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The impact of IT–business strategic alignment on firm performance: The evolving role of IT in industries

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ABSTRACT

This study proposes and validates a new industry taxonomy to understand the use of IT that generates superior economic returns based on the specific economic and competitive characteristics of four different industry types and the strategic role of IT in each of these industry environments. Our findings extend the well-established industry taxonomy on the strategic role of IT (Automate, Informate, Transform) by considering how IT is changing the nature of the product/service in industries where transformational logics prevail. We found that in industries where the product/service is digital in nature, the firms that achieve higher economic returns are those where IT is used to support dual strategies based on the integration of cost leadership and differentiation. Conversely, in other industries – with the exception of those producing commodities – the firms that achieve superior returns are those that use IT to support differentiation. The results of this study can help managers make intelligent decisions about competitive strategies and IT investments, depending on the business environment of the sector in which the firm operates and the generative potential of emerging technologies to do new things.

1. Introduction

The idea that industry matters in determining how information technology (IT) impacts businesses, shapes competitive dynamics and induces structural changes [1] has been well articulated in the information systems (IS) literature since the early contribution of Chiasson and Davidson [2]. However, despite the long tradition of IS studies that have predicted IT would have a transformative effect on the structures of industries [3], the empirical research carried out so far has not identified any idiosyncratic industry characteristics that could shape the association between IT use and business value.

The characteristics of an industry influence not only the type of IT that is needed, the way it is applied and the amount of value that is created [4], but also a firm's ability to capture value from specific business strategies; therefore, it is crucial to align the strategy of a firm with the industry environment [4–7]. The most popular approach in IS studies that propose a strategic alignment perspective to analyse the conditions under which IT investments produce business value has been to investigate the industry environment, in terms of dynamism, munificence, and complexity [e.g. 1,8–12]. However, this approach does not consider how the industry affects the way IT should be used to create economic value [12], and there is little guidance on how to prioritise IT investments based on the industry in which they compete [13]. Therefore, IS researchers introduced the construct of the 'strategic role of IT' in industry [5,7,14,15] to take these aspects into account and to understand the impact of IT on business activities and strategies [5]. Specifically, according to the different purposes of IT in various industries, the strategic role of IT can be classified into three categories: 'Automate', 'Informate' and 'Transform' [16]. This type of industry classification determines the type of IT that is needed, the amount of value that is produced and retained, and the main function that IT plays for business competition [4] – thus highlighting the importance of a strategic alignment between industry and business strategy [11,17]. Indeed, in many industries, IT offers companies an opportunity to implement dual strategies, based on pursuing and balancing both cost and differentiation strategies simultaneously [18–20]. However, our knowledge about how different business strategies affect the economic performance of a company, depending on the different strategic roles IT plays at the industry level, remains limited [13,21]. Furthermore, the existing industry categorisation scheme that defines the strategic role of IT in industry [13 p.534] is in danger of becoming obsolete due to the emergence of new digital technologies [22,23] – such as Artificial Intelligence and Blockchain – that offer not only new actions, but also new ways of recombining those actions into new ways of doing things.

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Pentland et al. [23] trace these effects back to the concept of generativity [24] and point out how emerging digital technologies can dramatically increase the number of paths available when transformational logics in the strategic use of IT prevail.

In this study, we distinguished the industries where transformation logics prevail in the strategic use of IT [7,16] into: 'Physical-Transform' industry – where the main product or service is tangible goods that follow the rules of the physical reality – and 'Digital-Transform' industry – where the product or service is a digitally native artefact whose economic value depends on the information it contains [25]. On the basis of this new industry categorisation scheme and drawing on the strategic alignment perspective [17], we investigated how the alignment between business strategy and the strategic role of IT in an industry influence the performance of firms in Italy. We used data from large Italian firms, active in the 2011–2020 period, to test the research model. As a result, we were able to consider 1769 firms operating in 382 four-digit industries for which complete data on the key variables of interest were available from 2011 to 2020. We then proposed, and empirically tested, that different types of business strategy – differentiation strategy, cost leadership strategy or dual strategy (based on the combination of the two previous strategic postures) – can have a differential impact on the process performance of a firm as the result of IT playing a different strategic role in the industry. Labour productivity growth is the most frequently discussed process performance measure in the context of IT investments [26–28] since it represents the primary lens through which the prevalence of the effects of economic growth (more output) or input reduction (less labour) can be discerned [29,30]. Therefore, in addition to testing the differential impact that a business strategy has on labour productivity growth, we also tested whether labour productivity growth is driven by output growth (i.e. value added growth) or input reduction (i.e. employment reduction).

Our results show that the cost leadership strategy has a greater impact on labour productivity growth in the Automate industry, and it is driven by both input reduction (i.e. employment reduction) and output growth (i.e. value added growth). Contrary to what we expected, it is the differentiation strategy, rather than the dual strategy, that has the greatest impact on labour productivity growth in the Informate industry. This form of strategic alignment mirrors the results that emerged for the Physical-Transform industry, thus signalling how the strategic roles of IT, are progressively converging in these two types of industries. Finally, in the Digital-Transform industry, the dual strategy showed a greater impact on labour productivity growth, which is associated with a growth in employment, accompanied by an even faster growth in value added. Our results are robust, as far as the use of different estimation methods and specifications are concerned, thus indicating that these effects might persist in the future and could also occur in other developed countries.

Our study contributes to the literature on IT business value in two ways. First, the study updates the view of the strategic role of IT by taking into account the generative potential of emerging technologies [23] and applies it to understand how the alignment between business strategy and the strategic role of IT in an industry influences the performance of a firm. We believe this is an important addition to the literature on IT business value and to the recent debate in Information & Management, as two research streams are considered and integrated simultaneously: industry-level and firm-level. At the industry-level, the study extends the seminal contribution of Chatterjee et al. [16] and enriches the debate carried out in Information & Management by Chae et al. [13] by updating the industry classification proposed by these authors. At the firm-level, the study contributes to another recent debate opened by Yin et al. [21] in Information & Management by confirming that alignment between a firm's business strategy and the strategic role of IT in the industry significantly improves not only the economic performance of such a firm [21], but also its process performance by distinguishing economic growth (more output) from input reduction (less labour). Second, the study enriches our understanding of how to configure an appropriate competitive strategy, taking into account the changes in business models induced by the emergence of new technologies, and how these changes vary from industry to industry. Looking forward, our study can provide insight into the drivers of IT business value generation as the generative potential of emerging digital technologies becomes concrete in a variety of industries. This better understanding of the industry can help managers and practitioners improve their IT decisions, both now and in the future. In the remainder of this paper, we present a review of relevant literature, establish our hypotheses, and report the results of the study. In the final section, we discuss the results, implications, and limitations of the study.

2. Theoretical background

2.1. *The strategic role of IT in industry*

The extent to which IT induces structural changes that have an impact on the business strategy of companies and their performance varies from industry to industry [1]. Farrell [31] argued that industries differ in the way they use IT and in their expected returns from using IT to support the definition of their business strategy. IS researchers have used the construct of the 'strategic role of IT' in industry to capture the characteristics and context of industry when studying the IT use practices of firms [cf. 7,14,15]. Zuboff [14] and Schein [15] provided the basis for studying the strategic role of IT by identifying three main categories of strategic IT roles: (1) Automate: IT replaces human work by contributing to the automation of production processes run by machinery; (2) Informate: IT provides data and information to improve management coordination, control and decision-making processes; (3) Transform: IT radically changes the traditional ways of doing business by redefining business models. This classification, which was created to understand the strategic role of IT at the enterprise level, was then extended by Chatterjee et al. [16] to the industry level.

Automate industries refer to industries in which the main role of IT is to support the automation of production processes. Informate industries are those in which the processes that can be improved through IT are related to the management and control of production and information flows in the logistics field, supply chain management and sales that allow managers and workers to make decisions more effectively in such processes. Chatterjee et al. [16] Chae et al. [13] considered retail as a paradigmatic sector of Informate industries where, since the early 2000s, there has been a trend towards the use of IT to induce decision-making and decision-taking at higher and lower organisational levels, respectively. Companies that use IT in a transform IT strategic role introduce radical business models that disrupt industry practices and market structures to position firms more favourably within industry and value chains. One example is the airline industry where, over the last two decades, IT has been used by airline companies and new entrants (online travel agencies) to create new customer relationships based on direct sales and bundled services (car rentals, hospitalities). Table 1 lists the industries as classified by Chatterjee et al. [16] according to the strategic role of IT during the 1995–1998 period (Column 1 in Table 1). Chatterjee et al. [16] documented that from 1987 to 1998, many industries evolved the way IT was applied from an 'Automate' to an 'Informate' logic. As a result of technological developments and events of the early 2000s, such as the Internet and the rise of new IT paradigms like cloud computing, Chae et al. [13] updated this classification to reflect the new developments of IT that shaped the business activities and business strategies of firms during the 2001–2004 and 2005–2007 periods (Column 2 in Table 1).

Yin et al. [21] have recently used the taxonomy updated by Chae et al. [13] to investigate how the business strategies of firms are aligned with the strategic role of IT in industry to improve the performance of such firms. However, our knowledge on how the effectiveness of different business strategies varies economic performance under the different strategic roles of IT industry remains limited [21]. One reason is that 'the industry categorisation scheme is retrospective, rather than

Table 1
Industry classification schemes.

IT role	Chatterjee et al., 2001 [16] *1995–1998*	Chae et al., 2018 [13] *2005–2007*	Industry classification scheme proposed in this study	
Automate	Computer Manufacturing; Metals (Aluminium, Steen) Manufacturer; Surety, Title, and Miscellaneous Insurance; Transportation – Ground and Railroad; Utilities – Electric	Coal Mining; Heavy Construction; Lumber & Wood Prods – except Furniture Manufacturing	As Chae et al., 2018 [13]	
Informate	Agricultural Machinery Manufacturing; Automotive Manufacturing; Automotive Parts and Services; Biotechnology Products/Services; Cleaning Products Manufacturing; Diversified Building Materials Manufacturing; Diversified Chemicals Manufacturer; Diversified Foods Manufacturing; Electronic Equipment, Electronic/Scientific Test and Measurement Instruments Manufacturer; Fluid Systems Manufacturing; Food Services; Health-Care Products Distribution; Heavy Construction; IT Consulting Services; Pharmaceuticals Manufacturer; Printing, Photocopying, and Graphics Design; Reinsurance; Retail – Apparel/Accessories and speciality Products; Retail – Department Stores and Discount/ Variety Stores; Retail – Grocery Stores; Semiconductor Equipment and Materials Manufacturer; Wire and Cable Manufacturer	Accounting, Bookkeeping, Collection & Credit Reporting; Agricultural Machinery Manufacturing; Amusement & Recreation Services; Apparel & Other Finished Products – Manufacturing; Auto Repair Services & Parking; Automotive Manufacturing; Automotive Parts & Service; Biotechnology Products/Services; Building Construction – General Contractors; Cleaning Products Manufacturing; Computer Manufacturing; Diversified Building Materials Manufacturing; Diversified Chemicals Manufacturer; Diversified Foods Manufacturing; Electrical Equipment, Electronic/Scientific Test & Measurement Instruments Manufacturer; Fabricated Metal Products Manufacturing; Fluid Systems Manufacturing; Food Services; Furniture & Fixtures Manufacturing; Health Care Products Distribution; Holding & Other Investment Offices; Long-Term Care Facilities; Measuring & Analysing Instruments Manufacturers; Metals (Aluminium, Steel) Manufacturer; Miscellaneous Retail; Motor Freight Transportation/Warehouse; Non-classified Establishments; Oil & Gas Extraction; Paper & Allied Products Manufacturing; Petroleum Refining & Related Industry Manufacturing; Pharmaceuticals Manufacturer; Reinsurance; Retail – Apparel/ Accessories & speciality Products; Retail – Department Stores & Discount/Variety Stores; Retail – Grocery Stores; Rubber & Miscellaneous Plastics Manufacturing; Semiconductor Equipment & Materials Manufacturer; Staffing, Outsourcing & Other Human Resources Services; Surety, Title and Miscellaneous Insurance; Transportation – Ground & Railroad; Transportation Services; Utilities – Electric; Wholesale Trade – Durable Goods; Wholesaler – Floral Products & Groceries; Wire & Cable Manufacturer	As Chae et al., 2018 [13]	
Transform	Accounting, Bookkeeping, Collection, and Credit Reporting; Advertising; Airlines; Banking; Computer Software Products and Services; Financial Services; Information Collection and Delivery Services; Internet and Online Service Providers; Long-Term Care Facilities; Media – Diversified; Publishing – News Services, Newspapers, and Periodicals; Staffing, Outsourcing, and Other Human Resources Services; Telecommunications Services; Telemarketing, Call Centres, and Other Direct Marketing; Wholesaler – Floral Products and Groceries	Advertising; Airlines; Banking; Computer Software Products & Services; Financial Services; Hotels Rooming Houses & Camps; Information Collection and Delivery Services; Internet and Online Service Providers; IT Consulting Services; Media – Diversified; Non-Depository Credit Institutions; Printing, Photocopying & Graphics Design; Publishing – News Services, Newspapers & Periodicals; Telecommunications Services; Telemarketing, Call Centres & Other Direct Marketing	**Physical-Transform**[1]	Advertising; Airlines; Banking; Financial Services; Hotels Rooming Houses & Camps; Non-Depository Credit Institutions; Printing, Photocopying & Graphics Design; Telemarketing, Call Centres & Other Direct Marketing
			Digital-Transform[2]	Publishing activities, including software (ISIC/NACE – 58); Motion picture, video, music, and sound recording activities (ISIC/ NACE – 59); Radio and TV broadcasting and programming activities (ISIC/NACE – 60); Telecommunication activities (ISIC/NACE – 61); Information technology activities (ISIC/ NACE – 62); Other information service activities including data processing, hosting and the related activities, web portals and news agency activities (ISIC/NACE – 63)

[1] To identify the Physical-Transform industry, we subtracted the sectors in section J ‘Information and Communication’ of ISIC Rev. 4 and NACE Rev. 2.), from the Transform industry – as identified by Chae et al. [13].

