https://doi.org/10.13169/workorgalaboglob.1.1.0001.

Hymer, S.H. (1960) *The international operations of national firms: A study of direct foreign investment.* MIT.

International Accounting Standards Board (IASB) (2014) *International Accounting Standards*. Available at: https://www.iasplus.com/en/standards/ias/ias38.

ITU (2008) *Transition from analogue to digital terrestrial broadcasting Note by the Chairman List of participants*.

Jacobs, J. (1961) *The death and life of great American cities*. New York: Random House.

Janský, P. (2020) ‘The costs of tax havens: evidence from industry-level data’, *Applied Economics*, 52(29), pp. 3204–3218. Available at: https://doi.org/10.1080/00036846.2019.1707765.

Jensen, J.B., McGuckin, R.H. and Stiroh, K.J. (2001) ‘The Impact of Vintage and Survival on Productivity: Evidence from Cohorts of U.S. Manufacturing Plants’, *The Review of Economics and Statistics*, 83(2), pp. 323–332. Available at: https://doi.org/10.2307/2095567.

Jogalekar, P. and Woodside, M. (2000) ‘Evaluating the scalability of distributed systems’, *IEEE Transactions on Parallel and Distributed Systems*, 11(6), pp. 589–603. Available at: https://doi.org/10.1109/71.862209.

Jones, C. and Temouri, Y. (2016) ‘The determinants of tax haven FDI’, *Journal of World Business*, 51(2), pp. 237–250. Available at: https://doi.org/10.5465/AMBPP.2014.45.

Jones, C., Temouri, Y. and Cobham, A. (2018) ‘Tax haven networks and the role of the Big 4 accountancy firms’, *Journal of World Business*, 53(2), pp. 177–193. Available at: https://doi.org/10.1016/j.jwb.2017.10.004.

Jones, C.I. and Romer, P.M. (2010) ‘The New Kaldor Facts Ideas.pdf’, *American Economic Journal: Macroeconomics*, 2(1), pp. 224–245.

Jorgenson, D.W. (2009) *The Economics of Productivity*. 1st edn, *The Economics of Productivity*. 1st edn. Edited by M. Blaug. Cheltenham: Edward Elgar Publishing.

Jorgenson, D.W. and Griliches, Z. (1967) ‘The Explanation of Productivity Change’, *The Review of Economic Studies*, 34(3), pp. 249–282. Available at: https://doi.org/10.2307/2296675.

Jorgenson, D.W. and Stiroh, K.J. (2000) ‘Raising the speed limit: US economic growth in the information age’, *Brookings Papers on Economic Activity*, (1), pp. 125–211. Available at: https://doi.org/10.4324/9781351154567-16.

Kalemli-Ozcan, S. *et al.* (2022) *How to Construct Nationally Representative Firm Level Data from the Orbis Global Database: New Facts and Aggregate Implications*, *NBER Working Paper Series*. Cambridge, MA. Available at: https://doi.org/10.1787/18151965.

Kallinikos, J. (2006) *The Consequences of Information*. Edward Elgar Publishing. Available at: https://doi.org/10.4337/9781847204301.

Kallinikos, J., Aaltonen, A. and Marton, A. (2013) ‘The Ambivalent Ontology of Digital Artifacts’, *MIS Quarterly: Management Information Systems*, 37(2), pp. 357–370. Available at: http://arxiv.org/abs/1011.1669.

Karkinsky, T. and Riedel, N. (2012) ‘Corporate taxation and the choice of patent location within multinational firms’, *Journal of International Economics* [Preprint]. Available at: https://doi.org/10.1016/j.jinteco.2012.04.002.

Keen, P.G. and Scott-Morton, M. (1978) *Decision Support Systems: an Organizational Perspective*. Reading, MA. Available at: Addison-Wesley Publishing Company.

Kehal, H. and Singh, V. (2005) *Digital Economy: Impacts, Influences and Challenges*. Edited by H. Kehal and V. Singh. Hershey, Pennylvania: IGI Global. Available at: https://doi.org/10.4018/978-1-59140-363-0.

Khan, L.M. (2019) ‘The separation of platforms and commerce’, *Columbia Law Review*, 119(4), pp. 973–1098. Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3180174.

Kling, R. and Lamb, R. (2000) ‘IT and organizational change in digital economies’, in E.B.& B.K. (eds) (ed.) *Understanding the Digital Economy*. Cambridge, MA: MIT Press, pp. 295–324.

Knickrehm, M., Berthon, B. and Daugherty, P. (2016) *Knickrehm, Mark, Bruno Berthon and Paul Daugherty*. Available at: https://www.infoiva.com/wp-content/uploads/2016/01/Accenture-Strategy-Digital-Disruption-Growth-Multiplier.pdf (Accessed: 7 January 2024).

Kogut, B. and Zander, U. (1992) ‘Knowledge of the Firm, Combinative Capabilities, and the Replication of Technology’, *Organization Science*, 3(3), pp. 383–397. Available at: https://doi.org/10.1287/orsc.3.3.383.

Kogut, B. and Zander, U. (1993) ‘Knowledge of the Firm and the Evolutionary Theory of the Multinational Corporation’, *Journal of International Business Studies*, 24(4), pp. 625–645. Available at: https://doi.org/10.1057/palgrave.jibs.8490248.

Kotha, S., Rindova, V.P. and Rothaermel, F.T. (2001) ‘Assets and Actions: Firm-Specific Factors in the Internationalization of U.S. Internet Firms’, *Journal of International Business Studies*, 32(4), pp. 769–791. Available at: https://doi.org/10.1057/palgrave.jibs.8490994.

Krautheim, S. and Schmidt-Eisenlohr, T. (2011) ‘Heterogeneous firms, “profit shifting” FDI and international tax competition’, *Journal of Public Economics*, 95(1–2), pp. 122–133. Available at: https://doi.org/10.1016/j.jpubeco.2010.10.008.

Kuznets, S. (1971) *Economic growth of nations: total output and production structure*. Cambridge, MA: Belknap Press of Harvard University Press.

Lane, N. (1999) 'Advancing the Digital Economy into the 21st Century', *Information Systems Frontiers*, 1(3), pp. 317–320. Available at: https://doi.org/10.1023/A:1010010630396.

Langlois, R.N. (2002) 'Modularity in technology and organization', *Journal of Economic Behavior and Organization*, 49(1), pp. 19–37. Available at: https://doi.org/10.1016/S0167-2681(02)00056-2.

Laudon, K.C. and Laudon, J.P. (1988) *Management information systems: a contemporary perspective*. 1st ed. Macmillan.

Lepak, D.P. and Snell, S.A. (1999) 'The Human Resource Architecture: Toward a Theory of Human Capital Allocation and Development', *The Academy of Management Review*, 24(1), p. 31. Available at: https://doi.org/10.2307/259035.

Lev, B. and Gu, F. (2016) *The End of Accounting and the Path Forward for Investors and Managers*. Wiley. Available at: https://doi.org/10.1002/9781119270041.

Levinsohn, J. and Petrin, A. (2003) 'Estimating production functions using inputs to control for unobservables', *Review of Economic Studies*, 70(2), pp. 317–341. Available at: https://doi.org/10.1111/1467-937X.00246.

Li, J. (2014) *Protecting the tax base in the digital economy*, *United Nations Handbook on Selected Issues in Protecting the Tax Base of Developing Countries*. Available at: https://doi.org/10.18356/df465d2c-en.

Lips, W. (2020) 'The EU Commission's digital tax proposals and its cross-platform impact in the EU and the OECD', *Journal of European Integration*, 42(7), pp. 975–990. Available at: https://doi.org/10.1080/07036337.2019.1705800.

Lipsey, R.G., Carlaw, K.I. and Bekar, C.T. (2005) *Economics Transformations: General Purpose Technology and Long Term Economic Growth*. 1st Editio, *Oxford University Press*. 1st Editio. New York, NY: Oxford University Press. Available at: http://wrap.warwick.ac.uk/32883/.

Lundan, S.M. (2009) 'What are Ownership Advantages?', *Multinational Business Review*, 18(1), pp. 51–69. Available at: https://doi.org/10.1108/1525383X201000010.

Ma, X. (2017) 'Do taxes influence the organizational boundaries of international firms? An incomplete-contracting model with empirical evidence', *Journal of International Trade and Economic Development*, 26(7), pp. 801–828. Available at: https://doi.org/10.1080/09638199.2017.1303744.

Mahoney, J.T. and Kor, Y.Y. (2015) 'Advancing the human capital perspective on value creation by joining capabilities and governance approaches', *Academy of Management Perspectives*, 29(3), pp. 296–308. Available at: https://doi.org/10.5465/amp.2014.0151.

