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Enterprise digitalization, business strategy and subsidy allocation: Evidence of the signaling effect

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ABSTRACT

Government subsidies are often used to overcome market imperfections that constrain investment and other business activities. Since the Chinese government proposed the "Internet Plus" action plan in 2015, many companies in a number of traditional industries have made significant efforts toward enterprise digitalization. Our paper investigates the signaling effect of enterprise digitalization on government subsidy allocation. Using a panel dataset of Chinese listed enterprises from 2013 to 2018, our fixed effects model shows a significant positive relationship between companies' digitalization efforts and the amount of government subsidies they receive. Furthermore, our analysis highlights the role of business strategy in moderating this relationship. These findings suggest that enterprise digitalization efforts can send valuable signals to the government agencies responsible for subsidy allocation.

1. Introduction

In recent years, substantial advances in digital technologies have greatly expanded the availability of resources and meaningfully changed the process of value creation. Digital technologies are an important type of external enabler (von Briel et al., 2018) that can not only can reshape or replace business models, but also substantially expand the scope of resources that are accessible to firms, thereby allowing them to configure their resources in novel ways (Amit and Zott, 2012; Amit and Han, 2017). In 2015, Chinese Premier Li Keqiang first proposed the "Internet Plus" action plan, which aimed to facilitate the integration of digital technologies with traditional industries. The main focus of this action plan is to leverage the mobile Internet, cloud computing, big data and the Internet of Things to upgrade modern manufacturing. Chinese government agencies at all levels issued numerous supporting policies and provided various forms of subsidies or grants to enterprises in traditional industries. Therefore, enterprises in many industries, especially the manufacturing and high-tech industries, have made efforts to explore new digital technologies and subsequently adopt the appropriate digital technologies. While many previous studies have highlighted the paradigm-shifting role of digital technologies (e.g., Nambisan, 2017), few have examined how the efforts made toward enterprise digitalization may influence government subsidy decision-making. Using the "Internet Plus" action plan and the recent surge in firms' digital transformation efforts as our research context, our empirical study focuses on two research questions: (1) How does enterprise digitalization influence the allocation of government subsidies? and (2) What is the role of business strategy in the relationship between enterprise digitalization and government subsidies?

Government subsidies are an important policy tool for overseeing the macro-allocation of resources (Wu, 2017). The Chinese government has prioritized integrating the use of the Internet into traditional industries to modernize them and fuel their growth. As a result, individual provinces and cities have been forced to formulate a myriad of implementation policies and incentive plans. Special subsidies given to enterprises that actively participate in digital transformation and smart manufacturing are an important type of subsidy. After reviewing the detailed government subsidy policies for enterprise digital transformation and smart manufacturing, we find that these subsidies can generally be classified as being either competitive or inclusive (Cao et al., 2021; Yang, 2017). Competitive subsidies are usually awarded to enterprises that have done a good job in intelligent upgrading and digital transformation. For example, to promote digital transformation of the manufacturing industry, Guangzhou city has given a one-time reward of 5 million RMB to the platform enterprises selected by the national industry and information department as the cross-industry and

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cross-domain comprehensive industrial internet platform; those selected as national characteristic or professional industrial internet platform were rewarded up to 3 million RMB at one time. Inclusive subsidies, which encourage companies to carry out digital transformation, are usually awarded to enterprises that are need of intelligent transformations and upgrades. From the perspective of special subsidies for digital transformation, the amount of subsidies obtained are mainly based on the needs for investment and completion of technology transformation. For example, in Guangdong province, the local government issued the "Suggestions on promoting the development of industrial robots and intelligent equipment industry" to fulfill the target penetration rates of industrial robots and intelligent equipment among its manufacturing enterprises. These local government suggestions clearly stated that for purchases of complete industrial robotics systems, the subsidy amount cannot be higher than RMB 500,000 per set. Similarly, for subsidies for the construction of smart factories and digital workshops, the city of Chongqing city requires the project investment (including software, hardware, network, system integration, information technology services, etc.) to reach >10 million RMB. Thus, how to select recipients and allocate subsidies is an important issue faced by government agencies at all levels. Very often, enterprises that excel in intelligent and digital transformation can send positive signals to government agencies, thereby increasing their chances of winning competitive subsidies. After receiving these signals, the government agencies can better understand the situations of these enterprises and make more informed subsidy allocation decisions. The extant studies that analyze government subsidies allocation and recipient selection have mostly focused on exploring the influence of the characteristics of firms' operational activities. For example, Wu and Liu Cheng (2011) find that top managers having strong political connections is conducive to obtaining more government subsidies or other forms of support. In addition, Boeing (2016) finds that firm selection for government subsidies is mainly determined by prior grant experience, high-quality innovation output, and minority state-ownership. As another example, Cantner and Kösters (2012) investigate the allocation of R&D subsidies for start-ups and suggest that R&D subsidies are often given to start-ups with innovative business ideas. However, previous studies of government subsidy allocation have rarely considered firms' strategic transformation activities in the context of the digital economy.

Digitalization provides opportunities for enterprises to access new markets and expand their customer bases (Nambisan, 2017). Many scholars have pointed out that digitalization aids firms in developing new capabilities (e.g., Gupta et al., 2020; Mikalef et al., 2021; Chatterjee et al., 2022) and provides them with more agility with which to navigate increasingly turbulent environments (Ciampi et al., 2022). Recently, several empirical studies have found that digitalization can boost enterprise performance (e.g., Truant et al., 2021; Li et al., 2022). One of the signaling effects of government subsidies is the certification effect (Yan and Li, 2018). Thus, we hypothesize that there is a positive relationship between enterprise digitalization and government subsidies.

Our paper mainly contributes to the literature in the following two aspects. First, we connect the literature on digital transformation to that on government subsidy allocation and in so doing highlight the signaling effect of enterprise digitalization efforts. Second, we extend the strategic transformation literature by exploring the alignment of the business strategy and digital transformation and testing the moderating role of business strategy in the relationship between enterprise digitalization and government subsidies.

The remainder of our study is structured as follows. In Section 2, we review prior studies and develop two research hypotheses. In Section 3, we describe the data and explain the econometric model we employ. Section 4 contains the descriptive statistics, our main empirical results, and the results of robustness tests. We conclude the paper and provide further discussions in the final section.