[2] To identify the Digital-Transform industry, we relied on Section J of the ‘Information and Communication’ industries (ISIC Rev. 4 and NACE Rev. 2), which includes all the products and services as a stream of bits.

progressive, based on historical archival data’ [13 p.534]. In fact, in the knowledge economy, the categorisation scheme of industry based on the strategic role of IT, which was updated by Chae et al. [13] to 2007, risks becoming obsolete once again as a result of the ongoing acceleration of technology development, which implies a progressive convergence between the physical and digital worlds that is increasingly blurred [32]. As recently argued by Pentland et al. [23], the strategic role of IT is changing with the emergence of new technologies – such as Artificial Intelligence, Additive Manufacturing, Big Data, Blockchain, and the 5 G protocol stack – that afford new possibilities for action but are qualitatively different from the emerging technologies of the past [23]. Rather, these emerging technologies are programmable and recombinable with layered and complex architectures composed of other technologies that are often connected through global digital infrastructures [32–34]. As a result of these characteristics, Pentland et al. [23] showed that such technologies are 'creating new spheres of practice', by offering not only new actions – 'doing new things' [14,16] – but also new ways of recombining these actions into 'novel ways of getting things done' [23]. For instance, an electronic health record (EHR) is a digital version of a patient's paper medical record. This technology has not transformed healthcare because it has introduced new actions to 'do new things' (e.g. automatic checking of drug interactions) without making them flexibly recombinable [23]. On the contrary, when Philips Lighting introduced the hue smart and connected light bulb, for example, it included a basic smartphone application that allowed users to control the colour and intensity of individual bulbs [35] – i.e. 'to do new things'. At the same time, Philips also released APIs, which led to independent software developers rapidly releasing dozens of applications that not only extended the features of the hue bulb but also generated completely new patterns of action and unprecedented ways of doing things through multi-party contributions – what Zittrain [24] called the generative potential of digital technologies. As another example, consider how social media made possible new types of actions [36], which could also be flexibly recombined with other actions (e.g. capturing and sharing a picture, making a purchase, reading an article, visiting a website, and many others). Moreover, in combination with other digital technologies (e.g. APIs, smartphones, or augmented reality viewers in the age of the Metaverse), social media users have generated a large number of new paths and new ways of doing things that have transformed several content and media sectors [37].

Therefore, as IT changes rapidly each year, the existing industrial categorisation schemes, based on the Automate, Informate and Transform logics, may no longer be adequate to fully capture the strategic role of IT at the industrial or firm level [13]. In this study, we propose and test a new taxonomy that distinguishes the transformative potential of IT to offer new actions to 'do new things' from the generative potential of IT to offer new ways of recombining these actions into 'novel ways of getting things done'. By the term 'generative potential of IT' we mean 'the overall capacity of a technology to produce unprompted change driven by large, varied, and uncoordinated audiences' [24 p.1980], a concept that is based on the adaptability and accessibility of the technology. As pointed out in recent studies [22,33], the generative potential of IT has a greater effect on industries in which the nature of the product or service essentially consists of information – where 'information' is intended as 'anything that can be digitised, that is, represented as a stream of bits' [25 p.3]. In fact, before the Internet and digitalisation, information-based sectors, such as the music and book sectors, were stable and characterised by slow growth and limited competitive pressure because only a few large players dominated these industries. The Internet and the digitalisation of products and services have radically changed the music and book industries and have led to the entry of new players (such as Amazon.com, Spotify and iTunes) that have disrupted the distribution channels, suppliers, buyers, and competition itself [38]. This has caused the competitive dynamics in these sectors to suddenly become more volatile, fast growing, complex and totally dependant on IT [39].

On the basis of these rationales, in this study, we have distinguished the Transform industry – where IT-induced structural changes occur most frequently [7,13] – into: Physical-Transform – where the main product or service is a type of tangible goods that follows the rules of the physical reality – and Digital-Transform – where the product or service is a digitally native artefact that enjoys the generative potential of IT and whose economic value depends on the information it contains. The industrial categorisation scheme that this study proposes is represented in Column 3 of Table 1 and the logic by which it was developed is reported in the methodology section.

2.2. Labour productivity growth, business strategies and strategic alignment perspective

Economic performance can be interpreted in a variety of ways at each level of analysis. Labour productivity growth, or the growth in output per worker, is a measure of the efficient use of labour inputs to create value [28]. It 'allows the economy to provide lower-cost goods and services relative to the income of domestic consumers, and to compete for customers in international markets' [40 p.1].

Labour productivity growth is a widely used economic performance indicator in both industry and firm-level studies [28]. A firm that is more productive than its competitors will generally enjoy higher profitability, which is a measure of the economic performance of firms that is widely used in strategic studies. A more productive firm will produce the same output with less inputs than its competitors, and thus experience a cost advantage, or will produce a higher quality output with the same inputs, thus achieving a price premium that cannot be easily imitated by competitors [41,42]. However, competition induces other firms to catch up on productivity, and sustaining higher profits through productivity gains requires a firm to adopt business strategies aimed at maintaining higher productivity levels than its competitors [28,43,44].

Cost leadership and differentiation have been seen as the two fundamental strategies that companies can adopt to gain a competitive advantage [43,45,46]. Cost leadership refers to the strategy by which firms create a low-cost advantage over their competitors to improve their market share and achieve operational efficiency [43,45]. Such an advantage is often pursued through a growth of the sales volume to exploit scale and learning economies or the capability to redesign the product and value chain in new ways, compared to normal 'industry recipes' [7]. Differentiation refers to the strategy by which firms differentiate their product/service features to meet the customers' needs, with the ultimate goal of increasing its economic benefit and the related willingness to pay for the product [43,46,47]. Researchers have started to shift their attention towards the effectiveness of 'dual' strategies as opposed to 'pure' strategies, arguing that a dual strategy that combines cost leadership and differentiation can lead to a better economic performance for firms, even though it requires more complex management practices [18,19]. In an attempt to resolve this debate, Li et al. [20] suggested that the effectiveness of a cost, differentiation or dual strategy depends on the industry in which they are implemented, and they acknowledged the different roles that IT can assume in defining and executing such a business strategy [48]. Therefore, the strategic role that IT plays in an industry brings about changes that differ from industry to industry and can influence the business strategies through which companies intend to capture economic value and build forms of competitive advantage [6].

Although the strategic role of IT in industry has been applied to assess structural differences in performance at the industry and firm levels [5,13,16,21], there is a paucity of studies that have investigated how a firm chooses its business strategy, based on the strategic role IT offers at the industry level to firms, to improve its economic performance [21]. Moreover, given the close correlation between business strategies and labour productivity – where a firm can increase its labour productivity by producing the same output with fewer inputs, and thus experience a cost advantage, or by producing a higher quality output with the same inputs and differentiating itself, and thus achieve a price premium – there is a dearth of research that looks at whether and how the business strategy is aligned with the strategic role of IT in the industry, and at how this alignment affects the labour productivity performance of a firm.

Henderson and Venkatraman [17], and Wade and Hulland [11] highlighted the importance of strategic alignment between industry and business strategy. As IT has become a key resource for business strategies, an alignment between IT and business strategies is achieved when firms apply an IT strategy appropriately to the industry in which they operate to achieve an optimal economic performance [21,48–51]. Yin et al. [21] have recently shown that the use of a cost leadership strategy produces superior economic returns in industries in which the role offered by IT at the industry level is 'Automate', while a dual strategy produces superior returns in industries where the role of IT is 'Informate', and the differentiation strategy in industries where the role of IT is 'Transform'. Such studies consider profitability as the dependant variable, consistently with the fact that profitability is the main metric used to measure the achievement of competitive advantages. However, it remains to be understood whether and how a business strategy is aligned with a strategic role of IT that is changing profoundly as a result of the emergence of new digital technologies [22,23] and how this alignment affects the growth of labour productivity. Labour productivity offers the opportunity of conducting a more granular analysis of the value creation mechanisms associated with IT use, since it allows the effects of growth on the economic value of the created output (which can be associated with higher unit gross profit margins or higher volumes) to be separated from those related to the use of less labour in primary or support processes.

2.3. Hypothesis development

2.3.1. Business strategies and labour productivity growth in industries where the strategic role of IT is automate

Industries dominated by the 'Automate' strategic role of IT require large capital investments in technical equipment, and include those involved in the extraction of oil, natural gas, and minerals, the construction of large infrastructures, such as roads, highways, and airport runways.

The main role of IT in such industries has traditionally been to replace human labour by automating production processes (introducing software in plants and machinery to codify the way they should be run) and improving the efficiency of existing operations [5]. Today, the role of IT in the Automate industry is to make automation even more seamless (e.g. through the use of sensors and AI) without needing to invest in data integration and interoperability. Although IT can be a substitute for human labour and ordinary capital, thanks to the addition of sensors and programmable logic controllers to plants and machinery, the benefits of using IT in the Automate industry may currently be limited [1]. In fact, capital in the Automate industry often consists of continuous-process production systems [52] governed by a relatively small number of machine operators; therefore, the substitution effects of IT are limited [53]. Several empirical research results [42,54,55] and market outlooks [56–58] have shown that firms in the Automate industry tend to systematically invest fewer resources in IT to plan their IT investments and to allocate decision-making power to such initiatives. This tendency is due to the fact that IT has never been a critical mission for operations [59]. Because of the limited strategic role of IT, the firms in such industries do not usually see any value in formalising governance frameworks for IT investments [13], and this has been documented to produce IT asset redundancies, limited interoperable systems, and lower economies of scale in IT procurement, thus making the IT conversion process into business value more difficult [60]. Furthermore, fewer IT capabilities and a lower persistence in the accumulation of IT assets can lead firms in the Automate industry to focus their investments on simpler domains, orientated towards improving efficiency and labour use, rather than pursuing more complex innovating product or service initiatives through IT [61,62].

Therefore, drawing upon a strategic alignment perspective, IT is not considered a critical success factor in the Automate industry for strategy, or a source of competitive advantage [43]. Moreover, companies in the Automate industry that sell homogeneous products (e.g. coal or crude oil) do not need the potential of IT to differentiate their products by offering, for example, better customer services [63], and they are therefore not incentivised to use IT to innovate their processes [55]. The prevailing role of IT in the Automate industry is to support common standards, foster integration between information systems and factory technical capital (e.g. see the role of Supervisory Control And Data Acquisition (SCADA) systems), reduce costs and promote operational efficiency [5]. This type of IT is standardised and easily accessible, requires minimal investments in IT infrastructures and has low maintenance costs. The prevalent use of IT in the Automate industry can help companies exploit the benefits of cost leadership through simplified operational processes and efficiencies to achieve economies of scale that result in lower production costs and higher capacity utilisation [64,65]. A lower unit cost can be converted into lower prices, which in turn can attract more customers, especially in industries with a high customer' price sensitivity.