Malecki, E.J. and Moriset, B. (2007) *The Digital Economy*, *The Digital Economy: Business organization, production processes, and regional developments*. Routledge. Available at: https://doi.org/10.4324/9780203933633.

Margherio, L. *et al.* (1999) *The emerging digital economy: Conclusions*, *Advances in Spatial Science*. Washington, DC. Available at: http://www.esa.doc.gov/sites/default/files/emergingdig_0.pdf.

Markle, K. and Shackelford, D. (2009) *Do Multinationals or Domestic Firms Face Higher Effective Tax Rates?*, *NBER WORKING PAPER SERIES*. Cambridge, MA. Available at: https://doi.org/10.3386/w15091.

Marrano, M.G., Haskel, J. and Wallis, G. (2009) 'What happened to the knowledge economy? ict, intangible investment, and Britain's productivity record revisited', *Review of Income and Wealth*, pp. 686–716. Available at: https://doi.org/10.1111/j.1475-4991.2009.00344.x.

Mathews, J.A. (2002) *Dragon Multinational: a new model for global growth*. Oxford University PressNew York, NY. Available at: https://doi.org/10.1093/oso/9780195121469.001.0001.

McLeod, R. and Schell, G.P. (2004) *Management Information Systems*. 9th editio. Pearson Education International.

Mesenbourg, T.L. (2001) *Measuring The U.S. Digital Economy: Theory and Practice*. Suitland, MD. Available at: https://www.census.gov/content/dam/Census/library/working-papers/2001/econ/umdigital.pdf (Accessed: 7 January 2024).

Miroudot, S. and Cadestin, C. (2017) *Services In Global Value Chains*, *OECD Trade Policy Papers. OECD Publishing, Paris.* Available at: https://doi.org/10.1787/465f0d8b-en.

Mokyr, J., Vickers, C. and Ziebarth, N.L. (2015) 'The History of Technological Anxiety and the Future of Economic Growth: Is This Time Different?', *Journal of Economic Perspectives*, 29(3), pp. 31–50. Available at: https://doi.org/10.1257/jep.29.3.31.

Moore, G.E. (1965) 'Cramming more components onto integrated circuits with unit cost', *Electronics*, 38(8), p. 114.

Mowery, D.C. and Rosenberg, N. (1981) 'Technical Change in the Commercial Aircraft Industry, 1925-1975', *Technological Forecasting and Social Change*, 20, pp. 347–358. Available at: https://doi.org/10.1016/0040-1625(81)90065-2 (Accessed: 4 October 2023).

Nagle, F. (2014) 'Crowdsourced Digital Goods and Firm Productivity: Evidence from Free and Open Source Software DRAFT', *Harvard Business School*, 15–062, pp. 1–48. Available at: http://www.usatoday.com/story/money/business/2013/01/19/crowdsourcing-super-bowl-.

Nambisan, S., Lyytinen, K. and Yoo, Y. (2020) 'Digital innovation: towards a transdisciplinary perspective', in *Handbook of Digital Innovation*, pp. 2–12. Available at: https://doi.org/10.4337/9781788119986.00008.

Narula, R. (2001) 'Choosing Between Internal and Non-internal R&D Activities: Some Technological and Economic Factors', *Technology Analysis & Strategic Management*, 13(3), pp. 365–387. Available at: https://doi.org/10.1080/09537320120088183.

Narula, R. (2010) 'Keeping the Eclectic Paradigm Simple', *Multinational Business Review*, 18(2), pp. 35–50. Available at: https://doi.org/10.1108/1525383X201000009.

Narula, R. (2012) 'Do we need different frameworks to explain infant MNEs from developing countries?', *Global Strategy Journal*, 2(1), pp. 41–47. Available at: https://doi.org/10.1111/j.2042-5805.2012.01035.x.

Narula, R. (2014) 'Exploring the paradox of competence-creating subsidiaries: Balancing bandwidth and dispersion in MNEs', *Long Range Planning*, 47(1–2), pp. 4–15. Available at: https://doi.org/10.1016/j.lrp.2013.10.006.

Narula, R. (2017) 'Emerging market MNEs as meta-integrators: the importance of internal networks', *International Journal of Technology Management*, 74(1–4), pp. 214–220. Available at: https://doi.org/10.1504/IJTM.2017.083625.

Narula, R. *et al.* (2019) 'Applying and advancing internalization theory: The multinational enterprise in the twenty-first century', *Journal of International Business Studies*. Palgrave Macmillan Ltd., pp. 1231–1252. Available at: https://doi.org/10.1057/s41267-019-00260-6.

Narula, R. and Dunning, J.H. (2010) 'Multinational enterprises, development and globalization: Some clarifications and a research agenda', *Oxford Development Studies*, 38(3), pp. 263–287. Available at: https://doi.org/10.1080/13600818.2010.505684.

Narula, R. and Verbeke, A. (2015) 'Making internalization theory good for practice: The essence of Alan Rugman's contributions to international business', *Journal of World Business*, 50(4), pp. 612–622. Available at: https://doi.org/10.1016/j.jwb.2015.08.007.

Naylor, T.H. (1982) 'Decision Support Systems or Whatever Happened to M.I.S.?', *Interfaces*, 12(4), pp. 92–94. Available at: https://www.jstor.org/stable/25060293.

Nelson, R.R. and Winter, S.G. (1982) *An evolutionary theory of economic change*. Cambridge, MA: The Belknap Press of Harvard University Press.

Nordhaus, W.D. (2006) *Baumol's Diseases: A Macroeconomic Perspective*. Cambridge, MA. Available at: https://doi.org/10.3386/w12218.

Nordhaus, W.D. (2021) 'Are We Approaching an Economic Singularity? Information Technology and the Future of Economic Growth', *American Economic Journal: Macroeconomics*, 13(1), pp. 299–332. Available at: https://doi.org/10.1257/mac.20170105.

OECD (2013) *Action Plan on Base Erosion and Profit Shifting*, *Action Plan on Base Erosion and Profit Shifting*. OECD. Available at: https://doi.org/10.1787/9789264202719-en.

OECD (2015a) *Addressing the Tax Challenges of the Digital Economy*, *Addressing the Tax Challenges of the Digital Economy*. OECD. Available at: https://doi.org/10.1787/9789264237858-zh.

OECD (2015b) *Addressing the Tax Challenges of the Digital Economy - Action 1*, *Addressing the Tax Challenges of the Digital Economy*. OECD. Available at: https://doi.org/10.1787/9789264237858-zh.

OECD (2015c) *Measuring and Monitoring BEPS, Action 11 - 2015 Final Report*, *OECD Publishing*. Available at: https://doi.org/10.1787/9789264241343.

OECD (2020) *OECD Digital Economy Outlook 2020*, *Digital Economy Outlook 2020*. Available at: https://www.oecd-ilibrary.org/science-and-technology/oecd-digital-economy-outlook-2020_bb167041-en.

OECD (2022) ‘Two-Pillar Solution to Address the Tax Challenges Arising from the Digitalisation of the Economy - OECD FAQ document July’, (July), pp. 1–4.

OECD (2023) *OECD/G20 Inclusive Framework on BEPS Progress report September 2022 – September 2023*. Available at: https://www.oecd.org/tax/beps/oecd-g20-inclusive-framework-on-beps-progress-report-september-2022-september-2023.htm.

OED (2024) *Oxford English Dictionary*. Available at: https://www.oed.com/dictionary/digital-economy_n?tab=meaning_and_use (Accessed: 7 January 2024).

Oh, C.H. and Li, J. (2015) ‘Commentary: Alan Rugman and the theory of the regional multinationals’, *Journal of World Business*, 50(4), pp. 631–633. Available at: https://doi.org/10.1016/j.jwb.2015.08.006.

Olley, G.S. and Pakes, A. (1996) ‘The Dynamics of Productivity in the Telecommunications Equipment Industry’, *Econometrica*, 64(6), pp. 1263–1297. Available at: http://www.jstor.org/stable/2171831.

Orhangazi, Ö. (2019) ‘The role of intangible assets in explaining the investment–profit puzzle’, *Cambridge Journal of Economics*. Oxford University Press, pp. 1251–1285. Available at: https://doi.org/10.1093/cje/bey046.

Oxelheim, L., Randøy, T. and Stonehill, A. (2001) ‘On the treatment of finance-specific factors within the OLI paradigm’, *International Business Review*, 10(4), pp. 381–398. Available at: https://doi.org/10.1016/S0969-5931(01)00022-1.