2. Literature review and hypotheses development

2.1. Enterprise digitalization and the allocation of government subsidies

Signaling theory was first proposed by economist Michael Spence in Spence, 1973. He points out that signaling can be used to reduce information asymmetries between signal senders and receivers (Spence, 1973). Signaling refers to the process through which one entity conveys important information to induce the other to make a suitable choice (Spence, 1973). The entity sending the information (signal) is defined as the signaler and the entity to whom the signal is sent is referred to as the receiver (Connelly et al., 2011). Information asymmetries arise when one party is uncertain about another party's behavioral intentions (Elitzur and Gavious, 2003). Recently, more and more management scholars have applied signaling theory in a broader research context to explain the impacts of information asymmetry (Connelly et al., 2011). In several strategic management studies, researchers point out that strategically important signals are often sent by enterprises (e.g., Basdeo et al., 2006; Zhang and Wiersema, 2009). Because insiders usually have more information than outsiders, they can send signals to outsiders through observable behaviors so that outsiders can make more informed decisions.

Digitalization refers to the frequent use of digital technologies for integrating people, processes, firms, products and services (Coreynen et al., 2017). Previous studies have shown that digital technologies can meaningfully influence firm performance through a variety of channels (e.g., Brynjolfsson and Hitt, 2000, 2003). For example, digital technologies have opened new channels through which individual customers can contribute valuable resources (Afuah and Tucci, 2003; Amit and Zott, 2015) and enabled enterprises to target their customers more accurately (Zott et al., 2011; Pagani, 2013). Moreover, digital technologies can eliminate obstacles in physical space, and cloud platform technology can be used to promote interaction among innovation subjects. Digitalization often involves standardizing business processes to achieve operational excellence (Ross et al., 2017). A key dimension of a firm's digitalization capability is the increased availability of digital data enabled by advances in methods for creating, transferring, storing, and analyzing digital data (Ritter and Pedersen, 2020). Firms actively engaging in digitalization have the potential to reshape and restructure their business processes, enhance their operational efficiency, and thus improve their performance.

Drawing upon signaling theory, we consider enterprises applying for subsidies as the signal senders. The relevant government agencies providing various subsidies or grants are considered as the signal receivers in our paper. There are at least two reasons why a firm's digitalization efforts can be viewed as an informative signal by government agencies. First, enterprises' digitalization efforts often significantly increase their performance and help enhance their core competitiveness (Mithas et al., 2013; Xu et al., 2016). Hence, digitalization can be viewed as an early indicator of potential growth and sustainable innovation capability. Second, as digitalization often leads to meaningful investment in digital technology or smart equipment, a firm's digitalization efforts can be viewed by government decision-makers as a credible signal about its capabilities and confidence in its future growth.

For the relevant government agencies at all levels that award subsidies or tax incentives, there are indeed significant information asymmetries that make it challenging to screen and select enterprises for subsidy allocation (Chen et al., 2020). In order to maximize the effectiveness of government subsidies and encourage enterprises to transform and upgrade smartly, government agencies need to carefully identify the enterprises that have the potential to achieve outstanding performance in terms of their digital transformation (Giebe et al., 2006). The primary goal of enterprise digitalization is to enhance competitiveness and performance rather than obtain subsidies (Eller et al., 2020). We believe that enterprises' meaningful digitalization efforts can be regarded as a credible and positive signal about their future growth and profitability.

These digitalization efforts may include the purchase and use of cloud platforms or smart devices, the construction of open-source innovation platforms, the transformation of smart factories, etc. (Vrana and Singh, 2021). Through a series of digital transformation activities, enterprises can actively convey positive signals to relevant government agencies. Through screening, observing and interpreting the digital transformation activities provided by signal transmitters (Bianchi et al., 2019), these government agencies can better judge their developmental potential and decide whether to grant subsidies accordingly. Therefore, we propose the following hypothesis:

Hypothesis 1. Enterprises' digitalization efforts can help them win more government subsidies.

2.2. The effect of business strategy

Business-level strategies focus on how to obtain and satisfy customers by offering goods and services that meet their needs (Porter, 1989). The typologies of business strategy and the features of each type vary widely among different scholars (Galbraith and Schendel, 1983). For example, Porter (1980) defines three types of generic strategies: cost leadership, differentiation, and focus. One of the best-known strategic typologies—*Defender, Reactor, Analyzer,* and *Prospector*—was proposed by Miles and Snow (1978). Defenders stress cost efficiency, and they are inclined to have a narrow product domain with limited adaptability to risk and uncertainty. By focusing on innovation and changes, Prospectors tend to have a very broad product domain.

Strategic fit is an influential paradigm in the literature on strategic management (e.g., Drazin and Van de Ven, 1985; Venkatraman, 1989; Venkatraman and Camillus, 1984). This paradigm suggests that the interaction between environment and strategy in a dynamic process exerts a positive effect on performance (e.g., Venkatraman and Prescott, 1990; Hughes and Morgan, 2008). Many researchers have pointed out the importance of using the contingency perspective to examine how the match between environment and strategy may affect performance (e.g., Coreynen et al., 2020). Based on the strategic fit and contingency theories, we postulate that corporate-level strategic transformation needs the support of matching business-level strategies.

As an important type of corporate-level transformation that is associated with high levels of risk and uncertainty, enterprise digitalization is influenced by business-level strategies. Enterprises pursuing the *Prospector* strategy are often innovation-oriented. By heavily spending in marketing and R&D, these enterprises more aggressively embrace change and risk, pursue new growth opportunities and seek to expand to new markets (Miles and Snow, 1978). Prospectors are more willing to take risks and make changes to seize new investment opportunities (Lane and Maxfield, 1996). Thus, prospectors can more effectively support the implementation of digital transformation, which often requires risky investments and bold initiatives to achieve superior performance. Consequently, prospectors may strengthen the signaling effect of enterprise digitalization.

Defensive and prospective strategies are located at opposite ends of a continuum of strategies (Miles and Snow, 1978; Shortell and Zajac, 1990). The *Defender* strategy mainly focuses on cost minimization and risk reduction and seeks to acquire a competitive advantage by improving production and distribution efficiencies while reducing R&D and marketing expenses. Enterprises pursuing the *Defender* strategy are often cautious about new investments due to investment irreversibility and other external uncertainties. Hence, defenders may face difficulties in quickly adapting to the significant changes brought by digitalization and, as a result, are often less capable of successfully digitally transforming. Therefore, the *Defender* strategy may weaken the signaling effect of digitalization. It is worth noting that the *Analyzer* strategy is located somewhere between the above two types of strategies. Analyzers behave like defenders in more stable areas and like prospectors in more turbulent areas. Therefore, our hypotheses do not cover the *Analyzer* strategy.

At present, the main forms of subsidies in China include financial discounts, R&D subsidies and government grants. In order to maximize the benefits of subsidies, the relevant government agencies have specific preferences for subsidy recipients. Boeing (2016) finds that government agencies tend to choose enterprises with better equipment and thus a more promising future. Cantner and Kösters (2012) argue that policymakers and program officials pay close attention to enterprises' capabilities to contribute to employment growth and positive structural change. As enterprises pursuing a *Prospector* strategy are generally more proactive and growth-oriented, their digitalization efforts may send a more convincing signal to the relevant government agencies. Therefore, we propose:

Hypothesis 2. When enterprises pursue a Prospector strategy, the signaling effect of enterprise digitalization on subsidy allocation will be strengthened.