In sum, firms in the Automate industry tend to be conservative, underinvest in IT to benefit from the large investments in ordinary capital required by the nature of the products and the industry [42,53], and have limited room to apply IT to innovate their processes or to differentiate their products [55]. Therefore, drawing upon a strategic alignment perspective, cost leadership for firms operating in the Automate industry might be better aligned with IT's strategic role of replacing capital-labour 'doing the same things with less (input)' [7] to achieve labour productivity growth targets based on input reduction. Thus, we hypothesise:

H1. *In industries where automation logics prevail in the strategic use of IT ('Automate' industry), the cost leadership strategy has a greater impact on labour productivity growth, which is driven by input reduction (*i.e. *employment reduction).*

2.3.2. Business strategies and labour productivity growth in industries where the strategic role of IT is informate

In the Informate industry, the strategic role of IT is to improve business processes and decision-making activities by facilitating information flows that involve both internal and external functions [7,11,13,16], and many manufacturing and retail companies belong to this category. The informative power of IT can be seen in the production environment when such technologies as programmable logic controllers and sensors are used to add a stream of digitised data to the physical production process [cf. 14]. These data, which result in a quantity and quality of information that did not exist before, are then made available within the organisation. For example, sensors and controllers are increasingly used in manufacturing companies 'not only to tell the machine what to do' (imposing information and operational procedures), but also to tell what the machine has done (translating the production process and making it visible). Similarly, the combination of online transaction systems (e-commerce), information systems for inventory control, and replenishment and communication technologies in retail firms creates a vast presence of information that was previously dispersed throughout the supply chain. In this case, IT allows information to be processed more quickly – and with fewer interventions – thus making it available, in real time, to the whole organisation.

The strategic role of IT in the Informate industry is therefore twofold. On the one hand, IT helps to distribute information between internal functions more easily and more efficiently, thereby promoting organisational cost control and internal co-ordination [5]. Specifically, firms can benefit from efficiency gains and the capability to use production assets efficiently (with less idle capacity), in order to handle more product variety on the production lines and the supply chain, and to deliver higher product quality, thus improving inventory turnover [13]. This relatively stable environment favours manufacturing firms in which process redesign and integration have enabled a greater sharing of new information, thus ensuring a faster response to changes in the environment and increasing the flexibility of the organisation [66]. One example of such firms is that of companies in the automotive industry that commonly use such planning systems as MRP and ERP for material requirement planning, scheduling, quality control reports, capacity planning and workload planning. The use of these systems has reduced the overall cost of operations, and has also improved inventory turns and operational efficiency [67]. Consistently with this trajectory of IT use, some large firms are now investing in Manufacturing Execution Systems that integrate data generated by more connected and sensorised machinery with production data managed by MRP and/or ERP systems.

On the other hand, IT allows firms to obtain timely responses from the market and quickly remedy them [11] but more importantly, to seize the changing needs of customers by fostering customisation and new product development [68]. For example, in the early 2000s, apparel companies such as Benetton used IT to support their shift to a 'mass customisation' strategy (more variety produced by pursuing product standardisation and cost advantages) or 'fast fashion'. These strategies were based on the use of IT to forecast and manage demand in a more granular and timely manner, to define and implement market segmentation more effectively, and to integrate information systems in a multi-channel perspective that improves the service level for the customer. In addition, IT has supported the orchestration of material flows in overseas nations, where production was relocated to take advantage of the lower cost of inputs, and particularly of labour [69]. In this sense, IT has enabled such firms to pursue two types of competitive advantage. First, IT enabled them to achieve efficiency gains and significant improvements in the management of their operating costs by increasing their responsiveness to market demands [cf. 17] and reducing the number of employees needed in such low-skilled positions as production [70–72]. Second, the efficient management of distribution channels enabled by IT has allowed them to collect and analyse information about and feedback from customers in a timely manner, segment different customer groups, and provide customers with increasingly customised products and services. From an organisational perspective, especially in the recent Industry 4.0 wave of IT use, this use of IT to generate and manage more information is expected to be associated with delayering trends and less use of middle line and support structures, thus resulting in employment reduction.

As such, from a strategic alignment perspective, IT can improve the internal production process in the Informate industry by reducing costs, but also help companies to differentiate their products from competitors [73,74]. However, the commoditisation of IT and the integration of business systems, such as ERP, SCM and CRM, made the benefits from the efficiencies in internal information flows achieved between the 1990s and 2000s increasingly labile and short-term, thereby levelling off the levels of competition between firms in the Informate industry [13]. Moreover, the lower codifiability of operational processes [93] that are based more on operator judgement and tacit knowledge than on data-driven approaches [92,97] may have less effect on output growth in the Informate industry than the growth that would be expected in the Transform industry. In this regard, Brynjolfsson and Hitt [75] showed that data-driven decision making in managing operations leads firms to achieve superior productivity and superior asset utilisation. Hence, the fact that decision-making in the Informate industry may be less codified in production and engineering processes can explain why it is difficult for IT investments to lead to a growth in output due to a better use of the available productivity capacity or higher sales from pure differentiation.

Therefore, drawing upon the strategic alignment perspective for firms operating in the Informate industry, the dual strategy could be better aligned with the strategic role of ITs of providing information about business activities to achieve labour productivity growth objectives based on output growth and input reduction. Thus, we hypothesise:

H2. *In industries where informate logics prevail in the strategic use of IT ('Informate' industry), a dual strategy has a greater impact on the growth of labour productivity, which is driven as much by input reduction (*i.e. *employment reduction) as by output growth (*i.e. *value added growth).*

2.3.3. Business strategies and labour productivity growth in industries where the strategic role of IT is physical-transform

In the 'Physical-Transform' industry, where sectors such as airlines, hotels, printing, and graphic design operate, the implementation of IT is more imperative and proactive than in the Informate industry [17]. The extant studies and market outlooks depict a situation of higher IT investments in the Physical-Transform industry than in the Informate industry [57,58], which is a result of the strategic role of IT in transforming externally orientated activities [9] – including the development of new business logics such as e-commerce and servitisation (i.e. selling an integrated combination of products and services) – and of the greater opportunities available to these firms to achieve competitive differentiation [59]. The role of IT in the Physical-Transform industry is in particular to introduce flexibility and agility into data management, thereby enabling innovation in products, services, and business models, which, in turn, leads to the abandonment of obsolete business processes. For example, starting from the industry deregulation in the 1970s, IT has played a key role for airlines with the introduction of reservation management systems that have allowed them to increase revenues through the use of dynamic pricing; this has evolved to the point whereby airlines have changed their business model through direct online sales channels and systems that can provide personalised services to travellers, thus helping airlines to differentiate their value proposition through total customer responsiveness.

In the Physical-Transform industry, the speed of a company's response to changing market conditions is vital, and companies need information processing capabilities to meet the demands and pressures of rapidly changing competitive environments. Having these 'sense and respond' capabilities allows firms in the Physical-Transform industry to improve their strategic agility [76] by shortening the development time of new products and innovations rather than the efficiency in the operations related to the existing ones [12,77]. In this respect, Yin et al. [21] argued that an increasing share of IT expenditure in these industries is devoted to product development rather than to making existing production more efficient.

In light of these arguments, the aims of a dual strategy or cost leadership strategy are not aligned with the strategic intent of the Physical-Transform industry. The differentiation strategy in fact focuses more on product innovation and improved customer service and therefore requires an advanced IT component – and IT capabilities – dedicated to researching and developing solutions that differentiate themselves and cannot be imitated by competitors [11,20]. Therefore, drawing upon the strategic alignment perspective, the differentiation strategy could be better aligned for companies operating in the Physical-Transform industry with the strategic role of IT in transforming externally orientated activities to achieve labour productivity growth targets based on output growth. Thus, we hypothesise:

H3. *In industries where transformation logics prevail in the strategic use of IT and the economic value of the product/service is associated with its physical nature ('Physical-Transform' industry), the differentiation strategy has a greater impact on labour productivity growth, which is driven by output growth (*i.e. *value added growth).*

2.3.4. Business strategies and labour productivity growth in industries where the strategic role of IT is digital-transform

The sectors belonging to the Digital-Transform industry – such as software, content creation, publishing, information-related and IT services, as well as media activities – unlike the sectors belonging to the Physical-Transform industry, develop products or services whose economic value depends primarily on the information they contain. 'Information is by nature a heterogeneous commodity' [78]: computer processing differs from data communication, and television is completely different from books. However, the generative potential enjoyed by these native digital artefacts and the purely digital media on which they travel (i.e. the Internet, digital platforms, social media) have provided the Digital-Transform industry with new ways of combining and distributing these services at a global level through an industrialised approach [79], thereby increasing the operational and strategic flexibility of the firms in this industry [32], as well as the cost efficiency that results from combining product customisation with a broader reach of customers [80].

The first reason why the Digital-Transform industry can obtain higher returns, in terms of labour productivity growth, is that when the carrier of information is no longer physical, and is instead digital, scalability and economies of scales as well as networking become possible [81]. Evans and Wuster [81], for example, showed that when the carrier of information is no longer material-based, and is instead Internet-based, the trade-off between richness (in the way information can be managed and transmitted) and reach is mitigated, and such a mitigation enables a mass customisation. Thus, achieving output growth and a global operational scale becomes possible, without the degree of inertia and bureaucracy that is historically associated with larger firms (Brynjolfsson and McAfee [82] labelled these dynamics 'scale without mass').

Second, the higher strategic dependence that firms in the Digital-Transform industry have on IT [57,58] leads such firms to broaden their repertoire of competitive actions and digital options by seizing the right opportunities offered by emerging digital technologies [82]. The creation process of new businesses through IT and digital technologies can occur by aligning the needs of new clients and the interests of a wide range of stakeholders with the creation of new ecosystems [83–85]. The implementation of such ecosystems involves a high level of social complexity [86], due to the necessity of integrating internal information systems with those of the supply chain partners. The way Amazon, Meta, Apple, and Google reapplied their core competencies by entering a multitude of markets as platform orchestrators [87] is evidence of how coordination costs are becoming extremely low, which not only allows an ease of searching and product comparison, but also enhances the ability to recombine digital products to create new value [33]. A related argument is that of product flexibility, due to an easier codifiability [88, 89] and a faster clock speed of innovation in the Digital-Transform industry than in the Physical-Transform industry [32,90]. In general, speed in the life cycle of a product/service is an important property that reflects the inherent dynamics of the Digital-Transform industry. The 'clock speed' of software development is generally much faster than that of traditional manufacturing firms that produce physical products (as in the case of the Physical-Transform industry), thus new avenues for digital options are created [82]. In this regard, recent studies [32,90–92] have underlined that when manufacturing firms add digitally enabled features or services to their legacy product, they are obliged to follow a more rigid clock speed of innovation, even when the digital technologies provide new avenues to add new features or to digitise some others.

Finally, as conceptualised by Shapiro and Varian [25] and Evans and Wurster [80], the production function in the Digital-Transform industry follows different economics from those of the Physical-Transform industry. On the one hand, the fixed costs of producing information goods/services are much higher, due to the human costs of developing intellectual capital [82]. On the other hand, the zero marginal cost associated with information and the fact that information exhibits the feature of non-rival goods imply that companies operating in the Digital-Transform industry can expand their output base with little effort [83] by pursuing cost leadership. In the same way, Evans and Wurster [81] argued that the use of the Internet as a distribution channel mitigates the trade-off between the richness of the information being exchanged and its reach (i.e. the number of possible recipients), and this enables more tailored digital goods/services to be delivered to the consumer in a more interactive way. This dramatically increases the economic value of the digital goods/services being exchanged and leads one to expect that the overall impact of IT investments in the Digital-Transform industry may be to 'generate new digital options' aimed at output growth [cf. 82], the search for more munificent and high-growth market segments, and increasing the customers' willingness to pay, through differentiation, personalisation, and bundled products with additional services. Therefore, drawing upon the strategic alignment perspective, the dual strategy of firms operating in the Digital-Transform industry could be better aligned with the generative potential of IT to offer new ways of recombining new digital options into 'novel ways of getting things done' [cf. 23]. On the basis of the above arguments, we expect that labour productivity growth in the Digital-Transform industry will be due to value added growth driven by competitive differentiation and a concomitant reduction in operating expenses aimed at achieving a global operating scale, following the logic of 'scale without mass' [81]. Thus, we assume:

H4. *In industries where transformation logics prevail in the strategic use of IT and the economic value of the product/service is associated with its digital nature and depends on the information it contains ('Digital-Transform' industry), the dual strategy has a greater impact on labour productivity growth, which is driven as much by output growth (*i.e. *value added growth) as by input reduction (*i.e. *employment reduction).*

3. Methodology

3.1. Empirical setting

The data from this analysis refers to 382 four-digit industries in Italy. Italy may be considered a representative setting of the average situation of the most industrialised European countries. Italy is the ninth largest economy in the world. Its economic structure is diversified and is mainly based on services and manufacturing. The service sector accounts for almost three quarters of the total GDP and employs about 65% of the country's total workforce. The manufacturing sector is the most important sub-sector within the industrial sector. It accounts for a quarter of Italy's total output and employs about 30% of the total workforce. Although Italy has a low percentage of IT investments – 11.3% of the total non-residential gross fixed capital formation as opposed to 32.14% in the USA and 25% in certain European countries, such as the UK and Sweden, which show a high tendency towards IT investments [93] – it shows a comparable IT adoption rate for several types of information systems, such as ERP, SCM and CRM, with the UK, Sweden, Germany and France [94]. In this context, the Italian policy maker launched a plan to promote and support investments in the digitalisation of industrial processes called the 'National Industrial 4.0 plan' for the years 2017–2020 through fiscal aid. Such a plan reduced companies' spending on investments in technologies such as IoT, AI, Big Data solutions, Additive Manufacturing, Virtual and Augmented Reality [95].