Palan, R., Murphy, R. and Chavagneux, C. (2013) *Tax Havens : How Globalization Really Works*. 1st edn. Edited by C.U. Press. Ithaca, New York.

Parker, G.G. and Van Alstyne, M.W. (2005) ‘Two-sided network effects: A theory of information product design’, *Management Science*, 51(10), pp. 1494–1504. Available at: https://doi.org/10.1287/mnsc.1050.0400.

Partridge, C. (2008) ‘The technical development of internet email’, *IEEE Annals of the History of Computing*, 30(2), pp. 3–29. Available at: https://doi.org/10.1109/MAHC.2008.32.

Penrose, E.T. (1959) *The theory of the growth of the firm*. Oxford: Wiley.

Persaud, A. (2001) ‘The Knowledge Gap’, *Foreign Affairs*, 80(2), pp. 107–117. Available at: https://doi.org/10.1017/CBO9781107415324.004.

Petrin, A., Poi, B.P. and Levinsohn, J. (2004) ‘Production Function Estimation in Stata using Inputs to Control for Unobservables’, *The Stata Journal: Promoting communications on statistics and Stata*, 4(2), pp. 113–123. Available at: https://doi.org/10.1177/1536867x0400400202.

Picciotto, S. *et al.* (2017) *The G20 and the “Base Erosion and Profit Shifting (BEPS) Project”*, *DIE Discussion Paper*. Available at: https://www.econstor.eu/bitstream/10419/199508/1/die-dp-2017-18.pdf.

Pitelis, C.N. and Teece, D.J. (2018) ‘The New MNE: “Orchestration” Theory as Envelope of “Internalisation” Theory’, *Management International Review*, 58(4), pp. 523–539. Available at: https://doi.org/10.1007/s11575-018-0346-2.

Platt, R.H. (2006) *The Humane Metropolis: People and Nature in the 21st-Century City*. MIT Press.

Polanyi, M. (1967) *The tacit dimension*. London: Routledge & Kegan Paul Ltd.

Porter, M.E. (1985) *Competitive Advantage: Creating and Sustaining Superior Performance*. London: Collier Macmillan.

Porter, M.E. (1990) 'The Competitive Advantage of Nations Harvard Business Review', *Harvard Business Review*, pp. 73–91.

Porter, M.E. (1998) 'Clusters and the New Economics of Competition', *Harvard Business Review*, (11), pp. 77–90.

Porter, M.E. (2003) 'The economic performance of regions', *Regional Studies*, 37(6–7), pp. 545–546. Available at: https://doi.org/10.1080/0034340032000108688.

Portolese, G.C. and Folloni, A. (2018) 'Digitalization, IPRs and tax innovation', *International Review of Sociology*, 28(3), pp. 432–446. Available at: https://doi.org/10.1080/03906701.2018.1529105.

Reed, R. and Defillippi, R.J. (1990) 'Causal Ambiguity, Barriers to Imitation, and Sustainable Competitive Advantage', *The Academy of Management Review*, 15(1), p. 88. Available at: https://doi.org/10.2307/258107.

Ross, J. and Herrington, M. (2013) 'A Call to Rewrite the Fundamentals of International Taxation: The OECD BEPS Action Plan', *International Tax Journal*, 39(5), pp. 15–66.

Rovigatti, G. and Mollisi, V. (2018) 'Theory and practice of total-factor productivity estimation: The control function approach using stata', *Stata Journal*, 18(3), pp. 618–662. Available at: https://doi.org/10.1177/1536867x1801800307.

Rugman, A.M. (1980) 'Internalization theory and corporate international finance.', *California Management Review*, 23(2), pp. 73–79.

Rugman, A.M. (1981) *Inside the Multinationals: The Economics of Internal Markets*. New York: Columbia University Press.

Rugman, A.M. (2005) *The Regional Multinationals*. Cambridge: Cambridge University Press. Available at: https://doi.org/10.1017/CBO9780511614071.

Rugman, A.M. (2010a) 'Do we need a new theory to explain emerging market MNEs?', in K.P. Sauvant, W.A. Maschek, and G.A. McAllister (eds) *Foreign direct investments from emerging markets: The challenges ahead.* New York: Palgrave McMillan. Available at: http://www.henley.reading.ac.uk/web/FILES/management/mgmt_A_Rugman_DoWeNeedANewTheory-ColumbiaU.pdf.

Rugman, A.M. (2010b) 'Reconciling Internalization Theory and the Eclectic Paradigm', *Multinational Business Review*, 18(2), pp. 1–12. Available at: https://doi.org/10.1108/1525383X201000007.

Rugman, A.M. and Almodóvar, P. (2011) 'The Born Global Illusion and the Regional Nature of International Business', in R. Ramamurti and N. Hashai (eds) *The Future of Foreign Direct Investment and the Multinational Enterprise (Research in Global Strategic Management, Vol.*

15. Leeds: Emerald Group Publishing Limited, pp. 251–269. Available at: https://doi.org/10.1108/S1064-4857(2011)0000015015.

Rugman, A.M. and Bennett, J. (2002) ‘Technology transfer and world product mandating in Canada’, in A.M. Rugman (ed.) *International Business: Strategic Management of Multinationals*. London: Routledge, pp. 367–377.

Rugman, A.M. and Eden, L. (1985) *Multinationals and Transfer Pricing*. Edited by A.M. Rugman and L. Eden. London: Croom Helm. Available at: https://doi.org/10.4324/9781315277554.

Rugman, A.M., Lecraw, D.J. and Booth, L.D. (1985) *International business: Firm and environmet*. New York: McGraw Hill.

Rugman, A.M. and Oh, C.H. (2013) ‘Why the Home Region Matters: Location and Regional Multinationals’, *British Journal of Management*, 24(4), pp. 463–479. Available at: https://doi.org/10.1111/j.1467-8551.2012.00817.x.

Rugman, A.M. and Verbeke, A. (1990) ‘Strategic Trade Policy is not Good Strategy’, *Hitotsubashi Journal of Commerce and Management*, 25(1), pp. 75–97. Available at: https://www.jstor.org/stable/43294924.

Rugman, A.M. and Verbeke, A. (1992) ‘A note on the transnational solution and the transaction cost theory of multinational strategic management’, *Journal of International Business Studies*, 32(4), pp. 761–771.

Rugman, A.M. and Verbeke, A. (2001) ‘Subsidiary-specific advantages in multinational enterprises’, *Strategic Management Journal*, 22(3), pp. 237–250.

Rugman, A.M. and Verbeke, A. (2002) ‘Edith Penrose’s contribution to the resource-based view of strategic management’, *Strategic Management Journal*, 23(8), pp. 769–780. Available at: https://doi.org/10.1002/smj.240.

Rugman, A.M. and Verbeke, A. (2003) ‘Extending the theory of the multinational enterprise: Internalization and strategic management perspectives’, *Journal of International Business Studies*, 34(2), pp. 125–137. Available at: https://doi.org/10.1057/palgrave.jibs.8400012.

Rugman, A.M. and Verbeke, A. (2004) ‘A perspective on regional and global strategies of multinational enterprises’, *Journal of International Business Studies*, 35(1), pp. 3–18. Available at: https://doi.org/10.1057/palgrave.jibs.8400073.

Rugman, A.M. and Verbeke, A. (2005) ‘Towards a Theory of Regional Multinationals: A Transaction Cost Economics Approach’, *MIR: Management International Review*, 475(1), pp. 5–17. Available at: https://www.jstor.org/stable/40836119?seq=1#metadata_info_tab_contents.

Rugman, A.M. and Verbeke, A. (2008a) ‘A new perspective on the regional and global strategies of multinational services firms’, *Management International Review*, 48, pp. 397–411. Available at: https://doi.org/10.4337/9781781009147.00021.

Rugman, A.M. and Verbeke, A. (2008b) ‘A regional solution to the strategy and structure of multinationals’, *European Management Journal*, 26(5), pp. 305–313. Available at: https://doi.org/10.1016/j.emj.2008.04.004.

Rugman, A.M., Verbeke, A. and D’Cruz, J.R. (2005) ‘Internalization and De-internalization: Will Business Networks Replace Multinationals?’, in *Analysis of Multinational Strategic Management*. Edward Elgar Publishing, pp. 27–48. Available at: https://doi.org/10.4337/9781035305254.00009.

Rugman, A.M., Verbeke, A. and Nguyen, Q.T.K. (2011) ‘Fifty Years of International Business Theory and Beyond’, *Management International Review*, 51(6), pp. 755–786. Available at: https://doi.org/10.1007/s11575-011-0102-3.