Hypothesis 3. When enterprises pursue a Defender strategy, the signaling effect of enterprise digitalization on subsidy allocation will be weakened.

3. Research methods

3.1. Data

We first identified 145 Chinese enterprises (listed on the Shenzhen Stock Exchange or the Shanghai Stock Exchange) that made meaningful digitalization efforts from 2013 to 2018. The financial data of these listed enterprises during 2013–2018 are collected from annual financial reports obtained from the WIND and China Stock Market and Accounting Research (CSMAR) databases. After screening for missing values, we obtained 798 firm-year observations of 133 firms listed from 2013 to 2018. The score of independent variables is based on a context-dependent analysis of annual financial reports and other major corporate announcements.

China's digital economy has surged over the past decade and, as a result, generated many benefits, including increased product sales, product value creation and productivity improvement, to enterprises in various industries. In addition, with the launch of the "Internet Plus" strategy at the national level, more and more traditional enterprises have begun to make strategic investments in digital transformation to facilitate enterprise digitalization. Our dataset excludes several industries according to the following criteria. First, we exclude any enterprises belonging to the software, information technology or Internet industries as they are an inherent part of the digital economy. Accordingly, the main business and operational behaviors of these enterprises naturally exhibit a high degree of digitalization. Consequently, firms in these industries tend to have much higher values for the independent variables included in this study than those in other industries. It is challenging to distinguish exactly the degree to which the results are explained by such firms' inherently digitalized business models and, alternatively, by digital transformation. Second, given the uniqueness of the financial industry, which has strict government supervision and regulations, we also exclude financial enterprises from our analysis. Third, we exclude several listed companies with missing data. After these exclusions, there are 133 enterprises included in our final dataset.

3.2. Measures

In this paper, the dependent variable is government subsidies. The number of digitalization practices *(Innumber)* is the independent variable. The moderator variable (*Strategy*) is the type of business-level strategy the enterprise pursues. In addition, our study also considers certain control variables that will be discussed later in this section.

(1) Government subsidies

According to the Chinese accounting regulations, all publicly listed firms must report the amount of government subsidies received as a separate item on their income statements. We measure government subsidies as the total amount of subsidies that an enterprise receives from the government during one fiscal year.

(2) Enterprise digitalization

Digitalization is still at an early stage in many Chinese enterprises (Wang et al., 2020). There is no separate and specific disclosure of digitalization-related investments in enterprises' financial reports, and a rigorous and comprehensive measurement of enterprise digitalization has not been developed. Content analysis of firms' annual financial reports is typically used to quantitatively study the activities of enterprises (Fiss and Zajac, 2006). Thus, it is used in this study. In this paper, the characterization of enterprise digitalization is based on the frequency of digitalization practices *(Innumber*). Therefore, digitalization is measured using both context-dependent and word count methods.

Regularly published annual reports are intended to reflect changes in business activities and contain information that reflects enterprises' operating conditions, as required by the Securities Regulatory Commission (Eggers and Kaplan, 2009; Abrahamson and Park, 1994). They not only expound on the direction of the business and its developmental issues, but also discuss its important strategic intentions (Cho and Hambrick, 2006; D'Aveni and Macmillan, 1990). In this study, annual reports are considered to be the appropriate vehicle through which to examine digitalization efforts and behavior.

Content analysis is an objective, systematic and quantitative description of communication content (Krippendorff, 2018). Our study uses contextual (Bryman, 2006) and keyword count (Ritala et al., 2018) methods to analyze corporate annual reports. We conduct a manual analysis of a large number of annual reports and identify highly relevant keywords to measure enterprise digitalization. The vocabulary related to digitalization behavior and efforts is preliminarily determined based on the definitions and the dimensions of enterprise digitalization in the extant literature.

The Delphi Technique is a method for obtaining judgments, assessments and forecasts from a panel of independent experts (Rowe and Wright, 2001). Because panel members do not meet directly but rather communicate by letters, this technique eliminates the influence of authority by allowing members to anonymously express their opinions (Andrew et al., 2020; Gupta and Clarke, 1996). After repeated consultation and modification, researchers can form a consistent view as the result of the final judgment (Diamond et al., 2014). In this study, the digitalization-related keywords we initially obtained were distributed to several experts. After several rounds of revisions, 52 highly relevant keywords are finally determined and reported in Table 1. In our study, *Innunber* is used to represent the frequency of keyword occurrence in the annual reports. We also categorize the keywords into three types, including digital technology (*Technology*), digital business process *(Process)* and digital organization (*Organization*), as shown in Table 1.

(3) Moderating variable

Using business strategy type as the moderating variable, we follow Bentley et al. (2013) and Higgins et al. (2015) in measuring different types of business strategy. We analyze business strategies from six dimensions: (1) the ability to find new products by the ratio of R&D expenditures to operating income; (2) the efficiency of producing and delivering products and services by the ratio of the number of employees to operating income; (3) historical growth and investment opportunities by the growth rate of operating income; (4) the development concentration of new products and services by the ratio of sales and management expenses to operating income; (5) organizational stability by the turnover rate of employees; and (6) the degree of technical efficiency by the ratio of fixed to total assets.

Table 1
Keywords related to enterprise digitization.

Digital technology	Digital business process	Digital organization
Cloud platform	Intelligent manufacturing	Open organization
Perceptive technology	Wisdom manufacturing	Digital strategy
Cloud computing	Automatization	Organizational restructuring
IT system support	Order management	Intelligentialize
Big data	Customer value	Intelligent enterprise
Cyber-Physical Systems (CPS)	Cloud manufacturing	Machine learning
Ubiquitous network	Human-computer interaction	Informatization
Information physical system	Customer core requirements	Digital initiatives
Global Positioning System (GPS)	Advanced process control (APC)	Organizational process automation
Computer aided engineering software	Information security	Online to Offline
Data warehouse	Proactive manufacturing	Data-driven decision making
Application (APP)	Statistical process control (SPC)	Digitization
Internet/Internet Plus	Supplier collaboration platform	Digital transformation
Virtual simulation testing technology	Business collaboration portal	Strategic position
Artificial intelligence (AI)	Internet of things	
Virtual reality technology (VR)	Digital marketing	
Wearable device	Data visualization	
Robot		
Mobile devices		
3D printing technology		

For the above six indicators, we sort the indicators from small to large according to “industry-year” and divide them into five groups. For variables (1) to (5), we assign 1 point to the smallest group, 2 points to the second group, and so on. For variable (6), the minimum group is assigned 5 points, the second group is assigned 4 points, and so on. Finally, the total scores of the six dimensions of each company are calculated to obtain a score in the range of 6–30 points. A score between 6 and 12 is classified as a *Defender Strategy*, a score between 13 and 23 is classified as an *Analyzer Strategy*, and a score between 24 and 30 is classified as a *Prospector Strategy*.