3.2. Data collection

Our sample population consisted of Italian companies listed on the Aida-Bureau van Dijk database, which contains up to ten years of accounting and corporate finance data on public and private firms operating in Italy, as well as multinational corporations that file separately for their Italian operations. Unlike other data providers, the Aida-Bureau van Dijk database discloses the original source(s) of its data, which allows users to create their own analyses on the basis of their assessment of the reliability of the underlying data sources.

To test our research model, we collected data from Italian companies over the 2011–2020 period as described hereafter. First, we collected data from all the enterprises included in the database for a total of over two million enterprises. Second, we reduced the number of enterprises to only those active in the period of analysis, thus reducing our sample to approximately one and a half million enterprises. As a third step, we eliminated any enterprises with missing observations because not all the firms reported the financial information that we needed, thus further reducing our sample to about 370 thousand enterprises. Subsequently, we reduced our unit of analysis to only large enterprises by imposing an employment requirement of at least 250 people (in accordance with the European Union's definition of a large enterprise) for the entire analysis period. Given the large presence of small and medium-sized enterprises in Italy that need to pay more attention to their resource allocation processes [21], we imposed this constraint in order to reduce the risk of reverse causality in how a firm could pursue and advance its business strategy over time. Furthermore, coherently with the extant studies that link IT investments, or the IT strategic role, with the economic performance of a firm [e.g. 1,21,64,86,96,97], we also measured the impact of the business strategy on the firm's economic performance using a one-year lag. This led us to exclude the missing observations resulting from the one-year lags of the independent and control variables. Finally, we traced the firms according to the classification on the strategic role of IT developed by Chatterjee et al. [16] and subsequently updated by Chae et al. [13], thus excluding the observations that did not belong to this classification. Finally, we obtained a total of 1769 firms operating in 382 four-digit industries for which complete data on the key variables of interest were available from 2011 to 2020.

3.3. Variables

3.3.1. Dependant variables

Differentiation strategy. Differentiation strategy refers to companies that provide a product or service with certain characteristics that distinguish them from those of their competitors and to which the customer recognises a value, in virtue of which it is willing to pay a premium price [43]. Thus, we used the profit margin ratio of firms to measure the differentiation strategy [21,65]. The values were deflated to the 2011-year values.

Cost leadership strategy. Cost leadership allows companies to lower the selling price of their offerings to a level that, while remaining above their average cost, is lower than that of competitors in the same strategic grouping [45]. Consequently, firms must use their assets efficiently to achieve cost leadership and keep their operations lean in order to make their competitive advantage sustainable over time [45]. Thus, we used the asset turnover ratio of firms to capture this strategy [21,66]. The values were deflated to the 2011-year values.

Dual strategy. Dual strategy refers to companies that 'pay attention to those factors that are critical for short-term success' while 'changing a business in anticipation of the future' by integrating some elements of cost reduction with some elements of differentiation [98]. According to this definition, we used the product of the asset turnover ratio and the profit margin ratio as the operationalisation of the dual strategy [21]. The values were deflated to the 2011-year values.

Labour productivity. Labour productivity is defined as the ratio of value added to the number of employees, and it reflects the productivity of the labour production factor [99]. Value added takes into account the sales revenues minus the external costs for raw material and service costs. The values were deflated to the 2011-year values. Compared with labour productivity based on gross output, labour productivity based on value added is 'less dependant on any change in the ratio between intermediate inputs and labour, or on the degree of vertical integration' [100 p.27]. Moreover, value added-based labour productivity measures tend to be less sensitive to processes of substitution between materials plus services and labour than gross-output based measures. The OECD [100] recommends using value added-based labour productivity measures to analyse micro-macro links, such as the contribution of an industry to economy-wide labour productivity and economic growth.

Labour productivity growth. This variable takes into account the logarithmic annual growth rate of the labour productivity of an industry. Deflated value added values were used.

Output growth. This variable was operationalised as the logarithmic annual growth rate of value added between 2011 and 2020. Deflated values were used.

Employment reduction. This variable was operationalised as the logarithmic growth rate of the number of workers employed at the industry level between 2011 and 2020.

3.3.2. Independent variables

IT strategic role. Since the purpose of this article has been to find how a company's business strategy is aligned with its IT strategic role to improve labour productivity growth, we divided the total sample into four subsamples (please refer to Table 1): Automate, Informate, Physical-Transform, and Digital-Transform. We followed the classification of Chatterjee et al. [16] covering the 1987–1998 period and subsequently updated by Chae et al. [13] to the 2001–2007 period to obtain the subsamples for the Automate and Informate industries. A dummy variable was created, from the operational standpoint, to identify such industries.

In order to overcome the emerging limitations of the 'Automate-Informate-Transform' taxonomy recently pointed out by Chae et al. [13], Bailey et al. [22], Yin et al. [21], and Pentland et al. [23], in this study we divided the Transform industry – where IT-induced structural changes occur most frequently [7,13] – into Physical-Transform and Digital-Transform. To do this, we subtracted the sectors where the product or service is a digital native artefact, whose economic value depends on the information it contains, from the Transform industry – as identified by Chatterjee et al., [16] and Chae et al., [13]. We relied on Section J of the 'Information and Communication' industries (ISIC Rev. 4 and NACE Rev. 2), which includes all the products and services as a stream of bits, to identify such sectors [57]. This section includes the production and distribution of information and cultural products, the provision of the means to transmit or distribute these products, as well as data or communications, information technology activities, and the processing of data and other information service activities. This section was introduced into the fourth version of ISIC published by the United Nations in 2008 (and, consistently, into the second version of the statistical classification of economic activities in the European Community, which is abbreviated to NACE) to better reflect the current economic phenomena and to be more in line with the modern trends dictated by the information economy (ISIC, Rev. 4; p. iii). The main components of this section are publishing activities, including software publishing (ISIC Code and NACE Division – 58), motion picture and sound recording activities (ISIC Code and NACE Division – 59), radio and TV broadcasting and programming activities (ISIC Code and NACE Division – 60), telecommunication activities (ISIC Code and NACE Division – 61), information technology activities (ISIC Code and NACE Division – 62) and other information service activities such as data processing, hosting and the related activities, web portals and news agency activities (ISIC Code and NACE Division – 63). Considering 2020 as the reference year, the Digital-Transform industry accounts for 12.12% of the total of the values added to the entire sample. According to OECD [58], although these industries account for a relatively small share of the OECD business sector's GDP, they may contribute significantly to their growth and productivity performance, if the latter grows more rapidly than the rest of the economy.

A dummy variable was created, from the operational standpoint, to discriminate between sectors from Section J of 'Information and Communication' – whose core product or service is a digitally native artefact whose value depends on the information it contains – and the other sectors of the Transform industry, as identified by Chatterjee et al. [16] and Chae et al. [13]. We used the dichotomy of Digital-Transform vs. Physical-Transform industry to distinguish between these two types of industries. Table 1 shows the categorisation scheme of the industries in our sample, which is based on the four strategic role categories of IT: Automate, Informate, Physical-Transform, and Digital-Transform.

3.3.3. Control variables

In order to avoid omission biases and unobserved heterogeneity when estimating the effects of business strategies on labour productivity growth, we checked for other variables that could affect the analysed dependant variables. First, the year variables were used to take into account the economic cycle.

Second, we considered the availability of qualified human capital, measured as the personnel cost per capita. An extensive amount of empirical literature on the IT business value argues that IT needs human capital investments to develop its full potential [101]. Industries with a larger availability of qualified human capital are usually more productive and require a limited amount of low qualified labour [102]. Personnel costs include the costs borne by firms for wages and training activities. Industries with higher personnel costs typically employ workers with higher educational attainment, a condition that goes hand in hand with higher budgets for employer-provided training [16,103].

Finally, we controlled for a firm's capital expenditure – measured as the natural logarithm of the capital expenditure on tangible fixed assets [21] – and the ratio of tangible fixed assets per employee. The reason for this dual control is that labour productivity generally increases as the amount of fixed investment per employee increases [104]. Capital intensive firms usually show a high degree of automation in their production processes, and they employ a restricted tier of qualified human capital in the programming, control, and inspection/maintenance of the production assets. The measure of a firm's capital expenditure that we employed was adjusted to account for inflation. Instead, the deflated measure of tangible fixed assets was divided by the number of employees for the amount of tangible fixed assets per employee.

3.4. Econometric approach

Coherently with the extant studies that link IT investments, or the IT strategic role, with the economic performance of a firm [e.g. 1,21,65,87,96,97], the econometric approach used here to test the hypotheses considered a one-year lag of dependant variables on labour productivity growth and its growth components, i.e. output growth and input reduction. This approach allows the impact of the business strategy on the economic performance of a company to be taken into account. Furthermore, the approach allows reverse causality and potential endogeneity to be considered and mitigated [21,97,105]. In this vein, the large number of observations in our panel data set allowed us to use time lags, without experiencing a substantial reduction in the statistical power of our regression models, thus overcoming an important limitation of previous studies [cf. 106]. Lastly, we considered Huber-White robust standard errors for any potential heteroskedasticity and autocorrelation in all our models.

The econometric estimates were drawn up according to the following three analysis steps.

(1) **Comparative analysis among subsamples**. First, we conducted a comparative analysis among subsamples (i.e. Automate, Informate, Physical-Transform, and Digital-Transform) to find the best alignment between business strategy and the strategic role of IT in industry (Table 4). The econometric approach was based on panel regression models with a fixed effects estimator. In general, fixed effects allow any omitted variable bias, due to time-invariant unobservable factors, to be eliminated [107]. In our specific case, this bias may have been related to the competitive forces and the institutional conditions at play in each sector. We tested the appropriateness of the specifications with fixed and random effects. The Hausman test was used to check the orthogonality of the industry-specific error with the explanatory variables [108]. According to the results, the null hypothesis was not accepted for any the model specifications. Hence, we used the fixed effects method in our analysis. The Hausman test results are not reported for brevity reasons but are available from the authors upon request.

Next, as a fixed-effects estimation model can include not only an individual fixed effect, but also a time fixed effect, we used the annual dummy variables as control variables in our model. We then estimated the following model:

$$
\begin{aligned}
&(\textit{Labour Productivity growth})_{i,\ t+1} \\
&= \alpha_{i,t} + \beta_1 \textit{fixed assets per employee}_{i,t} + \beta_2 \textit{personnel cost per capita}_{i,t} \\
&+ \beta_3 \textit{firm capital expenditure}_{i,t} + \beta_4 \textit{labour producitivty growth}_{i,t} \\
&+ \beta_5 \textit{differentiation strategy}_{i,t} + \beta_6 \textit{cost leadership strategy}_{i,t} + \beta_7 \textit{dual strategy}_{i,t} \\
&+ \textit{Year Effects}_{i,t} + \varepsilon_{i,t}
\end{aligned}
$$

The same model was estimated not only for labour productivity growth, but also for its growth components – i.e. output growth and input reduction – using value added growth and employment growth as the dependant variable, respectively. In order to test which business strategy has the greatest positive impact on labour productivity growth (and its components) for the different IT strategic roles in the industry, we compared the significant coefficients between the specific business strategy and the economic performance of the company [21].

(1) **The moderating role of the type of industry**. The second step was to estimate the second-order effect due to business strategies and the strategic role of IT. To do so, we considered the strategic role of the IT sector as a dummy variable to perform a hierarchical regression analysis, which examined the moderating effect of the strategic role of IT in industry (Table 5).
(2) **Extensions**. Although we considered individual and time fixed effects, one-year lags of the dependant variables on labour productivity growth and its growth components, Huber-White robust standard errors for potential heteroskedasticity and autocorrelation in all our models, another potential deviation from the modelling assumptions includes endogenous explanatory variables. Thus, we used a step-by-step procedure to further control for unobserved heterogeneity, simultaneity, and dynamic endogeneity. First, we conducted the Durbin-Wu-Hausman test to detect the endogeneity of individual regressors [cf. 21,109]. Theoretically, the explanatory variable should be uncorrelated with the error term, and this test determines whether the residuals (error terms) are correlated with the explanatory variables. In order to test whether an independent variable was endogenous or exogenous, we estimated a regression on each independent variable with all the other independent variables and the control variables to predict their residuals. We then estimated the coefficients of the residuals to test whether the residuals (error terms, $\varepsilon_{i,t}$) were significant. The non-significant Durbin-Wu-Hausman test statistic obtained for all our explanatory variables indicates that the variables are exogenous, that is, not correlated with the residuals (error terms).