Rugman, A.M., Verbeke, A. and Yuan, W. (2011) ‘Re-conceptualizing Bartlett and Ghoshal’s Classification of National Subsidiary Roles in the Multinational Enterprise’, *Journal of Management Studies*, 48(2), pp. 253–277. Available at: https://doi.org/10.1111/j.1467-6486.2010.00969.x.

Samuelson, L. (1982) ‘The multinational firm with arm’s length transfer price limits’, *Journal of International Economics*, 13(3–4), pp. 365–374. Available at: https://doi.org/10.1016/0022-1996(82)90064-2.

Schönauer, A. (2008) ‘Reorganising the front line: the case of public call centre services’, *Work Organisation, Labour and Globalisation*, 2(2), pp. 131–147. Available at: https://doi.org/10.13169/workorgalaboglob.2.2.0131.

Self, H. (2013) *Addressing Base Erosion and Profit Shifting*, *British Tax Review*. OECD. Available at: https://www.oecd-ilibrary.org/taxation/addressing-base-erosion-and-profit-shifting_9789264192744-en.

Shapiro, C. and Varian, H.R. (1999) *Information Rules: A Strategic Guide to the Network Economy*, *The Journal of Economic Education*. Boston, Massachusetts: Harvard Business School Press. Available at: https://www.jstor.org/stable/1183273?origin=crossref.

Shepherd, J. (2004) ‘What is the Digital Era?’, in *Social and Economic Transformation in the Digital Era*. IGI Global, pp. 1–18. Available at: https://doi.org/10.4018/978-1-59140-158-2.ch001.

da Silva Lopes, T., Casson, M.C. and Jones, G. (2019) ‘Organizational innovation in the multinational enterprise: Internalization theory and business history’, *Journal of International Business Studies*, 50(8), pp. 1338–1358. Available at: https://doi.org/10.1057/s41267-018-0156-6.

Simon, H.A. (1962) ‘The Architecture of Complexity’, in *Proceedings ofthe American Philosophical Society*, pp. 467–482. Available at: https://doi.org/10.7551/mitpress/12107.003.0011.

Simon, H.A. (1985) ‘What we know about the creative process’, in R.L. Kuhn (ed.) *Frontiers in creative and innovative management*. Cambridge: Ballinger, pp. 3–20.

Singh, N. and Kundu, S. (2002) ‘Explaining the Growth of E-Commerce Corporations (ECCs): An Extension and Application of the Eclectic Paradigm’, *Journal of International Business Studies*, 33(4), pp. 679–697. Available at: https://doi.org/10.1057/palgrave.jibs.8491039.

Smil, V. (2013) *Making the Modern World: Materials and Dematerialization*. Wiley.

Smil, V. (2017) *Energy and Civilization: a History*. 2nd editio, *Transhumanism*. 2nd editio. Cambridge, MA: The MIT Press.

Snow, C.P. (1966) 'Government, Science, and Public Policy', *Science*, 151(3711), pp. 650–653.

Solow, R. (1987) 'We'd better watch out', *New York Times Book Review*, 12 July, pp. 1–2. Available at: http://ci.nii.ac.jp/naid/10007455402/.

Solow, R.M. (1957) 'Technical Change and the Aggregate Production Function Author (s): Robert M . Solow Source : The Review of Economics and Statistics', *The Review of Economics and Statistics*, 39(3), pp. 312–320.

Steel, I. and Nair, V. (2021) *International corporate tax reforms: what could the OECD deal mean for lower-income countries?*, *ODI Emerging Analysis. London: ODI*. Available at: https://odi.org/en/ publications/international-corporate-tax-reforms-what-could-the-oecd-deal-mean-for-lower- income-countries.

De Stefano, T., Kneller, R. and Timmis, J. (2014) *The (Fuzzy) Digital Divide : The Effect of Broadband Internet Use on UK Firm Performance*, *University of Nottingham Discussion Papers*.

Stiroh, K.J. (2002) 'Are ICT Spillovers Driving the New Economy?', *Review of Income and Wealth*, 48(1), pp. 33–57. Available at: https://doi.org/10.1111/1475-4991.00039.

Storm, S. (2017) 'The New Normal: Demand, Secular Stagnation, and the Vanishing Middle Class', *International Journal of Political Economy*, 46(4), pp. 169–210. Available at: https://doi.org/10.1080/08911916.2017.1407742.

Strange, R. and Zucchella, A. (2017) 'Industry 4.0, global value chains and international business', *Multinational Business Review*, 25(3), pp. 174–184. Available at: https://doi.org/10.1108/MBR-05-2017-0028.

Strassmann, P.A. (1985) *Tranformation Pay Off: The Transformation of Work in the Electronic Age*. New York: The Free Press.

Stuckey, J.A. (1983) *Vertical integration and joint ventures in the aluminum industry*. Cambridge, MA: Harvard University Press.

Sundberg, L. (2024) 'Towards the Digital Risk Society: A Review', *Human Affairs*, 34(1), pp. 151–164. Available at: https://doi.org/10.1515/humaff-2023-0057.

Sutherland, W. and Jarrahi, M.H. (2018) 'The sharing economy and digital platforms: A review and research agenda', *International Journal of Information Management*, 43(February), pp. 328–341. Available at: https://doi.org/10.1016/j.ijinfomgt.2018.07.004.

Syverson, C. (2010) *What Determines Productivity*, *Nber Working Paper Series*. Available at: http://www.nber.org/papers/w15712.

Tapscott, D. (1996) *The Digital Economy: promise and peril in the age of networked intelligence*. New York: McGraw-Hill.

Taylor, G., Richardson, G. and Lanis, R. (2015) 'Multinationality, tax havens, intangible assets and transfer pricing aggressiveness', *Journal of International Accounting Research*, 14(1), pp. 25–57.

Teece, D.J. (2009) *Dynamic capabilities and strategic management: Organizing for innovation and growth.* Oxford: Oxford University Press.

Teece, D.J. (2018) ‘Business models and dynamic capabilities’, *Long Range Planning*, 51(1), pp. 40–49. Available at: https://doi.org/10.1016/j.lrp.2017.06.007.

Temouri, Y. *et al.* (2022) ‘Haven-Sent? Tax Havens, Corporate Social Irresponsibility and the Dark Side of Family Firm Internationalization’, *British Journal of Management*, 33(3), pp. 1447–1467. Available at: https://doi.org/10.1111/1467-8551.12559.

Temouri, Y., Driffield, N.L. and Higón, D.A. (2008) ‘Analysis of productivity differences among foreign and domestic firms: Evidence from Germany’, *Review of World Economics*, 144(1), pp. 32–54. Available at: https://doi.org/10.1007/s10290-008-0136-1.

Ting, A. and Gray, S.J. (2019) ‘The rise of the digital economy: Rethinking the taxation of multinational enterprises’, *Journal of International Business Studies*, 50(9), pp. 1656–1667. Available at: https://doi.org/10.1057/s41267-019-00223-x.

Tørsløv, T., Wier, L. and Zucman, G. (2023) ‘The Missing Profits of Nations’, *The Review of Economic Studies*, 90(3), pp. 1499–1534. Available at: https://doi.org/10.1093/restud/rdac049.

Trading Economics (2022) *Trading Economics*. Available at: https://tradingeconomics.com/ (Accessed: 7 January 2024).

van Tulder, R. (2015) ‘Getting all motives right: A holistic approach to internationalization motives of companies’, *Multinational Business Review*, 23(1), pp. 36–56. Available at: https://doi.org/10.1108/MBR-12-2014-0068.

UNCTAD (2013) ‘Global value chains: Investment and trade for development’, in, pp. 121–202. Available at: https://doi.org/10.18356/f045c54c-en.

UNCTAD (2015) *Information Economy Report 2015: Unlocking the Potential of E-commerce for Developing Countries*, *United Nations*. New York and Geneva. Available at: https://doi.org/10.1108/DLP-10-2017-0040.

UNCTAD (2017) ‘The Top 100 Digital MNEs. World Investment Report 2017 - Chapter IV’, pp. 1–11. Available at: http://unctad.org/en/PublicationChapters/wir2017ch4_Annex_en.pdf.

UNCTAD (2019) *World Investment Report*. New York.

Valenduc, G. and Vendramin, P. (2017) ‘Digitalisation, between disruption and evolution’, *Transfer*, 23(2), pp. 121–134. Available at: https://doi.org/10.1177/1024258917701379.

Verbeke, A. (2013) *International Business Strategy*. 2nd edn. Cambridge: Cambridge University Press.