(4) Control variables

Previous studies have identified many factors that may influence the effects of enterprise digitalization on government subsidies. For example, enterprise size is correlated to government subsidies, which mainly include the number of employees, profits, total assets, and fixed assets. In addition, the return on assets, debt-to-asset ratio, and regional government subsidies will also have an impact on government subsidies. Thus, the number of employees (*Labor*), total profits (*Profit)*, debt-to-asset ratio (*Debt*), fixed assets (*Asset*) and regional expenditures on science and technology *(Est)* are included in our analysis as control variables.

3.3. Econometric model

We first examine the impact of enterprise digitalization on the amount of government subsidies received. The amount of government subsidies is the explained variable. The frequency of the relevant keywords on enterprise digitalization (*Innumber*) is the explanatory variable. To account for the lag effect, the explanatory variable is lagged by one period. Thus, we propose the following model:

where i represents the enterprise, c_i represents the firm effect, t

$$Subsidy_{it} = c_i + \alpha_1\ Innumber_{it-1} + \alpha_2\ Est_{it} + \alpha_3\ Labor_{it} + \alpha_4\ Profit_{it+1} + \alpha_5\ Debt_{it} + \alpha_6\ Asset_{it} + \varepsilon_{it} \tag{1}$$

represents the time period, and ε_{it} is the error term.

In addition, the relationship between enterprise digitalization and government subsidies may be influenced by the business strategy type. Therefore, based on Model 1, we add the business strategy type and its interaction with the degree of enterprise digitalization, thereby resulting the following model:

$$Subsidy_{it} = c_i + \alpha_1\ Innumber_{it-1} + \alpha_2\ Est_{it} + \alpha_3\ Labor_{it} + \alpha_4\ Profit_{it+1} + \alpha_5\ Debt_{it} + \alpha_6\ Asset_{it} + \alpha_9\ Strategy_{it} + \alpha_{10}\ Strategy_{it}{*}Innumber_{it-1} + \varepsilon_{it} \tag{2}$$

where $Strategy_{it}$ is a dummy for the business strategy type, $Strategy_{it}*Innumber_{it-1}$ represents one of the two interaction terms of $Strategy_{it}$ with $Innumber_{it-1}$ (i.e., *Defensive* × $Innumber_{it-1}$, or the interaction term of $Innumber_{it-1}$ with a dummy for defensive firms, and *Prospective* × $Innumber_{it-1}$, or the interaction term of $Innumber_{it-1}$ with a dummy for prospective firms). In addition, i represents the enterprise, c_i represents the firm effect, t represents the time period, and ε_{it} is the error term.

The statistical software used in this article is Stata15.0. First, we carry out the Hausman test. The results of the Hausman test ($p = 0.000$) show that the fixed effects regression model is a suitable model for our study. Second, we conduct a Wald test for joint significance of the year dummy variables, and the result is not significant (see Appendices 2 and 3). Therefore, we finally select the one-way fixed effects model in this paper and use the robust standard errors.

4. Empirical results

4.1. Descriptive statistics and correlation analysis

The descriptive statistics and correlation analysis for the dependent variable, independent variables, moderating variable and control variables are reported in Tables 2 and 3. Table 2 indicates that there are large differences in the allocation of government subsidies, and the enterprises in our dataset exhibit significant differences in their degree of digitalization. From Fig. 1, it can be seen that enterprise digitalization has gained traction over time. Table 3 shows the correlation matrix for our variables, where the correlation coefficients are relatively small. It is therefore reasonable to assume that there are no collinearity problems in our model. We divide all enterprises into 38 categories of industries according to the *Industrial classification for national economic activities*, as shown in Appendix 1.

Table 2
Descriptive statistics.

Variables	Mean	S.D.	Min	Median	Max
Subsidy	6.930	23.03	0.00210	1.019	425.7
Innumber	14.46	20.50	0	9	177
Technology	4.763	7.582	0	3	84
Process	6.393	8.729	0	4	64
Organization	3.306	4.810	0	2	50
Debt	0.393	0.199	0.0525	0.359	0.965
Labor	14,199	44,949	102	1586	302,827
Profit	149.3	571.0	−554.7	16.59	7179
Asset	582.9	1752	0.233	50.38	21,126
Est	265.6	214.5	4.170	260.0	1035

Note: the unit of Subsidy, Debt, Profit, Asset is ten million yuan, the unit of Number is a thousand. The unit of Est is 100 million yuan.

4.2. Regression analysis

The results of our regression analysis are shown in Tables 4 and 5. Column 1 of Table 4 and columns 1, 4 and 7 of contains the results of the fixed effects model. The independent variable in column 1 of Table 4 and columns 1, 4 and 7 of Table 5, respectively, refer to *Innumber*, *Technology, Process and Organization*. Columns 2 and 3 of Table 4 and columns 2, 3, 5, 6, 7 and 8 of Table 5 show all main and moderating effects of business strategy type and enterprise digitalization. The results shown in column 1 of Table 4 and columns 1, 4 and 7 of Table 5 suggest that there is a positive relationship between implementation of digitalization (*Innumber*) and government subsidies ($\alpha = 0.068$, $p < 0.01$), a positive relationship between the utilization of digital technology (*Technology*) and government subsidies ($\alpha = 0.068$, $p < 0.01$), a positive relationship between the digitalization of business processes (*Process*) and government subsidies ($\alpha = 0.076$, $p < 0.01$), and a positive relationship between being a digital organization (*Organization*) and government subsidies ($\alpha = 0.050$, $p < 0.01$). From the magnitude of these relationships, it can be seen that each unit increase in the three independent variables is associated with 5 % to 7.6 % increases in subsidies. Among them, the positive relationship between digitalization of business processes (*Process*) and government subsidies is the strongest. Therefore, *H1* is supported.