We also used a dynamic panel data estimation as a robustness check to overcome any possible endogeneity issues arising from reverse causality due to prior firm performance. As we adopted a dynamic panel model, we applied a generalised method of moments (GMM) to obtain our results [21,109]. In short, the GMM allowed us to control for the three main sources of endogeneity (unobserved heterogeneity, simultaneity, and dynamic endogeneity) by including previous economic performance values (i.e. lagged values of labour productivity growth and the related growth components) as an explanatory variable in the model (Table 6). In order to confirm the validity of the GMM model used in our estimation process, we used two post-estimation tests: (i) the Sargan test; and (ii) the Arellano-Bond test for first-order and second-order correlations, respectively. The values of these two post-estimations (reported in Table 6) confirmed the validity of the instrument, by showing that the instruments included in the econometric specification are exogenous (Sargan test), and that the lagged variables are not correlated with the error term (Arellano-Bond test).

Overall, both the Durbin-Wu-Hausman test and the dynamic panel data estimation model (Table 6) allowed us to corroborate the results of the fixed effects models (Tables 4 and 5) with more sophisticated econometric techniques to control for potential sources of endogeneity bias, thus demonstrating the robustness of our conclusions.

4. Findings

4.1. Descriptive statistics

Table 2 reports the key descriptive statistics and correlation matrix for the variables applied in this study, with Bonferroni-adjusted significance levels below 0.01. Multicollinearity does not represent a problem for any of the variables as the Variance Inflation Factor (VIF) is largely below the suggested threshold of ten [110].

Table 3 shows the distribution of the strategic role of IT in industry in our sample of 1769 firms (and 17,690 observations) operating in 382 four-digit industries from 2011 to 2020.

4.2. Hypotheses validation

(1) **Comparative analysis among subsamples**

Models 1_a – 12_a in Table 4 report the comparative analysis among subsamples (i.e. Automate, Informate, Physical-Transform, and Digital-Transform) used to assess the best alignment between business strategy and the strategic role of IT in industry on labour productivity growth (Models 1_a, 4_a, 7_a, 10_a) and its value components – output growth (Models 2_a, 5_a, 8_a, 11_a) and input reduction (Models 3_a, 6_a, 9_a, 12_a) – in Automate, Informate, Physical-Transform and Digital-Transform industries, respectively.

We posited that the cost leadership strategy in the Automate industry has a greater impact on labour productivity growth, and that this is driven by input reduction (i.e. employment reduction). The results in Model 1_a in Table 4 show that only the cost leadership strategy has a significant positive impact on labour productivity growth ($\beta_{Cost\ leadership} = 0.1121\ p < 0.05$) in the Automate industry, while the differentiation and dual strategy coefficients are not statistically significant ($\beta_{Differentiation} = 0.7500\ p > 0.10$ and $\beta_{Dual\ strategy} = -0.1669\ p > 0.10$). This result suggests that the cost leadership strategy is better aligned with the Automate IT strategic role for labour productivity growth. The results of Model 3_a also confirm that the productivity growth resulting from the cost leadership strategy is driven by a reduction in employment ($\beta_{Cost\ leadership} = -0.1479\ p < 0.10$), thus confirming Hypothesis H1. In addition, the results of Model 2_a suggest that the observed labour productivity growth resulting from the cost leadership strategy in the Automate industry is not only driven by input reduction (as indicated by the results of Model 3_a), but also by output growth; in particular, by value added growth ($\beta_{Cost\ leadership} = 0.1953\ p < 0.01$). Taken together, these results support – and extend – Hypothesis H1.

Moreover, we posited that the dual strategy has a greater impact on labour productivity growth in the Informate industry, and that this is driven as much by an input reduction (i.e. employment reduction) as by output growth (i.e. value added growth). The Model 4_a results in Table 4 show that the differentiation strategy ($\beta_{Differentiation} = 0.7746\ p < 0.01$) and dual strategy ($\beta_{Dual\ strategy} = 0.4135\ p < 0.05$) have significant positive impacts on labour productivity growth in the Informate industry, while the cost leadership coefficient is not statistically significant ($\beta_{Cost\ leadership} = 0.0021\ p > 0.10$). Furthermore, the marginal analysis indicates that the alignment between the differentiation strategy and the Informate IT strategic role has a greater impact on labour productivity growth than the dual strategy.

The results of Model 5_a show that the differentiation strategy ($\beta_{Differentiation} = 0.8238\ p < 0.01$) and dual strategy ($\beta_{Dual\ strategy} = 0.3987\ p < 0.05$) have significant positive impacts on value added growth in the Informate industry, while the cost leadership coefficient is not statistically significant ($\beta_{Cost\ leadership} = 0.0091\ p > 0.10$). Here again, the marginal analysis indicates that the alignment between the differentiation strategy and the Informate IT strategic role has a greater impact on value added growth than the dual strategy.

The results of Model 6_a suggest that labour productivity growth in the Informate industry is not driven by input reduction – the coefficients are not significant for any of the business strategies ($p > 0.10$) – but is instead driven only by output growth (as indicated by the results of Model 5_a). Taken together, the results indicate that it is the differentiation strategy – and not the dual strategy as we had assumed – that has the greatest impact on labour productivity growth, and that this is only driven by output growth. Therefore, taken together, the results do not support Hypothesis H2.

We posited that the differentiation strategy has a greater impact on labour productivity growth in the Informate industry, and that this is driven by output growth (i.e. value added growth). The Model 7_a results in Table 4 show that only the differentiation strategy has a significant positive impact on labour productivity growth ($\beta_{Differentiation} = 0.9718\ p < 0.01$) in the Physical-Transform industry, while the cost leadership and dual strategy coefficients are not statistically significant ($\beta_{Cost\ leadership} = 0.0356\ p > 0.10$ and $\beta_{Dual\ strategy} = 0.1800\ p > 0.10$).

Table 3
Industry types ($N = 17{,}690$).

	Frequency	Percentage (%)	Cum percentage (%)
Automate industry	770	4.35	4.35
Informate industry	14,960	84.57	88.92
Physical-Transform industry	1250	7.07	95.99
Digital-Transform industry	710	4.01	100.00
Total	17,690	100.00	

Table 2
Descriptive statistics.

	Mean	Median	SD	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) Labour Productivity *(log deflated values, 2011 = base year)*	11.039	11.063	0.665	1								
(2) Value Added *(log deflated values, 2011 = base year)*	17.552	17.429	0.952	0.596*	1							
(3) Employment *(log values)*	6.499	6.34	0.726	−0.079*	0.676*	1						
(4) Fixed assets per employee *(log deflated values, 2011 = base year)*	10.102	10.498	1.791	0.180*	0.105*	−0.090*	1					
(5) Personnel cost per capita *(log deflated values, 2011 = base year)*	10.664	10.750	0.424	0.163*	0.157*	−0.129*	0.145*	1				
(6) Capital expenditure *(log deflated values, 2011 = base year)*	15.267	15.353	1.716	0.197*	0.121*	0.167*	0.143*	0.116*	1			
(7) Differentiation strategy	0.040	0.033	0.073	0.119*	0.158*	−0.036*	0.080*	0.148*	0.009*	1		
(8) Cost leadership strategy	1.173	1.040	0.694	−0.179*	−0.151*	0.043*	−0.103*	−0.191*	−0.177*	−0.136*	1	
(9) Dual strategy	0.042	0.035	0.057	0.178*	0.174*	0.016	−0.075*	0.041*	−0.007	0.174*	0.186*	1

* Bonferroni-adjusted significance levels below 0.01.

Table 4
Results of the comparative analysis between sub-samples.

	Automate industry			Informate industry			Physical-transform industry			Digital-transform industry		
	(1_a)	(2_a)	(3_a)	(4_a)	(5_a)	(6_a)	(7_a)	(8_a)	(9_a)	(10_a)	(11_a)	(12_a)
	Labour productivity growth [log deflated values]	Value added growth [log deflated values]	Employment growth [log deflated values]	Labour productivity growth [log deflated values]	Value added growth [log deflated values]	Employment growth [log deflated values]	Labour productivity growth [log deflated values]	Value added growth [log deflated values]	Employment growth [log deflated values]	Labour productivity growth [log deflated values]	Value added growth [log deflated values]	Employment growth [log deflated values]
Fixed assets per employee	0.1424***	0.1163***	−0.0610*	0.0051	−0.0229***	−0.0298***	0.0381*	−0.0666***	−0.1012***	0.0233	−0.0425	−0.0740***
[log deflated values]	(0.04)	(0.04)	(0.04)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)
Personnel cost per capita	0.4037***	0.3147***	−0.5305***	0.2990***	0.0027	−0.2965***	0.1437	0.0186	−0.1440	0.0824	0.1546*	−0.2317***
[log deflated values]	(0.08)	(0.09)	(0.08)	(0.02)	(0.02)	(0.02)	(0.09)	(0.10)	(0.09)	(0.07)	(0.10)	(0.09)
Capital expenditure	0.0036	0.0672***	−0.0690***	0.0044	0.0605***	−0.0573***	0.0026	0.0378***	−0.0388***	0.0076	0.0740***	0.0825***
[log deflated values]	(0.01)	(0.02)	(0.01)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
Lagged dependant Variable	0.5025***	0.5910***	0.7360***	0.4783***	0.6555***	0.7710***	0.6090***	0.6503***	0.7983***	0.3090**	0.7981***	0.8906***
[log deflated values]	(0.10)	(0.06)	(0.04)	(0.02)	(0.01)	(0.01)	(0.07)	(0.04)	(0.03)	(0.14)	(0.05)	(0.04)
Differentiation	0.7500	0.1483	0.3428	0.7746***	0.8238***	−0.0373	0.9718***	0.9246***	−0.3638	0.2733	0.6649	0.1371*
	(0.50)	(0.54)	(0.45)	(0.08)	(0.11)	(0.07)	(0.26)	(0.29)	(0.26)	(0.28)	(0.35)	(0.21)
Cost leadership	0.1121**	0.1953***	−0.1479*	0.0021	0.0091	−0.0087	0.0356	−0.0954	−0.0602	−0.0830	−0.0561	0.0363
	(0.06)	(0.06)	(0.05)	(0.01)	(0.01)	(0.01)	(0.04)	(0.04)	(0.04)	(0.06)	(0.09)	(0.08)
Dual strategy	−0.1669	−0.2335	−0.1461	0.4135**	0.3987**	−0.1673	0.1800	−0.4865	−0.5493	0.9541***	0.9337**	0.9957***
	(0.59)	(0.64)	(0.55)	(0.10)	(0.10)	(0.08)	(0.37)	(0.41)	(0.36)	(0.35)	(0.47)	(0.22)
Year dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
_cons	5.1885***	18.3482***	11.6415***	7.6209***	16.6998***	9.0032***	8.9465***	17.8213***	8.5214***	10.2630***	18.6515***	8.3921***
	(0.79)	(0.85)	(0.82)	(0.22)	(0.26)	(0.18)	(0.97)	(1.08)	(0.96)	(0.72)	(1.06)	(0.93)
N	770	770	770	14,960	14,960	14,960	1250	1250	1250	710	710	710
adj. R^2	0.5846	0.2412	0.2830	0.7878	0.4223	0.2463	0.6828	0.2013	0.1805	0.6013	0.2071	0.1885

Standard errors in parentheses.
* $p < 0.10$,.
** $p < 0.05$,.
*** $p < 0.01$.

This result suggests that the differentiation strategy is better aligned with the Physical-Transform IT strategic role for labour productivity growth. The results of Model 8_a also confirm that the productivity growth resulting from the differentiation strategy is driven by output growth ($\beta_{Differentiation} = 0.9246\ p < 0.01$), thus confirming our H3 hypothesis. In addition, the results of Model 6_a confirm that labour productivity growth in the Physical-Transform industry is only driven by output growth (as indicated by the results of Model 8a) as there is no statistically significant impact between business strategies and employment growth ($p > 0.10$). Taken together, these results support Hypothesis H3.