Verbeke, A., Amin Zargarzadeh, M. and Osiyevskyy, O. (2014) ‘Internalization theory, entrepreneurship and international new ventures’, *Multinational Business Review*, 22(3), pp. 246–269. Available at: https://doi.org/10.1108/MBR-06-2014-0023.

Verbeke, A. and Hillemann, J. (2013) ‘Internalization theory as the general theory of international strategic management: Jean-Francois Hennart's contributions.', *Advances in International Management*, 26(1), pp. 35–52.

Verbeke, A. and Kenworthy, T.P. (2008) 'Multidivisional vs metanational governance of the multinational enterprise', *Journal of International Business Studies*, 39(6), pp. 940–956. Available at: https://doi.org/10.1057/palgrave.jibs.8400344.

Verbeke, A. and Yuan, W. (2010) 'A Strategic Management Analysis of Ownership Advantages in the Eclectic Paradigm', *Multinational Business Review*, 18(2), pp. 89–108. Available at: https://doi.org/10.1108/1525383X201000012.

Virilio, P. (1977) *Speed and Politics: an essay on Dromology*. trans,2006. Edited by M. Polizzotti. Semiotext(e).

Virilio, P. (1999) *Politics of the Very Worst*. Edited by Semiotext(e). New York.

Weinstock, C. and Goodenough, J. (2006) *On System Scalability: Performance-Critical Systems*. Available at: http://www.sei.cmu.edu/publications/pubweb.html.

Westberg, B. (2014) 'Taxation of the Digital Economy - An EU Perspective', *European Taxation*, 54(12), pp. 541–544. Available at: https://doi.org/10.59403/3fdtepe.

Williamson, O.E. (1985) *The Economic Institutions of Capitalism*. New York: Macmillan.

Williamson, O.E. (1996) *The Mechanisms of Governance*. Oxford: Oxford University Press.

Wirth, N. (2008) 'A Brief History of Software Engineering', *IEEE Annals of the History of Computing*, 30(3), pp. 32–39. Available at: https://doi.org/10.1109/MAHC.2008.33.

Witt, M.A. and Lewin, A.Y. (2007) 'Outward foreign direct investment as escape response to home country institutional constraints', *Journal of International Business Studies*, 38(4), pp. 579–594. Available at: https://doi.org/10.1057/palgrave.jibs.8400285.

Woodall, P. (2000) 'Survey: the new economy', *The Economist*, September, pp. 27–32. Available at: https://www.economist.com/special-report/2000/09/23/untangling-e-conomics.

Wooldridge, J. (2016) *Introductory Econometrics: a modern approach*. 6th edn. Michigan: Cengage Learning.

Wooldridge, J.M. (2009) 'On estimating firm-level production functions using proxy variables to control for unobservables', *Economics Letters*, 104(3), pp. 112–114. Available at: https://doi.org/10.1016/j.econlet.2009.04.026.

Yeung, K. (2019) 'Regulation by blockchain: The emerging battle for supremacy between the code of law and code as law', *Modern Law Review*, 82(2), pp. 207–239. Available at: https://doi.org/10.1111/1468-2230.12399.

Zeng, J., Khan, Z. and De Silva, M. (2019) 'The emergence of multi-sided platform MNEs: Internalization theory and networks', *International Business Review*, 28(6), p. 101598. Available at: https://doi.org/10.1016/j.ibusrev.2019.101598.

Zucman, G. (2014) 'Taxing across Borders: Tracking Personal Wealth and Corporate Profits', *Journal of Economic Perspectives*, 28(4), pp. 121–148. Available at: https://doi.org/10.1257/jep.28.4.121.

Zucman, G. (2016) *The hidden wealth of nations: the scourge of tax havens*. First. Edited by The University of Chicago Pres. London: University of Chicago Press. Available at: https://doi.org/10.7208/chicago/9780226245560.001.0001.

APPENDIX A

Tables from Chapter 4:

Table A1: Firm observations, from 2008 to 2019, of 36 OECD sectors, within the service and manufacturing industry (excl. financial and insurance)

Country name	Frequency	Percent	Cum.
Austria	1594	1.49	1.49
Australia	677	0.63	2.12
Belgium	5820	5.44	7.56
Canada	196	0.18	7.74
Switzerland	455	0.43	8.17
Chile	60	0.06	8.23
Czech Rep.	2179	2.04	10.26
Germany	10981	10.26	20.52
Denmark	499	0.47	20.99
Estonia	3	0.00	20.99
Spain	20445	19.10	40.10
Finland	277	0.26	40.36
France	10319	9.64	50.00
UK	9466	8.85	58.84
Greece	66	0.06	58.91
Hungary	1171	1.09	60.00
Ireland	1259	1.18	61.18
Israel	111	0.10	61.28
Iceland	17	0.02	61.30
Italia	27491	25.69	86.98
Japan	103	0.10	87.08
South Korea	389	0.36	87.44
Lithuania	1	0.00	87.45
Luxembourg	125	0.12	87.56
Latvia	4	0.00	87.57
Mexico	1	0.00	87.57
Netherlands	76	0.07	87.64
Norway	676	0.63	88.27
New Zealand	51	0.05	88.32
Poland	323	0.30	88.62
Portugal	6088	5.69	94.31
Sweden	1632	1.53	95.83
Slovenia	2010	1.88	97.71
Slovakia	4	0.00	97.72
Turkey	76	0.07	97.79
United States	2369	2.21	100.00
Total Observations	107014	100.00	

Source: ORBIS

Table A2: Distribution across countries for digital versus non-digital firms

Countries	All sectors digital		
	Non-digital	Digital	Total
Austria	1341	177	1518
Australia	580	57	637
Belgium	5039	362	5401
Canada	133	61	194
Switzerland	408	44	452
Chile	57	1	58
Czech Rep.	1853	185	2038
Germany	9756	891	10647
Denmark	421	48	469
Estonia	3	0	3
Spain	16732	1745	18477
Finland	222	39	261
France	8656	1181	9837
UK	7867	1206	9073
Greece	49	9	58
Hungary	1010	58	1068
Ireland	1028	110	1138
Israel	75	32	107
Iceland	11	6	17
Italia	23961	1708	25669
Japan	91	6	97
South Korea	317	50	367
Luxembourg	85	25	110
Latvia	4	0	4
Mexico	1	0	1
Netherlands	57	13	70
Norway	549	93	642
New Zealand	41	10	51
Poland	282	15	297
Portugal	4759	510	5269
Sweden	1347	165	1512
Slovenia	1638	229	1867
Slovakia	4	0	4
Turkey	58	11	69
United States	1550	759	2309
Total	9806	89985	99791

Source: ORBIS

Table A3: Correlation matrix

Pairwise correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
(1) Log Added value	1.000																
(2) Log Tangible Fixed Assets	0.790	1.000															
(3) Log Number of employees	0.911	0.752	1.000														
(4) Log Creditors	0.781	0.685	0.758	1.000													
(5) log TFP Wooldridge	0.622	0.355	0.257	0.266	1.000												
(6) log TFP LevPet Residual	0.786	0.550	0.464	0.484	0.967	1.000											
(7) log TFP LevPet Omega	0.342	0.002	-0.012	-0.001	0.888	0.781	1.000										
(8) Digital manufacturer	0.059	0.040	0.068	0.050	0.011	0.025	0.000	1.000									
(9) Digital service	0.033	-0.098	0.036	-0.035	0.049	0.031	0.075	-0.036	1.000								
(10) Non-digital service	-0.078	-0.117	-0.123	-0.148	0.077	0.028	0.079	-0.106	-0.232	1.000							
(11) Intangibles/Total Assets	0.330	0.197	0.334	0.241	0.163	0.215	0.087	0.046	0.198	-0.028	1.000						
(12) Parent age	0.305	0.312	0.295	0.257	0.144	0.210	0.044	-0.001	-0.101	-0.098	-0.014	1.000					
(13) log Cash Flow (de)	0.947	0.797	0.809	0.734	0.673	0.820	0.386	0.062	0.010	-0.064	0.320	0.278	1.000				
(14) log LT Debt (de)	0.706	0.693	0.613	0.583	0.458	0.587	0.173	0.043	-0.023	-0.035	0.304	0.205	0.710	1.000			
(15) log Total Assets (de)	0.930	0.802	0.801	0.787	0.627	0.786	0.301	0.055	-0.011	-0.044	0.314	0.293	0.924	0.776	1.000		
(16) Metropolitan area	-0.166	-0.143	-0.125	-0.149	-0.140	-0.165	-0.085	-0.014	-0.026	0.010	-0.121	-0.014	-0.137	-0.135	-0.153	1.000	
(17) Year	-0.014	-0.104	-0.052	-0.055	0.087	0.056	0.122	-0.042	0.076	0.112	-0.019	0.013	-0.034	-0.074	-0.027	-0.033	1.000

(de) = deflated

Table A4: TFP estimates for all OECD firms.