Previous studies on digital technology have indicated that digitalization has a positive impact on the business activities of enterprises (e.g., Autio, 2017; Nambisan et al., 2018). In particular, digital technology has promoted the creation of new business models (Fichman et al., 2014; Berman and Bell, 2011), and played a significant role in improving performance (Mithas et al., 2013). The four fundamental properties of digital technologies (i.e., editability, malleability, openness and relevance) (Briel et al., 2018; Garud et al., 2008) allow them to evolve continuously after use and to generate new forms of agency. Specifically, editability allows digital content to be recombined with data from other devices, thus separating media devices from digital content (Huang et al., 2017). The expandability of digital technologies can help enterprises to more accurately identify resources and their potential sources (Nambisan, 2017). Openness can reduce asymmetries in market information and enhance transparency between enterprises (Smith et al., 2017; Nambisan et al., 2018). Owing to the relevance of digital technologies, enterprises can broaden the scope of their resource acquisition, which is conducive to their sustainable development (Briel et al., 2018). The novelty of business ideas can increase the likelihood of government subsidies (Cantner and Kösters, 2012). Thus, digitalization enables enterprises to obtain more information and resources, introduce new products, identify market opportunities, and increase their operating capacity. Thus, enterprise digitalization can send the government a positive signal to suggest that the enterprise has strong profitability and capacity for growth.

As shown by column 3 in Table 4 and columns 3, 6 and 9 in Table 5, the moderating effects are highly significant for the impact of government subsidies. In order to test the moderating effect of the defensive

Table 3
Correlation matrix.

	Subsidy	Innumber	Debt	Profit	Labor	Asset	Est
Subsidy	1						
Innumber	0.053**	1					
Debt	0.240***	0.004*	1				
Profit	0.275***	0.024	0.410***	1			
Labor	0.302***	−0.015	0.509***	0.833***	1		
Asset	0.354***	−0.009	0.518***	0.490***	0.565***	1	
Est	−0.005	0.146***	−0.012	−0.002	−0.034	−0.02	1

Note.
*** $p < 0.01$.
** $p < 0.05$.
* $p < 0.1$.

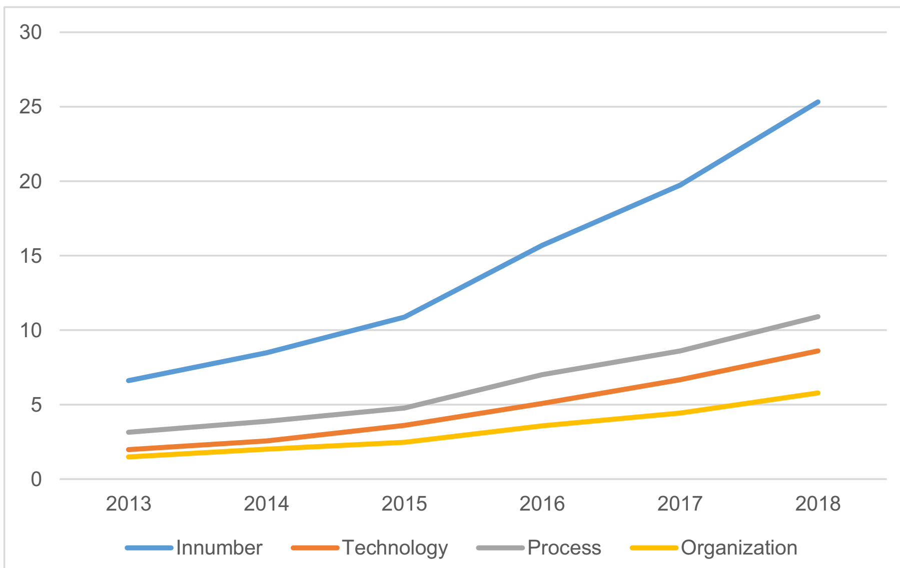

Fig. 1. Enterprise digitalization during 2013–2018.

and prospective strategies, we add the interaction term between the two strategy types and digitalization. As expected, the results show that the *Defender* strategy has a significant negative moderating effect on the frequency of digitalization practices (*Innumber*) and government subsidies ($\alpha = -0.115$, $p < 0.05$), and the *Prospector* strategy may have a positive moderating effect on the above relations ($\alpha = 0.143$, $p < 0.1$). Similarly, the *Defender* strategy also has a significant negative moderating effect on the utilization of digital technology *(Technology)* and government subsidies ($\alpha = -0.104$, $p < 0.05$), and the *Prospector* strategy have a positive moderating effect on the above relations ($\alpha = 0.190$, $p < 0.05$). Moreover, the *Defender* strategy has a significant negative moderating effect on the digitalization of business processes (*Process)* and government subsidies ($\alpha = -0.107$, $p < 0.05$), and the *Prospector* strategy may have a positive moderating effect on the above relations, but it is not significant ($\alpha = 0.111$, $p < 0.1$); the *Defender* strategy also has a significant negative moderating effect on being a digital organization *(Organization)* and government subsidies ($\alpha = -0.132$, $p < 0.05$), and the *Prospector* strategy have a positive moderating effect on the above relations ($\alpha = 0.174$, $p < 0.05$).

Furthermore, we calculate the marginal effect for different values using the delta method. We summarize the interaction effects between the *Prospector* and *Defender* strategies and enterprise digitalization in Tables 6 and 7, respectively. The marginal effect suggests that the signaling effect of digitalization efforts on subsidy allocation varies by strategy type. That is, as shown in Table 6, the relationship between enterprise digitalization and subsidies is less positive in cases defined by the *Defender* strategy. When the *Defender* strategy is implemented, the marginal effect of digitalization on subsidies is 0.022 ($p < 0.05$); otherwise, the marginal effect is 0.136 ($p < 0.01$). We find the opposite pattern in the interaction effect of the *Prospector* strategy and enterprise digitalization. Table 7 shows that the relationship between enterprise digitalization and subsidies is more positive in cases defined by the *Prospector* strategy. When the *Prospector* strategy is implemented, the marginal effect of digitalization on subsidies is 0.174 ($p < 0.05$); otherwise, the marginal effect is 0.031 ($p < 0.05$). In addition, we also conduct a Wald test of joint significance on the interaction term and the two other variables that underlie the interaction term (shown in the Appendix 4). And we find the p-value is under 0.01. Thus, H2 and H3 are both supported in this study.

For enterprises that adopt a defensive strategy, the positive impact of enterprise digitalization on government subsidy allocation will weaken, whereas for enterprises mainly adopting a prospective business strategy, the positive impact of enterprise digitalization on government subsidy allocation will strengthen. Overall, these findings are in accordance with those reported previously. Many previous studies have demonstrated the significant positive impact of organizational risk-taking and entrepreneurial culture on firms' innovation performance (e.g., Giaccone and Magnusson, 2022; Laforet, 2016). Consistent with these observations, our results suggest that, compared with the *Defender* strategy, the *Prospector* strategy, which often requires proactivity and risk-taking, is more suitable for enterprise digitalization. Furthermore, these findings support the notion that governmental agencies are more likely to award

Table 4
The regression results of *Innumber* on Government Subsidies.