Lastly, we posited that the dual strategy in the Digital-Transform industry has a greater impact on labour productivity growth, and that this is driven as much by output growth (i.e. value added growth) as by input reduction (i.e. employment reduction). The Model 10_a results in Table 4 show that only the dual strategy has a significant positive impact on labour productivity growth ($\beta_{Dual\ strategy} = 0.9541\ p < 0.01$) in the Digital-Transform industry, while the differentiation and cost leadership coefficients are not statistically significant ($\beta_{Differentiation} = 0.2733\ p > 0.10$ and $\beta_{Cost\ leadership} = -0.0830\ p > 0.10$). This result suggests that the dual strategy is better aligned with the Digital-Transform IT strategic role for labour productivity growth. The results of Model 11_a also confirm that the productivity growth resulting from the dual strategy is driven by output growth ($\beta_{Dual\ strategy} = 0.9337\ p < 0.05$). In addition, the results of Model 12_a suggest that, in spite of what we had expected, the labour productivity growth resulting from the dual strategy in the Digital-Transform industry is associated with growth in employment – ($\beta_{Dual\ strategy} = 0.6957\ p < 0.01$) – and an even faster growth in value added – as indicated by the results of Model 11_a. More specifically, the results of Model 12_a show that the dual strategy ($\beta_{Dual\ strategy} = 0.9957\ p < 0.01$) and differentiation strategy ($\beta_{Differentiation} = 0.1371\ p < 0.10$) have a significant positive impact on employment growth in the Digital-Transform industry, while the cost leadership coefficient – although positive – is not statistically significant ($\beta_{Cost\ leadership} = 0.0363\ p > 0.10$). Furthermore, the marginal analysis indicates that the alignment between the dual strategy and the Digital-Transform IT strategic role has a greater impact on employment growth than the differentiation strategy. Taken together, these results partially support – and unexpectedly extend – Hypothesis H4.

As far as the effect of the control variables included in our model specification is concerned, it is worth noting that capital expenditure has a positive, albeit not significant, effect on labour productivity growth, and this is consistent with its positive effect on value added growth and negative (positive only for the Digital-Transform industry) effect on employment growth. Human capital, measured through the personnel cost per capita, positively affects labour productivity growth. This result seems to mainly be due to the positive effect of human capital on output growth and its negative effect on employment growth. Finally, the ratio of tangible fixed assets per employee positively affects employment growth. Most of these effects are plausible, considering how industrial economics depicts the effects of an industry structure on performance [111].

(1) **The moderating role of the type of industry**

In order to confirm the robustness of our results, we estimated the second-order effect due to business strategies and the strategic role of IT. To do so, we operationalised the strategic role of IT in the industry as a dummy variable to perform a hierarchical regression analysis, which we conducted to examine the moderating effect of the strategic role of IT in industry (Table 5).

The results, presented in Table 5, are consistent with those of the comparative analysis of the subsamples presented in Table 4 and discussed above. Specifically, the Model 1_b results in Table 5 show that the first-order effects on the labour productivity growth of the entire sample, resulting from the cost leadership strategy, are absent, while the direct effects of the dual and differentiation strategies are positive and significant ($\beta_{Dual\ strategy} = 0.5704\ p < 0.01$ and $\beta_{Differentiation} = 0.7489\ p < 0.01$). The same positive and significant results emerge for Model 2_b for the first-order effects of the dual strategy and differentiation on the value added growth of the entire sample ($\beta_{Dual\ strategy} = 0.6699\ p < 0.01$ and $\beta_{Differentiation} = 0.7620\ p < 0.01$). On the other hand, there are no significant first-order effects on the employment growth of the entire sample (see Model 3_b). Next, we hierarchically added interaction terms to the Automate industry (Models 4_b, 5_b, 6_b), Informate industry (Models 7_b, 8_b, 9_b), Physical-Transform industry (Models 10_b, 11_b, 12_b), and Digital-Transform industry (Models 13_b, 14_b, 15_b).

The results shown in Models 4_b, 5_b, and 6_b corroborate the moderating effect of the strategic role of IT in the Automate industry already found for the previously discussed models depicted in Table 4. Specifically, the interaction between the strategic role of the Automate industry and the cost leadership strategy is positively correlated with labour productivity growth (Model 4_b, $\beta_{Automate\ x\ Cost\ leadership} = 0.0347\ p < 0.05$) and value added growth (Model 5_b, $\beta_{Automate\ x\ Cost\ leadership} = 0.0657\ p < 0.05$), and negatively correlated with employment reduction (Model 6_b, $\beta_{Automate\ x\ Cost\ leadership} = -0.0196\ p < 0.05$). Taken together, the results support – and extend – Hypothesis H1.

Models 7_b, 8_b, and 9_b confirm the moderating effect of the strategic role of IT in the Informate industry found for the previous models (Table 4). In particular, although the interaction between the strategic role of the Informate industry and the dual strategy is positively correlated with labour productivity growth (Model 7_b, $\beta_{Informate\ x\ Dual\ strategy} = 0.1793\ p < 0.10$), the marginal contribution of the differentiation strategy is higher in terms of both magnitude and significance (Model 7_b, $\beta_{Informate\ x\ Differentiation} = 0.4100\ p < 0.05$). The same applies to value added growth (see Model 8_b). The non-significant correlation of the interaction between the strategic role of the Informate industry and business strategies with employment growth for Model 9b is also confirmed. Therefore, these results do not support Hypothesis H2 either.

As far as the Physical-Transform industry is concerned, the results shown in Models 10_b, 11_b, 12_b confirm the results of the previous models (see Table 4). Specifically, the results confirm the moderating effect of the strategic role of IT in the Physical-Transform industry proposed in Hypothesis H3 on both labour productivity growth (Model 10_b, $\beta_{Transform-Physical\ x\ Differentiation} = 0.1974\ p < 0.05$) and value added growth (Model 11_b, $\beta_{Transform-Physical\ x\ Differentiation} = 0.2248\ p < 0.01$). The results of Model 12_b also confirm the non-significant correlation of the interaction between the strategic role of the Informate industry and business strategies with employment growth. Therefore, taken together, the results corroborate the findings of the previous models that support Hypothesis H3 (Table 4).

Finally, Models 13_b, 14_b, and 15_b also confirm the moderating effect of the strategic role of IT in the Digital-Transform industry found for the previous models (see Table 4). In particular, the interaction between the strategic role of the Digital-Transform industry and the dual strategy is positively correlated with labour productivity growth (Model 13_b, $\beta_{Transform-Digital\ x\ Dual\ strategy} = 0.5628\ p < 0.05$) and value added growth (Model 14_b, $\beta_{Transform-Digital\ x\ Dual\ strategy} = 0.2466\ p < 0.05$). The positive correlation of the interaction between the strategic role of the Digital-Transform industry and the dual strategy with employment growth is also confirmed by Model 15b ($\beta_{Transform-Digital\ x\ Dual\ strategy} = 0.4943\ p < 0.10$). Therefore, these results also corroborate previous evidence that supports – and extends – Hypothesis H4.

It is worth noting that the Adjusted R-sqrd values increased when the interactions with the four subsamples (Models 4–15_b) were added, compared to the whole-sample baseline (Models 1–3_b) and that the effects of the control variables on the dependant variables discussed in Table 4 were confirmed for all the model specifications discussed above.

Table 5
Results of hierarchical regression analysis.

	(1_b) Labour productivity growth [log deflated values]	(2_b) Value added growth [log deflated values]	(3_b) Employment growth [log deflated values]	(4_b) Labour productivity growth [log deflated values]	(5_b) Value added growth [log deflated values]	(6_b) Employment growth [log deflated values]	(7_b) Labour productivity growth [log deflated values]	(8_b) Value added growth [log deflated values]	(9_b) Employment growth [log deflated values]	(10_b) Labour productivity growth [log deflated values]	(11_b) Value added growth [log deflated values]	(12_b) Employment growth [log deflated values]	(13_b) Labour productivity growth [log deflated values]	(14_b) Value added growth [log deflated values]	(15_b) Employment growth [log deflated values]
Fixed assets per employee	0.0156***	0.0247***	−0.0419***	0.0666***	0.0145**	−0.0563***	0.0675***	−0.0134**	−0.0560***	0.0672***	−0.0144**	−0.0562***	0.0685***	−0.0112*	−0.0554***
[log deflated values]	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)	(0.00)
Personnel cost per capita	0.2895***	0.0326	−0.2979***	0.8378***	0.2959***	−0.2893***	0.8342***	0.2917***	−0.2914***	0.8348***	0.2956***	−0.2899***	0.8343***	0.2890***	0.2929***
[log deflated values]	(0.02)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)
Capital expenditure	0.0035	0.0598***	−0.0570***	0.0299***	0.1212***	−0.0802***	0.0299***	0.1209***	−0.0800***	0.0300***	0.1212***	−0.0801***	0.0291***	0.1203***	0.0801***
[log deflated values]	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Lagged dependant Variable	0.4833***	0.6560***	0.7800***	0.8835***	0.9678***	0.9706***	0.8877***	0.9676***	0.9706***	0.8909***	0.9676***	0.9707***	0.8817***	0.9682***	0.9704***
[log deflated values]	(0.02)	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)
Differentiation	0.7489***	0.7620***	−0.0380	0.1971	0.9259	0.0404	0.9003***	0.9938***	0.3573*	0.2308***	0.9422***	0.0254	0.2657***	0.9541***	0.0211
	(0.08)	(0.10)	(0.07)	(0.08)	(0.11)	(0.07)	(0.17)	(0.23)	(0.16)	(0.08)	(0.11)	(0.08)	(0.08)	(0.11)	(0.07)
Cost leadership	0.0037	0.0075	−0.0076	0.1160***	0.2132*	−0.1088**	−0.0103	−0.0527*	−0.0038	−0.0193***	−0.0096	0.0118	−0.0107	−0.0045	0.0100
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.03)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Dual strategy	0.5704***	0.6699***	−0.0753	0.6218	−0.6792	−0.0709	0.4007*	−0.0924	−0.4390*	0.5941***	0.7008***	0.1059	0.5568***	0.6484***	0.0807
	(0.09)	(0.11)	(0.08)	(0.09)	(0.12)	(0.08)	(0.23)	(0.31)	(0.22)	(0.09)	(0.12)	(0.09)	(0.09)	(0.12)	(0.08)
Year dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Automate				0.0264	−0.0187	−0.0384									
				(0.05)	(0.08)	(0.07)									
Automate x Differentiation				0.2736	0.3637	0.2434									
				(0.37)	(0.55)	(0.40)									
Automate x Cost leadership				0.0347**	0.0657**	−0.0196**									
				(0.05)	(0.06)	(0.05)									
Automate x Dual strategy				−0.0128	−0.1084	−0.4053									
				(0.48)	(0.67)	(0.49)									
Informate							0.0458	−0.1702	−0.0860						
							(0.02)	(0.05)	(0.04)						
Informate x Differentiation							0.4100**	0.9315**	−0.3754						
							(0.19)	(0.26)	(0.18)						
Informate x Cost leadership							−0.0032	0.0495	−0.0156						
							(0.02)	(0.03)	(0.02)						
Informate x Dual strategy							0.1793*	0.5293*	−0.5870						
							(0.25)	(0.34)	(0.23)						
Transform-Physical										0.0541	0.0880	−0.1229			
										(0.03)	(0.06)	(0.06)			
Transform(P) x Differentiation										0.1974**	0.2248***	−0.3185			
										(0.24)	(0.33)	(0.23)			
Transform(P) x Cost leadership										−0.0552	−0.0309	−0.0375			
										(0.02)	(0.04)	(0.03)			
Transform(P) x Dual strategy										0.2144	−0.1442	−0.7137			
										(0.33)	(0.46)	(0.31)			
Transform-Digital													0.2652***	0.4721***	0.1205
													(0.05)	(0.09)	(0.08)

(*continued on next page*)

Table 5 (*continued*)

	(1_b) Labour productivity growth [log deflated values]	(2_b) Value added growth [log deflated values]	(3_b) Employment growth [log deflated values]	(4_b) Labour productivity growth [log deflated values]	(5_b) Value added growth [log deflated values]	(6_b) Employment growth [log deflated values]	(7_b) Labour productivity growth [log deflated values]	(8_b) Value added growth [log deflated values]	(9_b) Employment growth [log deflated values]	(10_b) Labour productivity growth [log deflated values]	(11_b) Value added growth [log deflated values]	(12_b) Employment growth [log deflated values]	(13_b) Labour productivity growth [log deflated values]	(14_b) Value added growth [log deflated values]	(15_b) Employment growth [log deflated values]
Transform(D) x Differentiation													0.0734	0.4510	0.3114
													(0.29)	(0.41)	(0.25)
Transform(D) x Cost leadership													−0.1778	−0.2055	−0.0002
													(0.05)	(0.07)	(0.05)
Transform(D) x Dual strategy													0.5628**	0.2466**	0.4943*
													(0.37)	(0.52)	(0.33)
_cons	7.6405***	17.0597***	9.1533***	0.9154***	12.5765***	8.8633***	0.9816***	12.7554***	8.9551***	0.9460***	12.5720***	8.8589***	0.9393***	12.6121***	8.8864***
	(0.19)	(0.23)	(0.17)	(0.11)	(0.20)	(0.16)	(0.12)	(0.21)	(0.16)	(0.11)	(0.20)	(0.16)	(0.12)	(0.20)	(0.16)
N	17,690	17,690	17,690	17,690	17,690	17,690	17,690	17,690	17,690	17,690	17,690	17,690	17,690	17,690	17,690
adj. R^2	0.5750	0.3246	0.2176	0.6234	0.5245	0.3092	0.6642	0.5234	0.3101	0.6740	0.5257	0.3094	0.6442	0.5163	0.3074

Standard errors in parentheses.