	Levinsohn Petrin estimation (Omega)	Wooldridge estimation
Log number of employees	.6456***	.6716***
	(.0037)	(.0026)
Log tangible fixed assets	.0125**	.0472***
(deflated)	(.0062)	(.0028)
Log creditors	.0601***	.1152***
(deflated)	(.0041)	(.004)
Observations	203730	138705
Chi^2	1363.39	1664.04

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Table A5: TFP estimates for all EU firms.

	Levinsohn Petrin estimation (Omega)	Wooldridge estimation
Log number of employees	.6569***	.6825***
	(.0042)	(.0026)
Log tangible fixed assets	.0108**	.044***
(deflated)	(.0055)	(.0028)
Log creditors	.0575***	.1114***
(deflated)	(.0046)	(.0041)
Observations	197476	134750
Chi^2	1578.76	1520.64

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

APPENDIX B

Tables from Chapter 5:

Table B1: Correlation matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) J&T 2016(Dots)	1.000											
(2) J&T 2018	0.596	1.000										
(3) H&R 1994	0.939	0.563	1.000									
(4) Big 7	0.295	0.642	0.289	1.000								
(5) Digital Services	0.001	0.006	0.001	0.019	1.000							
(6) Non-Digital Services	0.023	-0.008	0.019	-0.010	-0.315	1.000						
(7) Digital Manufacturers	0.016	0.055	0.017	0.049	-0.043	-0.120	1.000					
(8) Non-Digital Manufacturers	-0.037	-0.008	-0.032	-0.004	-0.248	-0.702	-0.095	1.000				
(9) IATA	-0.001	-0.001	-0.001	-0.001	-0.001	0.002	-0.000	-0.002	1.000			
(10) Parent Age	0.087	0.136	0.087	0.148	-0.118	-0.124	0.002	0.212	-0.002	1.000		
(11) Log Cash Flow	0.284	0.372	0.273	0.370	-0.019	-0.143	0.065	0.170	-0.012	0.299	1.000	
(12) Log Turnover	0.228	0.324	0.218	0.330	-0.019	-0.181	0.066	0.200	-0.015	0.317	0.850	1.000

Table B2: Coefficients for Hypothesis 1 (logit)

VARIABLES	J&T 2016(Dots)	J&T 2018	H&R 1994	Big 7
Digital Services	0.304***	0.326***	0.290***	0.480***
	(0.0645)	(0.0468)	(0.0653)	(0.0468)
Non-Digital Services	0.532***	0.344***	0.488***	0.369***
	(0.0400)	(0.0293)	(0.0405)	(0.0298)
Digital Manufacturers	0.177	0.728***	0.188*	0.649***
	(0.109)	(0.0806)	(0.110)	(0.0856)
Intang. Assets/Total	-4.74e-05	-6.23e-05*	-5.20e-05*	-5.88e-05*
Assets	(3.11e-05)	(3.20e-05)	(3.13e-05)	(3.16e-05)
Log Cash Flow	0.482***	0.406***	0.475***	0.358***
	(0.0136)	(0.0106)	(0.0138)	(0.0106)
Log Turnover	-0.0744***	0.0173*	-0.0819***	0.0568***
	(0.0127)	(0.0103)	(0.0128)	(0.0106)
Parent Age	0.00155***	0.00316***	0.00190***	0.00458***
	(0.000577)	(0.000500)	(0.000584)	(0.000527)
Constant	-9.010***	-8.383***	-8.781***	-8.336***
	(0.151)	(0.112)	(0.152)	(0.115)
Observations	243,248	243,248	243,248	243,248
ll	-56998	-95087	-56011	-98686
Chi^2	2836	5197	2630	4881
N_cdf	1	1	1	1
R^2	0.146	0.154	0.138	0.150

Notes: variables of interest grouped based on NACE Rev.2 (2008) as explained in Chapter 3. All monetary values are in USD and using GDP deflators. Clustered standard errors at the MNE level. All explanatory variables are lagged one period. Robust standard errors in parentheses.

* p < 0.1. ** p < 0.05. *** p < 0.01.

Table B3: Marginal effects for Hypothesis 1.2 (all)

VARIABLES	J&T 2016(Dots)	J&T 2018	H&R 1994	Big 7
Digital Wholesale	0.0235	0.0593***	0.0256	0.0846***
	(0.0161)	(0.0194)	(0.0162)	(0.0200)
Digital Retail	0.0455**	0.0252	0.0244	0.0582*
	(0.0219)	(0.0271)	(0.0195)	(0.0298)
Digital Publishing	0.0194*	0.0947***	0.0211*	0.137***
	(0.0117)	(0.0181)	(0.0116)	(0.0205)
Digital Video, Film and	-0.0172	-0.0564***	-0.0223	-0.0474**
Sound	(0.0166)	(0.0184)	(0.0160)	(0.0192)
Digital Broadcasting	0.0205	0.00640	0.0242	-0.0276
	(0.0219)	(0.0353)	(0.0237)	(0.0306)
Digital	0.0154	0.0351*	0.00944	-0.00211
Telecommunications	(0.0112)	(0.0198)	(0.0106)	(0.0196)
Digital Computer	0.0223***	0.0524***	0.0229***	0.0836***
Programming	(0.00769)	(0.00964)	(0.00762)	(0.0104)
Digital Information	0.0301	0.0606**	0.0224	0.117***
Services	(0.0213)	(0.0261)	(0.0195)	(0.0286)
Digital Advertising	0.00751	0.0296	0.00846	0.0708***
	(0.0162)	(0.0202)	(0.0160)	(0.0231)
Digital Rental and Leasing	0.141**	0.126**	0.132**	0.0789
	(0.0552)	(0.0586)	(0.0551)	(0.0575)

Digital Travel Agency	0.0358**	0.000876	0.0286	0.0484**
	(0.0181)	(0.0201)	(0.0181)	(0.0236)
Digital Administrative services	-0.0516**	-0.0942**	-0.00850	-0.00606
	(0.0235)	(0.0470)	(0.0430)	(0.0524)
Digital Gambling	0.137*	-0.0121	0.127*	-0.0801*
	(0.0779)	(0.0648)	(0.0765)	(0.0411)
Digital Computer Repair	-0.0411	0.0152	-0.0184	-0.0533
	(0.0265)	(0.0521)	(0.0339)	(0.0463)
Non-Digital Wholesale Vehicles	-0.0126	-0.0653***	-0.00719	-0.0671***
	(0.0106)	(0.0133)	(0.0109)	(0.0130)
Non-Digital Wholesale	-0.00529	0.00198	-0.00385	0.0174***
	(0.00354)	(0.00514)	(0.00356)	(0.00550)
Non-Digital Retail	0.0458***	0.0331***	0.0345***	0.0271**
	(0.00900)	(0.0112)	(0.00855)	(0.0122)
Non-Digital Land Transport	0.00295	-0.0502***	0.00269	-0.0274**
	(0.00985)	(0.0112)	(0.00979)	(0.0136)
Non-Digital Water Transport	0.132***	0.155***	0.117***	0.0852***
	(0.0221)	(0.0267)	(0.0215)	(0.0249)
Non-Digital Air Transport	0.0303	-0.0189	0.0222	-0.0492**
	(0.0207)	(0.0250)	(0.0194)	(0.0219)
Non-Digital Warehousing	0.0370***	0.0609***	0.0437***	0.0614***
	(0.0103)	(0.0131)	(0.0105)	(0.0136)
Non-Digital Postal and Courier	0.0214	-0.0684**	0.0243	-0.00735
	(0.0488)	(0.0347)	(0.0497)	(0.0581)
Non-Digital Hospitality	0.0355**	-0.0252	0.0340**	-0.00612
	(0.0142)	(0.0165)	(0.0142)	(0.0225)
Non-Digital Food and Beverage	0.0937***	0.0735***	0.0802***	0.0373
	(0.0259)	(0.0278)	(0.0249)	(0.0279)
Non-Digital Publishing	0.0202	0.0377*	0.00884	0.0271
	(0.0148)	(0.0203)	(0.0140)	(0.0204)
Non-Digital Real Estate	0.0850***	0.0755***	0.0774***	0.0470***
	(0.00935)	(0.0110)	(0.00907)	(0.0116)
Non-Digital Legal and Accounting	0.117***	0.113***	0.104***	0.0791***
	(0.0203)	(0.0223)	(0.0201)	(0.0235)
Non-Digital Consultancy	0.0719***	0.111***	0.0661***	0.134***
	(0.00600)	(0.00773)	(0.00584)	(0.00804)
Digital Architecture and Engineering	0.0328***	0.0609***	0.0298***	0.0326***
	(0.00874)	(0.0109)	(0.00848)	(0.0109)
Non-Digital Scientific Research	-0.0154	0.0241	-0.0159	0.0452**
	(0.0116)	(0.0202)	(0.0116)	(0.0230)
Non-Digital Advertising	0.0225	0.138***	0.0203	0.180***
	(0.0245)	(0.0360)	(0.0236)	(0.0394)
Non-Digital Other professional act	0.0282**	0.0691***	0.0240**	0.101***
	(0.0110)	(0.0153)	(0.0108)	(0.0170)
Non-Digital Veterinary	-	-	-	-0.0945*
	0.0225	0.138***	0.0203	0.180***
Non-Digital Rental and Leasing	0.0161	-0.0168	0.0111	-0.0158
	(0.0132)	(0.0169)	(0.0129)	(0.0173)
Non-Digital Employment	0.0668***	0.0896***	0.0552***	0.0788***
	(0.0195)	(0.0229)	(0.0196)	(0.0231)