	(1)	(2)	(3)
Variables	Subsidy	Subsidy	Subsidy
Innumber	0.068***	0.136***	0.031**
	(3.385)	(2.898)	(2.235)
Defensive		−0.036	
		(−0.685)	
Innumber*Defensive		−0.115**	
		(−2.353)	
Prospective			0.107
			(1.289)
Innumber*Prospective			0.143*
			(1.785)
Debt	−0.031	−0.034	−0.035
	(−0.940)	(−1.022)	(−1.031)
Profit	−0.059	−0.059	−0.056
	(−0.447)	(−0.445)	(−0.421)
Labor	−0.323	−0.322	−0.323
	(−1.475)	(−1.476)	(−1.481)
Asset	0.562	0.565	0.569
	(1.527)	(1.534)	(1.541)
Est	−0.022	−0.041	−0.034
	(−0.940)	(−1.542)	(−1.332)
Constant	−0.190***	−0.159***	−0.244***
	(−4.199)	(−2.961)	(−3.916)
Firm effects	Yes	Yes	Yes
R-squared	0.810	0.811	0.811
Obs.	563	563	563

Note: Robust t-statistics in parentheses.
*** $p < 0.01$.
** $p < 0.05$.
* $p < 0.1$.

subsidies to firms with bold and innovative ideas and outstanding innovation performance (e.g., Boeing, 2016; Cantner and Kösters, 2012).

4.3. Robustness test

To test the sensitivity of the empirical findings, we carry out a robustness test to further assess our empirical results. The results are displayed in Table 8.

5. Conclusions and discussion

Based on signaling theory and the strategic fit paradigm (e.g., Lukas et al., 2001; Zajac et al., 2000; Waterman, 1982; Chorn, 1991; Prajogo, 2016), our study explores the relationship between enterprise digitalization and government subsidies and examines the moderating effect of business strategy on that relationship. Our empirical analysis yields the following two results. First, enterprise digitalization can lead to the allocation of more government subsidies. This result is consistent with the government's motivation to provide subsidies to enterprises from high-tech industries and strategic emerging industries (Spencer et al., 2005; Wu and Liu Cheng, 2011). While few scholars have investigated the relationship between enterprise digitalization and government subsidies, many previous studies have confirmed that enterprises can obtain government subsidies more easily if they continue to innovate and transform by leveraging digital technologies. Moreover, previous studies have shown that subsidies are often granted to firms with innovative business ideas, especially academic spin-offs (Cantner and Kösters, 2012), highly productive firms within a given industry (Busom et al., 2017), and young, growing and productive firms with strong cash flows (Decramer and Vanormelingen, 2016). Our study contributes to this stream of literature by examining the determinants of government subsidies and their influence on firms' behavior (i.e., enterprise digitalization). Our findings suggest that enterprise digitalization can send positive signals to relevant government agencies, which is consistent with the basic logic of signaling theory.

Second, the choice of business strategy exerts a significant moderating effect on the signaling effect of enterprise digitalization on subsidy allocation. Previous studies have mainly focused on the effect of business strategy types on organizational performance (e.g., Slater et al., 2011; Vorhies and Morgan, 2003) or innovative practices (e.g., Blumentritt and Danis, 2006; Teece, 2010). Our study highlights the potential of examining the effect of business strategy types through the lens of signaling theory. By integrating signaling theory in this study, we essentially view the choice of business strategy as a key internal contextual factor. Specifically, we find that the *Defender* strategy weakens the signaling effect, while the *Prospector* strategy strengthens it. This result is consistent with the observed differences in innovation performance between conservative and entrepreneurial firms (Miller and Friesen, 1982; Baker et al., 2016). Moreover, this moderating effect is consistent with the positive effect of entrepreneurial orientation on innovation performance (e.g., Madhoushi et al., 2011; Wu et al., 2008). It is also worth noting that while many previous studies focus on exploring internal structure–strategy fit and external environment–strategy fit (e.g., Chen and Wu, 2011), very few of them have explored the alignment of digitalization with business strategy. Thus, our study contributes to the extant literature by examining the signaling effect of enterprise digitalization through the lens of the strategic fit paradigm and contingency theory.

This study has several limitations. First, we only obtain the panel dataset from 2013 to 2018, which is a relatively short time period. Consequently, we cannot explore the long-term effects and observe the changes in firms' digitalization over a longer time period. We will attempt to investigate the long-term effect of enterprise digitalization on subsidy allocation in the future. In addition, our dataset only includes publicly traded companies, of which most are large companies with solid performance. In the future, we will attempt to explore the effect of digitalization on subsidy allocation by choosing non-listed firms, especially small and medium-sized firms. Second, we only use the accounting value of subsidies, which does not necessarily reflect the actual subsidy value in certain situations. Thus, we will seek to improve the measurement quality of the subsidy variable in future studies. Third, based on the content analysis, we use the frequencies of the words and phrases related to digitalization to measure enterprises' digitalization practices. With the evolution of and advances in enterprises' digital transformation, we expect to be able to find more suitable indices and data with which to measure enterprises' digitalization efforts.

There are several research directions that merit further exploration. Future studies can classify subsidies into government subsidies afterwards (GSA) and government subsidies beforehand (GSB) or choose a specific type of subsidy to investigate the signaling effect on enterprise digitalization. In addition, we can identify different characteristics of different stages of enterprise digitalization and explore the signaling effect of different digital transformation stages on subsidy allocation. Finally, other dynamic panel data models can be used to test the relations examined in this study.

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CRediT authorship contribution statement

Feifei Yu & Hong yan Du: Conceptualization, Methodology, Writing- Original draft preparation; Writing- Reviewing and Editing.

Xiaotong Li: Writing- Original draft preparation; Writing- Reviewing and Editing.

Jiayu Cao: Methodology, Writing- Original draft preparation.