* $p < 0.10$,.

** $p < 0.05$,.

*** $p < 0.01$.

(1) **Extensions**

As a robustness check, we also used a dynamic panel data estimation to overcome any possible endogeneity issues arising from reverse causality due to the prior performance of a firm. The results are shown in Table 6 and are consistent with the results of the comparative analysis of the subsamples (Table 4) and with the results on the moderating effect of the strategic role of IT in industry (Table 5).

Specifically, in the Automate industry, the cost leadership strategy shows a positive and significant impact on labour productivity growth ((Model 1_c, $\beta_{Cost\ leadership} = 1,0196\ p < 0.10$) and value added growth (Model 2_c, $\beta_{Cost\ leadership} = 0.09165\ p < 0.05$); the results of Model 3_c also confirm the negative impact that the cost leadership strategy has on employment growth ($\beta_{Cost\ leadership} = -0.1676\ p < 0.10$). It has been confirmed that the differentiation strategy in the Informate and Physical-Transform industry has a positive and significant impact on labour productivity growth (Model 4_c and Model 7_c) and value added growth (Model 5_c and Model 8_c); the non-significant impact of business strategies on employment growth (Model 6_c and Model 8_c) is also confirmed. Finally, the results of Models 10_c, 11_c, and 12_c confirm that, in the Digital-Transform industry, the dual strategy has a positive and significant impact on labour productivity growth (Model 10_c, $\beta_{Dual\ strategy} = 1.9166\ p < 0.10$), value added growth (Model 11_c, $\beta_{Dual\ strategy} = 1.5179\ p < 0.10$), and employment growth (Model 12_c, $\beta_{Dual\ strategy} = 1.0467\ p < 0.10$).

The validity of the instruments has been tested using the Sargan test for over-identifying restrictions and the Arellano-Bond test for the absence of serial correlation of the residuals. The Sargan and Arellano-Bond tests did not reject the null hypothesis of correct specification (p-value of the Sargan test and the AR (2) test are larger than 0.05), thus lending support to our estimation results [cf. 109].

The results of the dynamic panel models in Table 6 confirm the results of the comparative analysis between the subsamples (Table 4) and the results on the moderating effect of the strategic role of IT in industry (Table 5), thereby further demonstrating the robustness of our conclusions. In fact, the hypotheses of our study were generally confirmed (and extended) – except for Hypothesis H2 on the Informate industry – thus showing that the alignment between the business strategy of firms and the strategic role of IT in industry significantly improves labour productivity growth.

5. Discussion

Drawing on the strategic alignment perspective, this study aims to investigate whether and how a company's business strategy aligns with the strategic role of IT in the industry in which the company competes, and how this alignment influences the company's labour productivity growth. We also test whether labour productivity growth is driven by output growth (i.e. value added growth) or input reduction (i.e. employment reduction). After collecting data from large Italian firms active in the 2011–2020 period, we classified the total sample into four subsamples (Automate, Informate, Physical-Transform, Digital-Transform) on the basis of a new industry categorisation scheme that takes into account the strategic role of IT in industry [13,16] and the generative potential of emerging technologies [23]. We conducted a comparative analysis for each subsample to find the best alignment between business strategy and the strategic role of IT in industry. Furthermore, we examined the moderating effect of the strategic role of IT and used a dynamic panel data estimation as a robustness check to overcome any possible endogeneity issues that could have arisen from reverse causality due to prior firm performance. The results of all the models confirmed our conclusions, a comprehensive summary of which is reported in Table 7.

In Hypothesis H1, we proposed that IT in the Automate industry can lead to labour productivity growth by helping firms automate

Table 6
Results of dynamic panel data estimation (GMM).

	Automate industry			Informate industry			Physical-transform industry			Digital-transform industry		
	(1_c) Labour productivity growth [log deflated values]	(2_c) Value added growth [log deflated values]	(3_c) Employment growth [log deflated values]	(4_c) Labour productivity growth [log deflated values]	(5_c) Value added growth [log deflated values]	(6_c) Employment growth [log deflated values]	(7_c) Labour productivity growth [log deflated values]	(8_c) Value added growth [log deflated values]	(9_c) Employment growth [log deflated values]	(10_c) Labour productivity growth [log deflated values]	(11_c) Value added growth [log deflated values]	(12_c) Employment growth [log deflated values]
Fixed assets per employee	0.0065	0.0169	−0.0123	0.1915*	0.1977**	−0.0983**	−0.0998*	−0.0596	−0.0674**	0.0329	−0.0298	−0.0249
[log deflated values]	(0.08)	(0.07)	(0.05)	(0.04)	(0.04)	(0.05)	(0.03)	(0.04)	(0.03)	(0.03)	(0.04)	(0.03)
Personnel cost per capita	1.0181*	−0.5003*	0.3303*	0.4350*	−0.4914*	0.2623**	0.1636	0.0568	0.0016	0.3144	−0.5106**	0.1616
[log deflated values]	(0.27)	(0.22)	(0.17)	(0.23)	(0.26)	(0.09)	(0.28)	(0.21)	(0.14)	(0.22)	(0.17)	(0.12)
Capital expenditure	−0.0266	0.0414	0.0407	−0.1743*	0.0170	0.0245	0.0578	0.0327	0.0992**	−0.0234	−0.0097	0.0041
[log deflated values]	(0.03)	(0.05)	(0.03)	(0.05)	(0.04)	(0.03)	(0.04)	(0.05)	(0.03)	(0.03)	(0.05)	(0.03)
Lagged dependant Variable	−0.0615	0.9488	0.9937	0.3506	0.9121	1.0189	1.1099	0.9104*	0.9422	0.2835	0.0140	0.9863
[log deflated values]	(0.25)	(0.06)	(0.06)	(0.15)	(0.07)	(0.04)	(0.19)	(0.07)	(0.06)	(0.22)	(0.07)	(0.05)
Differentiation	1.3585	−1.3998	−1.2390	1.5394***	0.9673**	−0.4107	1.6430**	1.7131**	−1.0300	1.5873	1.3502	0.7417
	(1.15)	(1.16)	(1.19)	(1.20)	(1.05)	(0.77)	(0.94)	(0.61)	(0.53)	(1.86)	(2.45)	(1.11)
Cost leadership	1.0196*	0.9165**	−0.1676*	−0.1081	−0.2725	0.0249	−0.3062	−0.1082	−0.0646	−0.3793	−0.0487	0.0416
	(0.17)	(0.12)	(0.12)	(0.10)	(0.09)	(0.07)	(0.09)	(0.07)	(0.14)	(0.16)	(0.25)	(0.17)
Dual strategy	−1.3217	−0.3950	1.8912	−2.9802	0.4750*	0.4689	1.6376	1.6774*	−0.6275	1.9166*	1.5179*	1.0467*
	(1.85)	(1.35)	(1.74)	(1.63)	(1.16)	(0.65)	(1.01)	(1.38)	(1.19)	(2.64)	(2.98)	(1.33)
Year dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
_cons	1.1951	5.6348***	−3.8895*	3.3462***	4.8422**	−2.3370***	−2.4540*	1.1920	−0.4180	5.0452***	5.8950***	−1.5051
	(1.29)	(2.14)	(2.15)	(1.00)	(2.25)	(0.82)	(1.45)	(2.46)	(1.36)	(0.96)	(1.73)	(1.25)
N	770	770	770	14,960	14,960	14,960	1250	1250	1250	710	710	710
Sargan	17.86	33.87	55.70	59.54	63.82	15.87	12.71	25.47	19.24	38.94	10.41	11.63
AR(1)	−5.60	−6.65	−7.68	−14.26	−12.56	−24.03	−7.86	−8.92	−7.15	−4.43	−5.18	−6.78
AR(2)	0.93	1.81	1.02	3.04	2.39	0.893	2.14	0.91	1.10	0.35	0.88	0.96

Standard errors in parentheses.
[*] $p < 0.10$.
[**] $p < 0.05$.
[***] $p < 0.01$.

Table 7
Synthesis of the results.

Exemplary industries	Strategic role of IT	Hypotheses	Results	Description of result	What we can conclude about the role of IT
Coal Mining Heavy Construction	Automate	H1: In industries where automation logics prevail in the strategic use of IT (‘Automate’ industry), the cost leadership strategy has a greater impact on labour productivity growth, which is driven by input reduction (i.e. employment reduction).	Supported and extended	The cost leadership strategy is better aligned with the Automate IT strategic role for labour productivity growth, which is not only driven by an input reduction (as we had assumed), but also by output growth.	IT is used to support companies in pursuing cost leadership strategies that result in lower production costs and a higher capacity utilisation.
Automotive Manufacturing Computer Manufacturing Retail Apparel/Accessories Grocery Stores Transportation Utilities	Informate	H2: In industries where informate logics prevail in the strategic use of IT (‘Informate’ industry), a dual strategy has a greater impact on the growth of labour productivity, which is driven as much by input reduction (i.e. employment reduction) as by output growth (i.e. value added growth).	Not supported	It is the differentiation strategy - and not the dual strategy as we had assumed - that has the greater impact on labour productivity growth, and that this is only driven by output growth.	IT is used to support competition in terms of variety and customisation, to achieve more precise and effective market segmentation, to improve stock rotation, and to integrate information systems in a multi-channel perspective that improves the service level for the customer.
Airlines Hotels Printing & Graphics Design	Physical-Transform	H3: In industries where transformation logics prevail in the strategic use of IT and the economic value of the product/service is associated with its physical nature (‘Physical-Transform’ industry), the differentiation strategy has a greater impact on labour productivity growth, which is driven by output growth (i.e. value added growth).	Supported	The differentiation strategy is better aligned with the Transform-Physical IT strategic role for labour productivity growth, which is only driven by output growth.	
Publishing activities, including software Motion picture, video, music, and sound recording activities Radio and TV broadcasting and programming activities Telecommunication activities Information technology activities Other information service activities including data processing, hosting and the related activities, web portals and news agency activities	Digital-Transform	H4: In industries where transformation logics prevail in the strategic use of IT and the economic value of the product/service is associated with its digital nature and depends on the information it contains (‘Digital-Transform’ industry), the dual strategy has a greater impact on labour productivity growth, which is driven as much by output growth (i.e. value added growth) as by input reduction (i.e. employment reduction).	Partially supported	The dual strategy is better aligned with the Transform-Digital IT strategic role for labour productivity growth, which is associated with growth in employment and an even faster growth in value added	IT is used to pursue new digital options related to entering new geographical markets and developing new products and services by pursuing scalability and taking into account how the generative potential of emerging technologies is giving rise to ’novel ways of getting things done’.

production processes, reduce costs, and promote operational efficiency [5]; this, coupled with the fact that firms in the Automate industry sell homogeneous products or services (e.g. coal or crude oil) is consistent with the aims of the cost leadership strategy of achieving economies of scale that result in lower production costs and higher capacity utilisation [64,65]. Our results confirm that there is an alignment between the cost leadership strategy and the strategic role of IT in the Automate industry that drives productivity growth. At the same time, the results also show that productivity growth in the Automate industry is driven as much by input reduction (as we had assumed) as by output growth, expressed in terms of value added. This result shows that, in the Automate industry, IT has enabled both process efficiency and cost reduction, as well as increased revenues for the same amount of production capacity used, and has thus extracted more added value. In this regard, it is interesting to note that this growth in added value appears to be intrinsic to the IT efficiency process and does not depend on an increase in demand resulting from product differentiation. In fact, the results show that the dual strategy – based on pursuing and balancing both cost and differentiation strategies simultaneously [18–20] – has a negative (albeit non-significant) association with productivity growth and value added in the Automate industry. This emphasises that, in the Automate industry, IT cannot help companies achieve the goals of cost leadership and differentiation simultaneously, and corroborates our intuition that value added growth derives purely from streamlining production processes, rather than pursuing more complex product or service innovation initiatives through IT. In this sense, it is logical to think that a lower unit cost can be converted into lower prices, which in turn can attract more customers (especially in industries with a high customer price sensitivity) with a consequent growth in added value. Taken together, these results provide initial evidence of the importance for companies to align their business strategy with the strategic role of IT in industry [cf. 21].