Non-Digital Security	0.0620	0.0337	0.0630	0.0409
	(0.0390)	(0.0474)	(0.0391)	(0.0489)
Non-Digital Cleaning and Landscape	0.0793***	0.0834**	0.0736**	0.00762
	(0.0297)	(0.0351)	(0.0293)	(0.0323)
Non-Digital Office Support	0.0566***	0.101***	0.0445***	0.118***
	(0.00982)	(0.0129)	(0.00934)	(0.0135)
Non-Digital Education	0.0406*	0.0758**	0.0280	0.105***
	(0.0226)	(0.0304)	(0.0225)	(0.0347)
Non-Digital Healthcare	0.00505	-0.0447***	0.00678	-0.0462**
	(0.0114)	(0.0158)	(0.0118)	(0.0222)
Non-Digital Residential	0.0737	-0.0156	0.0752	-0.0879**
Care	(0.0614)	(0.0615)	(0.0617)	(0.0385)
Non-Digital Social Work	0.149**	0.123*	0.0988*	0.0300
	(0.0643)	(0.0671)	(0.0585)	(0.0572)
Non-Digital Creative Arts	0.0842**	0.0738	0.0432	0.0300
	(0.0408)	(0.0473)	(0.0304)	(0.0481)
Non-Digital Libraries and Museums	-	-	-	-
Non-Digital Sports	-0.00250	0.0123	-0.0111	0.0735**
	(0.0139)	(0.0243)	(0.0123)	(0.0332)
Non-Digital Repair household goods	-	-	-	-
Non-Digital Other personal	-0.00250	0.0123	-0.0111	0.0735**
service	(0.0139)	(0.0243)	(0.0123)	(0.0332)
Digital Manufacturers	0.0125	0.103***	0.0129*	0.0939***
	(0.00774)	(0.0129)	(0.00770)	(0.0139)
Intang. Assets/Total Assets	-3.30e-06	-8.00e-06**	-3.49e-06*	-7.79e-06**
	(2.03e-06)	(3.78e-06)	(2.01e-06)	(3.89e-06)
Log Cash Flow	0.0269***	0.0433***	0.0262***	0.0402***
	(0.000906)	(0.00126)	(0.000894)	(0.00135)
Log Turnover	-0.00105	0.00784***	-0.00177**	0.0124***
	(0.000859)	(0.00128)	(0.000841)	(0.00138)
Parent Age	0.000117***	0.000425***	0.000132***	0.000622***
	(3.72e-05)	(6.05e-05)	(3.65e-05)	(6.61e-05)
Observations	243,167	243,167	243,167	243,167
R^2	0.1489	0.1565	0.1408	0.1526

Notes: variables of interest grouped based on NACE Rev.2 (2008) as explained in Chapter 3. All monetary values are in USD and using GDP deflators. Clustered standard errors at the MNE level. All explanatory variables are lagged one period. Robust standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1

Table B4: Coefficients for Hypothesis 1.2 (logit)

VARIABLES	J&T 2016	J&T 2018	H&R 1994	Big 7
Digital Wholesale	0.337	0.454***	0.370*	0.605***
	(0.208)	(0.135)	(0.208)	(0.127)
Digital Retail	0.598**	0.204	0.355	0.433**
	(0.241)	(0.209)	(0.253)	(0.202)
Digital Publishing	0.284*	0.688***	0.312**	0.920***
	(0.156)	(0.115)	(0.155)	(0.118)
Digital Video, Film and	-0.308	-0.557***	-0.427	-0.436**
Sound	(0.332)	(0.213)	(0.361)	(0.198)
Digital Broadcasting	0.298	0.0539	0.352	-0.241
	(0.289)	(0.293)	(0.307)	(0.285)
Digital	0.229	0.280*	0.147	-0.0174
Telecommunications	(0.154)	(0.148)	(0.158)	(0.162)
Digital Computer	0.322***	0.405***	0.336***	0.599***
Programming	(0.101)	(0.0689)	(0.101)	(0.0671)
Digital Information	0.420	0.463**	0.329	0.805***
Services	(0.261)	(0.181)	(0.257)	(0.170)
Digital Advertising	0.116	0.238	0.133	0.517***
	(0.240)	(0.154)	(0.240)	(0.152)
Digital Rental and Leasing	1.428***	0.882**	1.377***	0.569
	(0.397)	(0.349)	(0.406)	(0.370)
Digital Travel Agency	0.488**	0.00746	0.408*	0.365**
	(0.212)	(0.171)	(0.227)	(0.165)
Digital Administrative	-1.293	-1.070	-0.147	-0.0505
services	(1.032)	(0.761)	(0.787)	(0.441)
Digital Gambling	1.400**	-0.106	1.337**	-0.815
	(0.567)	(0.583)	(0.574)	(0.538)
Digital Computer Repair	-0.903	0.126	-0.341	-0.498
	(0.840)	(0.418)	(0.715)	(0.498)
Non-Digital Wholesale	-0.260	-0.726***	-0.144	-0.711***
Vehicles	(0.241)	(0.185)	(0.231)	(0.171)
Non-Digital Wholesale	-0.103	0.0179	-0.0751	0.146***
	(0.0708)	(0.0463)	(0.0708)	(0.0452)
Non-Digital Retail	0.672***	0.279***	0.537***	0.223**
	(0.108)	(0.0884)	(0.113)	(0.0954)
Non-Digital Land Transport	0.0542	-0.527***	0.0501	-0.256*
	(0.178)	(0.138)	(0.179)	(0.136)
Non-Digital Water	1.470***	1.088***	1.362***	0.635***
Transport	(0.169)	(0.154)	(0.173)	(0.163)
Non-Digital Air Transport	0.476*	-0.180	0.367	-0.490*
	(0.278)	(0.250)	(0.283)	(0.252)
Non-Digital Warehousing	0.564***	0.487***	0.652***	0.475***
	(0.133)	(0.0948)	(0.128)	(0.0955)
Non-Digital Postal and	0.352	-0.771	0.398	-0.0652
Courier	(0.712)	(0.501)	(0.708)	(0.524)
Non-Digital Hospitality	0.545***	-0.244	0.530***	-0.0541
	(0.184)	(0.171)	(0.187)	(0.202)
Non-Digital Food and	1.159***	0.576***	1.039***	0.301