Table 5
The regression results of *Technology, Process and Organization* on Government Subsidies.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Variables	Subsidy	Subsidy	Subsidy	Subsidy	Subsidy	Subsidy	Subsidy	Subsidy	Subsidy
Technology	0.068***	0.128***	0.032***						
	(3.446)	(2.860)	(1.902)						
Defensive		−0.017							
		(−0.338)							
Technology*Defensive		−0.104**							
		(−2.238)							
Prospective			0.117						
			(1.363)						
Technology*Prospective			0.190**						
			(1.895)						
Process				0.076***	0.130***	0.035**			
				(3.248)	(2.767)	(2.345)			
Defensive					−0.038				
					(−0.733)				
Process*Defensive					−0.107**				
					(−2.194)				
Prospective						0.097			
						(1.213)			
Process*Prospective						0.111*			
						(1.630)			
Organization							0.050***	0.149***	0.025**
							(3.317)	(2.899)	(2.427)
Defensive								−0.040	
								(−0.725)	
Organization*Defensive								−0.132***	
								(−2.494)	
Prospective									0.115
									(1.301)
Organization*Prospective									0.174**
									(1.881)
Debt	−0.032	−0.035	−0.036	−0.030	−0.034	−0.035	−0.032	−0.034	−0.035
	(−0.962)	(−1.039)	(−1.044)	(−0.927)	(−1.010)	(−1.022)	(−0.962)	(−1.027)	(−1.037)
Profit	−0.060	−0.060	−0.055	−0.059	−0.058	−0.056	−0.060	−0.059	−0.056
	(−0.452)	(−0.453)	(−0.417)	(−0.442)	(−0.437)	(−0.422)	(−0.449)	(−0.447)	(−0.421)
Labor	−0.322	−0.321	−0.323	−0.323	−0.323	−0.324	−0.322	−0.322	−0.323
	(−1.472)	(−1.471)	(−1.480)	(−1.478)	(−1.480)	(−1.482)	(−1.473)	(−1.473)	(−1.479)
Asset	0.561	0.562	0.568	0.563	0.566	0.569	0.562	0.565	0.570
	(1.524)	(1.527)	(1.540)	(1.531)	(1.538)	(1.542)	(1.526)	(1.535)	(1.543)
Est	−0.019	−0.033	−0.035	−0.028	−0.044	−0.034	−0.012	−0.038	−0.030
	(−0.837)	(−1.318)	(−1.386)	(−1.143)	(−1.583)	(−1.333)	(−0.546)	(−1.437)	(−1.190)
Constant	−0.195***	−0.173***	−0.250***	−0.183***	−0.156***	−0.242***	−0.197***	−0.152***	−0.239***
	(−4.396)	(−3.455)	(−3.981)	(−3.934)	(−2.856)	(−3.869)	(−4.462)	(−2.773)	(−3.883)
Firm effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.810	0.810	0.811	0.810	0.811	0.811	0.809	0.810	0.811
Obs.	563	563	563	563	563	563	563	563	563

Note: Robust t-statistics in parentheses.
*** $p < 0.01$.
** $p < 0.05$.
* $p < 0.1$.

Table 6
The moderating effect of defensive strategy on the marginal effect of enterprise digitalization on the subsidy allocation.

	Marginal effect			
Moderator	Innumber*	Technology	Process	Organization
Implementing	0.022**	0.023**	0.023**	0.018**
Defensive strategy	(2.19)	(2.18)	(2.10)	(2.19)
Not implementing	0.136***	0.128***	0.130***	0.149***
	(2.90)	(2.86)	(2.77)	(2.90)

Note: Robust t-statistics in parentheses.
*** $p < 0.01$.
** $p < 0.05$.
* $p < 0.1$.

Table 7
The moderating effect of prospective strategy on the marginal effect of enterprise digitalization on the subsidy allocation.

	Marginal effect			
Moderator	Innumber	Technology	Process	Organization***
Implementing	0.174**	0.222**	0.146**	0.199**
Prospective strategy	(2.28)	(2.33)	(2.26)	(2.21)
Not implementing	0.031**	0.032*	0.035**	0.025**
	(2.24)	(1.90)	(2.35)	(2.43)

Note: Robust t-statistics in parentheses.
*** $p < 0.01$.
** $p < 0.05$.
* $p < 0.1$.

Table 8
Results of robustness test.

	(1)	(2)	(3)
Variables	Subsidy	Subsidy	Subsidy
Innumber	0.041***	0.076***	0.028***
	(3.633)	(2.732)	(3.570)
Defensive		−0.011	
		(−0.358)	
Innumber*Defensive		−0.053*	
		(−1.918)	
Prospective			0.026**
			(0.760)
Innumber*Prospective			0.060*
			(1.902)
Debt	0.025	0.021	0.022
	(1.359)	(1.185)	(1.197)
Profit	0.058	0.059	0.059
	(0.850)	(0.856)	(0.867)
Labor	−0.097	−0.093	−0.098
	(−0.345)	(−0.333)	(−0.352)
Asset	0.111	0.112	0.118
	(0.424)	(0.428)	(0.453)
Est	−0.004	−0.012	−0.009
	(−0.328)	(−0.870)	(−0.650)
Constant	−0.243***	−0.226***	−0.245***
	(−8.757)	(−7.323)	(−7.856)
Firm effects	Yes	Yes	Yes
R-squared	0.939	0.939	0.939
Observations	380	380	380

Note: Robust t-statistics in parentheses.
*** $p < 0.01$.
** $p < 0.05$.
* $p < 0.1$.

Declaration of competing interest

None.

Data availability

Data will be made available on request.

Appendix 1. Classification of the sample enterprises

Industry	Number	Province	Number
Production and distribution of electric power and heat power	1	AnHui	3
Manufacture of electrical machinery and equipment	8	BeiJing	26
Manufacture of textiles, clothing; apparel industry	2	ChongQing	3
Manufacture of textiles	1	FuJian	4
Manufacture of non-metallic mineral products	5	GanSu	4
Management of public facilities	1	GuangDong	18
Radio, television, film and television recording production	5	GuangXi	1
Air transport	1	HaiNan	1
Mining and processing of ferrous metal ores	1	HeBei	3
Manufacture of chemical raw materials and chemical products	14	HeiLongJiang	3
Manufacture of furniture	1	HeNan	2
Manufacture of metal products	1	HuBei	1
Manufacture of alcohol, beverages and refined tea	2	HuNan	7
Retail trade	2	JiangSu	12
Production and distribution of gas	3	LiaoNing	2
Mining and washing of coal	3	QingHai	1
Farming	1	ShanDong	5
Wholesale trade	1	ShangHai	5
Manufacture of leather, fur, feather and related products; footwear industry	1	Shannxi	3
Mining of other ores	1	ShanXi	1
Other services	2	SiChuan	1
Other manufacturing	2	TianJin	4
Extraction of petroleum and natural gas	1	XinJiang	2
Manufacture of foods	1	XiZang	1
Production and distribution of tap water	1	YunNan	1
Water transport	2	ZheJiang	19
Manufacture of railway, ships, aerospace and other transportation equipment	9		
Manufacture of general purpose machinery	9		
Civil engineering	9		
Culture and arts	2		

(continued on next page)

(*continued*)

Industry	Number	Province	Number
Manufacture of rubber and plastics	1		
News and publishing	4		
Manufacture of medicines	8		
Manufacture of measuring instrument	3		
Smelting and processing of non-ferrous metals	1		
Metal products, machinery and equipment repair services	7		
Manufacture of special purpose machinery	15		
Leasing	1		
Total	133		133

Appendix 2. Wald test for joint significance of the Year dummy variables (Innumber on Government Subsidies)