In Hypothesis H2, we put forward that, in the Informate industry, IT can lead to labour productivity growth by helping not only companies to differentiate their products or services, but also to improve operational efficiency [73,74]. However, the results do not confirm our hypothesis, and indicate that it is the differentiation strategy rather than the dual strategy – that has a greater impact on labour productivity growth. This result can be traced back to the fact that the commoditisation of IT and the integration of business systems, such as ERP, SCM and CRM, made the benefits from the efficiencies in internal information flows achieved between the 1990s and 2000s increasingly labile and short-term, thereby levelling off the levels of competition between firms in the Informate industry [13]. Furthermore, unlike the Automate industry, the Informate industry started to invest in IT earlier [16]; therefore, all the employment reduction efficiencies and all the delaying processes that lead to the reduction of the hierarchical levels, and the middle line in which the organisational structure is articulated, may have already taken place in the early 2000s, which is why we do not observe input reduction effects in our data (2011–2020) but only output growth. Our results in fact confirm how IT has enabled companies in the Informate industry to differentiate their products and promote customisation and new product development [68]. In this regard, the retail sector, where, in several product categories (e.g. food, furniture, clothing), IT has supported differentiation strategies based on increasing the level of benefit offered to customers, thus enabling the integration of online and physical distribution channels, end-to-end integration in the customer journey [79], and mass customisation, can be considered as an illustrative example. Taken together, the results show that the growth in process performance of companies in the Informate industry is supported by the alignment between the differentiation strategy and a use of IT (a) to forecast and manage demand in a more granular and timely manner, (b) to define and implement market segmentation more effectively, (c) and to integrate information systems in a multi-channel perspective that improves the service level for the customer.

This form of alignment between the role of IT and business strategies, mirrors the results that emerged for the Physical-Transform industry (Hypothesis H3), thus signalling how the strategic roles of IT in industries, whose value is linked to the physical and tangible aspects of the product or service, are progressively converging.

Finally, we proposed Hypothesis H4, according to which IT in the Digital-Transform industry can lead to labour productivity growth by helping not only companies to differentiate their products or services, but also to improve operational efficiency aimed at achieving a global operating scale, following the logic of 'scale without mass' [81]. As we expected, the results confirm that the dual strategy is better aligned with the Digital-Transform IT strategic role for labour productivity growth, and that this growth is driven by output growth. However, although these results support the first part of Hypothesis H4, the second part of the hypothesis on improved operational efficiency, resulting from reduced employment, is not supported. In fact, in spite of what we had expected, the labour productivity growth that results from the dual strategy in the Digital-Transform industry is associated with growth in employment, and an even faster growth in value added. This result provides important empirical evidence that IT has only brought about both economic growth and employment growth over the last ten years in just the Digital-Transform industry.

Overall, these results indicate a possible gradual convergence in the strategic role of IT between the industries originally classified by Chatterjee et al. [16] and Chae et al. [13] into the two distinct classes of 'Informate' and 'Transform'. More specifically, our results show that the best strategies for value creation coincide with benefit differentiation in Informate industries, as well as in industries characterised by the physical materiality of the product/service and the transformative potential of IT – what we have called 'Physical-Transform'. On the other hand, our analysis shows that the industries inserted into the Transform category, which are characterised by a lack of materiality in the services, emerge to be the ideal settings for the success of dual strategies, based on the combination of benefit differentiation and cost leadership. In this sense, our findings confirm and extend the idea that the strategic role of IT takes on different trajectories and has different competitive implications depending on the prevailing nature of the industry's key product in the duality between materiality ('atoms') and information ('bits'). Whether or not the convergence highlighted by our results between the Informate and Physical-Transform industries can be a temporary effect related to learning effects in the use of emerging digital technologies is a question that this study is unable to answer. However, what undoubtedly emerges from our analysis is that to date, dual strategies can hardly be successfully implemented due to the scalability constraints generated by the materiality of the physical product, or the service being delivered.

In fact, Informate industries where the role of IT has traditionally been that of generating and using increasing amounts of information to improve operational decision-making and coordination are now seeing opportunities for business model transformation. The seamless integration of physical and online channels [112], mass customisation [68], servitisation [113], finer-grained market segmentation, based on a greater variety of products/services and reaching the long tails of international markets [113], as well as faster product development processes are examples of these opportunities. However, the scalability of business models in these areas remains anchored to the materiality and physical constraints of the product/service. For example, Iansiti and Lakhani [114], in the industrial machinery sector, documented General Electric's difficult attempt to become a digital company, showing how it attempted to integrate complementors' data to become the industry's platform orchestrator and to seize the servitisation opportunities enabled by emerging technologies such as Digital Twin, AI, IoT. Prospectively, other Informate industries, such as the automotive, appliances, and all the other sectors that produce physical objects that can become 'smart' and 'connected' through digitalisation [35,115] have shown a similar transformation trend. In undertaking this type of transformation, these sectors risk disintermediation in value capture and increased exposure to international competition, in a similar way to what the Physical-Transform industry has already seen in such sectors as hospitality, transport and logistics, where digitisation has enabled the use of 'sharing economy' schemes in business model innovation.

In contrast, in the Digital-Transform industry, the transformation of business models takes on a different trajectory that has different implications on market competition than our study has documented for the Informate and Physical-Transform industry type. In other words, the Digital-Transform industry is the ideal context for dual strategies, because the information-based structure of products and services and the different economics of information goods [25] offer more digital options [82] and more scalability (what Brynjolfsson et al. [81] termed 'scale without mass'). Furthermore, in the Digital-Transform industry, the generative potential of IT [23,24] has generated a large number of new paths, thus giving rise to the 'novel ways of getting things done' that have been transforming the structure and value chains of entire industries (e.g. media, software, advertising, cultural heritage, education – [cf. 37,116]).

The importance of strategic flexibility [82] and scalability [81] as factors of critical success in the Digital-Transform industry, and the different results documented by our study concerning the industry classes we propose, raise another important point. Dual strategies may be a more difficult option for firms in the Informate and Physical-Transform industries to undertake, due to the fact that the firms in these groups suffer from an 'IT rigidity' effect [117] that originates from the prevalence of legacy systems [118] and siloed approaches to data management related to the path dependency of IT architecture choices made between the 1970s and the late 1990s. In point of fact, although new business models require constant adaptations to market changes, the information systems of companies that invested aggressively in IT in the early 2000s may now be closely coupled or otherwise not agile enough to respond to the new requirements [119]; this would make the IT infrastructure of such companies counterproductive in dynamic and volatile environments such as those of the Physical-Transform industry [119], thus turning what were core capabilities into core rigidities [118]. In other words, although most companies in the Physical-Transform sector implemented information systems in the early 2000s [120], some of them may have slowed down their implementation due to the rigidity of the systems in responding adequately to changes [121]. In many cases, companies are discouraged from upgrading their systems and continue to use their old ones [122]; even the implementation of software 'as a service' solution may sometimes fail in dynamic and volatile environments, such as those in which Physical-Transform companies operate.

Finally, our study shows that, apart from the automation sector, the value creation opportunities pursued in the past by companies through IT consist of output growth rather than labour input reduction. In most industries, opportunities for input reduction were probably pursued by reducing the middle line and increasing the span of control of middle managers and by automating the routine tasks of the administrative support staff. However, our study documents that dual strategies in the Digital-Transform industry have generated employment growth, due to the need for more qualified employees. An anecdotal example of this trend can be found in Microsoft's recent statement (May 2022) that it will 'nearly double its budget for employee salary increases and boost the range of stock compensation it gives some workers by at least 25%' [123], in an effort to retain staff in a fierce battle for talent with companies like Amazon.com Inc., Google and Facebook owner Meta Platforms Inc., as well as startups.

6. Limitations and future studies

In this study, we set out with the aim of trying to understand the role of industry in aligning business strategy and business performance through the perspective of the strategic role of IT in business. We found that the impact of a business strategy on labour productivity growth (and its components, output growth and input reduction) varies from industry type to industry type. The results raise interesting questions about the differences between the Physical-Transform industry and the Digital-Transform industry in which the strategic role of IT is changing profoundly. As in any econometric study, our research design is not without limitations, especially as a result of shortcomings concerning the data and sample. Therefore, future studies are needed to help managers in the process of IT capability development, depending on the type of industry in which they operate and compete.

First, although our econometric results are robust to different estimation methods and specifications, and our theoretical arguments lead us to expect that these effects might also hold in other countries and over the next few years, further investigations are needed to generalise the new industry categorisation scheme proposed in this study across contexts and countries. Second, due to data limitations, we only integrated the strategic role of IT with business strategy (i.e. cost leadership, differentiation, dual strategy). Although the perspective of the strategic role of IT clearly reflects the state of IT in an industry, the ability of each company to utilise IT is different. Leidner et al. [124] suggested that companies tend to have one of the following three types of IT strategies: IT Innovator, IT Conservative or IT Undecided. Future research could investigate how a company's business strategies align with its IT strategies [125] and the strategic role of industry [13]. Furthermore, this study can be extended by including additional external and internal moderating and contingency factors. For example, future research could consider how business strategies align with IT spending and the strategic role of industry. With a few notable exceptions [e.g. 9,125], the spending on IT is very difficult to capture at a firm-level. Another potential future research agenda is to explore whether a rapid alignment between business strategy and the strategic role of IT in industry generates first-mover advantages – especially in the Digital-Transform industry. Deciding what and when to invest is a key issue for managers [126,127], and timing, especially in the Digital-Transform industry, can be crucial (e.g. Uber, Airbnb). On the other hand, those who move later may benefit from newer and more efficient technologies, while those who invested earlier may end up with older technologies or with an obsolete infrastructure that needs to be retrofitted (e.g. Yahoo vs. Google or Kodak vs. Instagram). This discourse should not be limited to the Digital-Transform industry alone but should also be extended to physical-based industries where understanding the advantages and disadvantages of first-movers can provide managers with an important guideline on the timing of IT investments (e.g. Tesla vs. other car makers investing in their fast-charging infrastructure).

Finally, having discussed how organisational agility or rigidity may be among the causes of the convergence of Informate and Physical-Transform industries, future research could explore whether popular information systems provide agility or impose rigidity on these industries. Cases such as FCA, Ford, Motorola and Dell may provide insights into how once successful just-in-time information systems may have caused problems in achieving a digital transformation capable of radically changing business perspectives.

7. Conclusion

This study, which has had the main objective of understanding the role of industry in the connection between business strategy and firm performance, offers several important contributions to the IS research community and practitioners.

First, the study updates the view of the strategic role of IT by taking into account the generative potential of emerging technologies [23] and applies it to understand how the alignment between business strategy and the strategic role of IT in an industry influences the performance of a firm. We believe this is an important addition to the literature on IT business value, as two research streams are considered and integrated simultaneously: the industry-level and the firm-level. At the industry-level, the study extends the seminal contribution of Chatterjee et al. [16] and enriches the debate carried out in Information & Management by Chae et al. [13]. We believe that this result calls for more comprehensive and rigorous research on the strategic role of IT in different contexts and countries. At the firm-level, the study confirms that the alignment between a firm's business strategy and the strategic role of IT in industry improves not only the economic performance of such a firm [21], but also its process performance by distinguishing economic growth (more output) from input reduction (less labour). This result reminds researchers and practitioners of the importance of the strategic role of IT in industry, and calls for more attention being paid to changes in technology and the competitive environment in which IT is adopted and used.

Second, the study enriches our understanding of how to configure an appropriate competitive strategy, taking into account the changes in business models induced by the emergence of new technologies, and how these changes vary from industry to industry. Managers often use 'industry norms' as the basis of their decisions. Our study emphasises that such norms should be adapted, in a co-evolutionary (rather than predeterministic and retrospective [cf. 13]) perspective, to both the competitive environment and technological changes. In this sense, our study shifts the focus from what business strategy was effective in a world that was based on predetermined logics, such as automating, informing, or transforming, to the context in which a business strategy is effective when it takes into account how the generative potential of IT is changing the attributes of information-based products and services. This better understanding of the industry can help managers and practitioners improve their IT decisions.

CRediT authorship contribution statement

Danilo Pesce: Conceptualization, Methodology, Formal analysis, Investigation, Writing – original draft, Writing – review & editing, Visualization. **Paolo Neirotti:** Conceptualization, Methodology, Formal analysis, Writing – review & editing.

Declaration of Competing Interest

None.

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