Beverage	(0.231)	(0.192)	(0.238)	(0.210)
Non-Digital Publishing	0.329	0.309**	0.154	0.216
	(0.218)	(0.157)	(0.235)	(0.159)
Non-Digital Real Estate	1.073***	0.585***	1.009***	0.364***
	(0.0904)	(0.0767)	(0.0913)	(0.0847)
Non-Digital Legal and	1.353***	0.831***	1.251***	0.595***
Accounting	(0.163)	(0.139)	(0.171)	(0.155)
Non-Digital Consultancy	0.949***	0.818***	0.898***	0.928***
	(0.0636)	(0.0502)	(0.0641)	(0.0496)
Digital Architecture and	0.510***	0.488***	0.473***	0.266***
Engineering	(0.117)	(0.0791)	(0.117)	(0.0838)
Non-Digital Scientific	-0.325	0.207	-0.344	0.359**
Research	(0.278)	(0.165)	(0.285)	(0.169)
Non-Digital Advertising	0.369	0.988***	0.340	1.195***
	(0.354)	(0.214)	(0.351)	(0.216)
Non-Digital Other	0.448***	0.545***	0.394**	0.735***
professional act	(0.151)	(0.108)	(0.156)	(0.108)
Non-Digital Veterinary	-	-	-	-1.128
				(0.917)
Non-Digital Rental and	0.273	-0.159	0.195	-0.143
Leasing	(0.204)	(0.167)	(0.213)	(0.163)
Non-Digital Employment	0.903***	0.685***	0.784***	0.593***
	(0.201)	(0.152)	(0.218)	(0.154)
Non-Digital Security	0.853**	0.284	0.869**	0.328
	(0.413)	(0.373)	(0.411)	(0.363)
Non-Digital Cleaning and Landscape	1.026***	0.644***	0.976***	0.0653
	(0.285)	(0.236)	(0.290)	(0.273)
Non-Digital Office Support	0.795***	0.756***	0.662***	0.842***
	(0.110)	(0.0842)	(0.114)	(0.0830)
Non-Digital Education	0.609**	0.592***	0.449	0.762***
	(0.279)	(0.209)	(0.310)	(0.216)
Non-Digital Healthcare	0.0915	-0.461**	0.123	-0.456*
	(0.201)	(0.187)	(0.204)	(0.250)
Non-Digital Residential	0.972	-0.147	0.991	-1.016
Care	(0.605)	(0.606)	(0.603)	(0.626)
Non-Digital Social Work	1.593***	0.896**	1.208**	0.246
	(0.460)	(0.410)	(0.506)	(0.441)
Non-Digital Creative Arts	1.072***	0.578*	0.645*	0.245
	(0.380)	(0.326)	(0.368)	(0.371)
Non-Digital Libraries and	-	-	-	-0.431
Museums				(1.634)
Non-Digital Sports	0.676**	0.0366	0.530*	0.226
	(0.302)	(0.242)	(0.319)	(0.301)
Non-Digital Repair	-	-	-	-
household goods				
Non-Digital Other personal	-0.0476	0.108	-0.229	0.558**
service	(0.269)	(0.209)	(0.277)	(0.223)
Digital Manufacturers	0.186*	0.732***	0.195*	0.653***
	(0.108)	(0.0804)	(0.109)	(0.0857)
Intang. Assets/Total Assets	-5.20e-05	-6.71e-05**	-5.64e-05*	-6.25e-05**

	(3.21e-05)	(3.17e-05)	(3.24e-05)	(3.12e-05)
Log Cash Flow	0.425***	0.363***	0.423***	0.323***
	(0.0146)	(0.0110)	(0.0147)	(0.0111)
Log Turnover	-0.0166	0.0658***	-0.0285**	0.0996***
	(0.0136)	(0.0107)	(0.0136)	(0.0111)
Parent Age	0.00185***	0.00356***	0.00213***	0.00499***
	(0.000587)	(0.000508)	(0.000589)	(0.000532)
Constant	-9.166***	-8.611***	-8.949***	-8.575***
	(0.157)	(0.114)	(0.157)	(0.117)
Observations	243,167	243,167	243,167	243,208
ll	-56103	-93924	-55273	-97489
Chi^2	3199	5628	2939	5314
N_cdf	1	1	1	1
R^2	0.159	0.164	0.149	0.160

Notes: variables of interest grouped based on NACE Rev.2 (2008) as explained in Chapter 3. All monetary values are in USD and using GDP deflators. Clustered standard errors at the MNE level. All explanatory variables are lagged one period. Robust standard errors in parenthesis
*** p<0.01, ** p<0.05, * p<0.1

Table B5: Coefficients for Hypothesis 2 (logit)

VARIABLES	J&T 2016	J&T 2018	H&R 1994	Big 7
Digital Services	0.351***	0.377***	0.341***	0.567***
	(0.0831)	(0.0557)	(0.0844)	(0.0546)
Non-Digital Services	0.658***	0.436***	0.610***	0.472***
	(0.0442)	(0.0311)	(0.0448)	(0.0316)
Digital Manufacturers	0.0742	0.740***	0.0778	0.680***
	(0.141)	(0.0983)	(0.141)	(0.103)
Intang. Assets/Total	-0.000105***	-0.000150***	-0.000107***	-0.000164***
Assets (IATA)	(3.09e-05)	(3.16e-05)	(3.10e-05)	(3.42e-05)
IATA * Digital Services	0.556**	0.358*	0.512**	0.163
	(0.246)	(0.204)	(0.254)	(0.206)
IATA * non-Digital	-0.00168	0.000151***	-0.0131	0.000166***
Services	(0.0104)	(3.20e-05)	(0.0180)	(3.45e-05)
IATA * Digital	2.105***	1.117**	2.131***	1.040*
Manufacturers	(0.604)	(0.517)	(0.604)	(0.556)
IATA * non-Digital	1.697***	1.737***	1.654***	1.975***
Manufacturers	(0.176)	(0.164)	(0.177)	(0.168)
Log Cash Flow	0.465***	0.392***	0.458***	0.344***
	(0.0137)	(0.0106)	(0.0138)	(0.0107)
Log Turnover	-0.0761***	0.0156	-0.0835***	0.0547***
	(0.0127)	(0.0102)	(0.0128)	(0.0105)
Parent Age	0.00171***	0.00337***	0.00205***	0.00483***
	(0.000577)	(0.000505)	(0.000584)	(0.000532)
Digital Services	-8.829***	-8.238***	-8.605***	-8.193***
	(0.152)	(0.112)	(0.153)	(0.115)
Observations	243,248	243,248	243,248	243,248
ll	-56793	-94827	-55818	-98357
Chi^2	3022	5413	2804	5108
N_cdf	1	0	1	0
R^2	0.149	0.156	0.141	0.153

Notes: variables of interest grouped based on NACE Rev.2 (2008) as explained in Chapter 3. All monetary values are in USD and using GDP deflators. Clustered standard errors at the MNE level. All explanatory variables are lagged one period. Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table B6: Coefficients for Hypothesis 3 (logit)

VARIABLES	J&T 2016	J&T 2018	H&R 1994	Big 7
Digital Services	2.355***	2.098***	2.258***	2.172***
	(0.541)	(0.388)	(0.542)	(0.381)
Non-Digital Services	3.974***	3.539***	3.954***	2.786***
	(0.358)	(0.257)	(0.358)	(0.259)
Digital Manufacturers	-4.870***	-3.066***	-4.950***	-1.344
	(1.644)	(1.020)	(1.640)	(1.051)
Log Turnover (LTurn	0.121***	0.176***	0.112***	0.169***
	(0.0207)	(0.0155)	(0.0207)	(0.0155)
LTurn * Digital Services	-0.150***	-0.118***	-0.143***	-0.101***
	(0.0283)	(0.0214)	(0.0284)	(0.0211)
LTurn * non-Digital	-0.227***	-0.198***	-0.226***	-0.142***
Services	(0.0190)	(0.0142)	(0.0191)	(0.0144)
LTurn * Digital	0.199**	0.177***	0.206**	0.0949*
Manufacturers	(0.0804)	(0.0535)	(0.0801)	(0.0551)
LTurn * non-Digital	-0.0516***	-0.0264***	-0.0486***	-0.0112***
Manufacturers	(0.00444)	(0.00353)	(0.00445)	(0.00361)
Intang. Assets/Total	-6.65e-05**	-7.19e-05**	-7.04e-05**	-6.22e-05*
Assets (IATA)	(3.10e-05)	(3.23e-05)	(3.12e-05)	(3.18e-05)
Log Cash Flow	0.445***	0.374***	0.436***	0.335***
	(0.0138)	(0.0105)	(0.0139)	(0.0105)
Parent Age	0.00160***	0.00310***	0.00193***	0.00446***
	(0.000584)	(0.000505)	(0.000590)	(0.000531)
Constant	-11.30***	-10.39***	-11.05***	-9.866***
	(0.306)	(0.217)	(0.305)	(0.217)
Observations	243,248	243,248	243,248	243,248
ll	-56340	-94425	-55385	-98360
Chi^2	2975	5308	2772	4915
N_cdf	1	1	1	1
R^2	0.156	0.160	0.147	0.153

Notes: variables of interest grouped based on NACE Rev.2 (2008) as explained in Chapter 3. All monetary values are in USD and using GDP deflators. Clustered standard errors at the MNE level. All explanatory variables are lagged one period. Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1