	(1)	(2)	(3)
Variables	Subsidy	Subsidy	Subsidy
Innumber	0.092***	0.167***	0.054**
	(3.025)	(2.981)	(2.585)
Defensive		−0.026	
		(−0.336)	
Innumber*Defensive		−0.125**	
		(−2.388)	
Prospective			0.058
			(0.548)
Innumber*Prospective			0.148*
			(1.852)
Debt	−0.022	−0.025	−0.026
	(−0.667)	(−0.762)	(−0.763)
Profit	−0.058	−0.058	−0.054
	(−0.444)	(−0.441)	(−0.416)
Labor	−0.325	−0.325	−0.326
	(−1.495)	(−1.496)	(−1.502)
Asset	0.569	0.571	0.576
	(1.550)	(1.558)	(1.565)
Est	0.037	0.021	0.024
	(0.978)	(0.560)	(0.658)
Firm effects	Yes	Yes	Yes
Year2015	0.076	0.075	0.081
	(1.016)	(1.014)	(1.077)
Year2016	0.001	−0.000	0.013
	(0.009)	(−0.004)	(0.173)
Year2017	−0.123	−0.125	−0.115
	(−1.212)	(−1.235)	(−1.161)
Year2018	−0.116	−0.126	−0.114
	(−1.327)	(−1.434)	(−1.322)
Constant	−0.132	−0.094	−0.141
	(−1.527)	(−0.979)	(−1.204)
Wald test	0.81	0.87	0.83
p-value	0.518	0.480	0.506
R-squared	0.813	0.814	0.814
Obs.	563	563	563

Note:Robust t-statistics in parentheses.
*** $p < 0.01$.
** $p < 0.05$.
* $p < 0.1$.

Appendix 3. Wald test for joint significance of the Year dummy variables (Technology, Process and Organization on Government Subsidies)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Variables	Subsidy	Subsidy	Subsidy	Subsidy	Subsidy	Subsidy	Subsidy	Subsidy	Subsidy
Technology	0.094***	0.159***	0.056***						
	(3.105)	(2.884)	(2.634)						
Defensive		−0.008							
		(−0.112)							
Technology*Defensive		−0.113**							
		(−2.223)							
Prospective			0.071						
			(0.664)						
Technology*Prospective			0.201**						

(continued on next page)

(*continued*)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Variables	Subsidy	Subsidy	Subsidy	Subsidy	Subsidy	Subsidy	Subsidy	Subsidy	Subsidy
			(1.986)						
Process				0.100***	0.157***	0.059**			
				(2.997)	(2.867)	(2.52)			
Defensive					−0.024				
					(−0.300)				
Process*Defensive					−0.112**				
					(−2.165)				
Prospective						0.046			
						(0.441)			
Process*Prospective						0.110*			
						(1.630)			
Organization							0.070***	0.186***	0.044**
							(2.868)	(3.045)	(2.502)
Defensive								−0.033	
								(−0.426)	
Organization*Defensive								−0.152***	
								(−2.631)	
Prospective									0.068
									(0.601)
Organization*Prospective									0.188**
									(2.034)
Debt	−0.023	−0.026	−0.026	−0.021	−0.025	−0.025	−0.023	−0.026	−0.026
	(−0.697)	(−0.789)	(−0.782)	(−0.648)	(−0.740)	(−0.749)	(−0.697)	(−0.780)	(−0.775)
Profit	−0.059	−0.059	−0.054	−0.057	−0.056	−0.054	−0.059	−0.058	−0.054
	(−0.450)	(−0.450)	(−0.413)	(−0.438)	(−0.432)	(−0.418)	(−0.447)	(−0.444)	(−0.416)
Labor	−0.324	−0.324	−0.325	−0.326	−0.326	−0.326	−0.325	−0.324	−0.326
	(−1.492)	(−1.490)	(−1.501)	(−1.499)	(−1.501)	(−1.503)	(−1.492)	(−1.493)	(−1.500)
Asset	0.567	0.568	0.575	0.570	0.573	0.576	0.569	0.573	0.577
	(1.545)	(1.549)	(1.564)	(1.555)	(1.563)	(1.566)	(1.547)	(1.559)	(1.567)
Est	0.040	0.029	0.024	0.031	0.016	0.023	0.045	0.024	0.028
	(1.040)	(0.774)	(0.656)	(0.846)	(0.434)	(0.627)	(1.138)	(0.662)	(0.751)
Constant	−0.138	−0.110	−0.147	−0.125	−0.097	−0.139	−0.145*	−0.082	−0.137
	(−1.627)	(−1.202)	(−1.289)	(−1.420)	(−1.012)	(−1.191)	(−1.737)	(−0.828)	(−1.132)
Firm effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year2015	0.075	0.074	0.081	0.077	0.079	0.082	0.075	0.071	0.080
	(1.011)	(1.002)	(1.078)	(1.037)	(1.055)	(1.088)	(1.006)	(0.954)	(1.060)
Year2016	−0.004	−0.006	0.010	0.005	0.006	0.014	0.003	−0.002	0.014
	(−0.048)	(−0.078)	(0.132)	(0.061)	(0.082)	(0.198)	(0.037)	(−0.022)	(0.192)
Year2017	−0.123	−0.125	−0.117	−0.122	−0.120	−0.114	−0.117	−0.127	−0.114
	(−1.216)	(−1.233)	(−1.176)	(−1.208)	(−1.199)	(−1.150)	(−1.162)	(−1.251)	(−1.142)
Year2018	−0.115	−0.125	−0.117	−0.117	−0.121	−0.112	−0.106	−0.129	−0.111
	(−1.329)	(−1.421)	(−1.353)	(−1.340)	(−1.385)	(−1.302)	(−1.230)	(−1.446)	(−1.290)
Wald test	0.82	0.87	0.8	0.82	0.85	0.82	0.76	0.87	0.81
p-value	0.513	0.482	0.493	0.513	0.492	0.512	0.552	0.484	0.520
R-squared	0.813	0.813	0.814	0.813	0.814	0.814	0.812	0.814	0.814
Obs.	563	563	563	563	563	563	563	563	563

Note: Robust t-statistics in parentheses.

*** $p < 0.01$.

** $p < 0.05$.

* $p < 0.1$.

Appendix 4. Wald test for joint significance of the interaction term and the two other variables which are underlying the interaction term

	Innumber		Technology		Process		Organization	
	Defensive	Prospective	Defensive	Prospective	Defensive	Prospective	Defensive	Prospective
Wald test (F value)	5.51***	4.14***	5.79***	3.92***	4.82***	4.05***	5.77***	4.40***
p-value	0.0010	0.0066	0.0007	0.0088	0.0026	0.0074	0.0007	0.0046

*** $p < 0.01$.

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