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The Impact of Data Activities on Innovation Performance in Service Industries

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Abstract

Data-driven decision making, the collection of and dependence on data for management activities, has expanded swiftly in the United States, and many studies abroad have measured the impacts of the changes in decision-making processes on productivity. However, in Japan, large-scale data on the use of data by establishments has been lacking, and the analysis was limited. In this paper, we exploit survey data of the "Japanese Management and Organizational Practices Survey," the first large-scale survey about management activities by establishments in Japan, carried out by the Economic and Social Research Institute of Cabinet Office in 2017 and 2018. We construct a measure of data activities and estimate its impact on innovation performance. We find that (i) establishments that use data intensively have a better performance on innovation outcomes, (ii) the impact of data activities, by which we mean data-driven decision making and data analytics, on innovation is comparable in magnitude to that of the “good” management practice, and (iii) the relationship between the intensiveness of data activities and the innovation outcomes varies depending on industries, establishment size and the degree of decentralization in decision making. For example, more decentralization in decision making may relate to more frequent innovations in terms of introducing new products/services and processes.

Keywords: Data, Management, Innovation, Decentralization in decision making

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1. Introduction

As information technology develops rapidly, firms can collect a huge amount of digital data on customers, sales, operations, and the market, structured or unstructured. A number of analytical tools are available at a reasonable cost, which can transform raw data into potentially useful information. Though a vague concept, big data is attracting great attention across all sectors - manufacturing and services alike. Whether named as big data or not, data and data analytics's increased importance in today's businesses is undeniable. In these circumstances, data-driven decision making (DDD), which refers to the practice of basing decisions on the analysis of data rather than purely on intuition (Provost and Fawcett 2013), is expected to improve the performance of firms.

Among many aspects of firm performances, we focus on innovation, both concerning products and processes, which is a major source of productivity improvements and economic growth. This focus is because the effects of DDD have not been examined in detail, especially regarding service-sector innovation. Our novel feature is the use of a large-scale survey on establishments in road freight transport, wholesale trade, and medical and other health services to empirically examine how the "data activities," by which we mean data-driven decision making and data analytics, of an establishment is related to its propensity to innovate. We also add retail trade (food and beverages) and information services to the above list for supplementary exercises. The survey, the Japanese Management and Organizational Practices Survey (JP-MOPS), was conducted by the Economic and Social Research Institute of Cabinet Office (ESRI) in cooperation with Hitotsubashi University and Kyushu University in 2017 and 2018.

Our empirical results can be summarized as follows. First, establishments that use data intensively have a better performance on innovation outcomes. Second, the impact of data activities on innovation is comparable in magnitude to that of the 'good' management practice. Third, the relationship between the intensiveness of data activities and the innovation outcomes varies depending on industry, establishment size, and the degree of decentralization in decision making. For example, more decentralization in decision making may relate to more frequent innovation in terms of introducing new products/services and processes.

This paper is organized as follows. Section 2 describes related literature. Section 3 explains our empirical framework, and Section 4 describes the data used. Section 5 presents empirical results and interpretations. Section 6 concludes our paper.

2. Related Literature

Our present paper is inspired by a few important studies on the relationship between data-driven decision making or data analytics and firms' productivity. Brynjolsson et al. (2011), examining 179 large publicly traded firms, find that the productivity of the firms that adopt DDD is 5 - 6 percent higher. Bakhshi et al. (2014) use a survey of 500 UK firms commercially active on the Internet. The result is that a one-standard-deviation greater use of online data is associated with an 8 percent higher level of total factor productivity. Brynjolfsson and McElheran (2016) analyze large-scale data from the Management and Organizational Practices Survey (US-MOPS) for 2010. Brynjolfsson and McElheran (2019), using the US-MOPS for 2010 and 2015, show that DDD is strongly associated with increased productivity.

The US-MOPS is motivated to explain productivity differences among firms with heterogeneous adoption of management practices and therefore designed to collect information such as monitoring, targeting, and incentive practices (Bloom et al. (2013), Buffingtona et al. (2017)). The use of ICT also plays a key role in explaining differences in the performance of firms, but a complementary effect between ICT and management practices should be taken into consideration (Brynjolfsson and Hitt (2000), Bresnahan et al. (2002), for example). This kind of complementarities could also exist in the case of DDD. Brynjolfsson and McElheran (2016) report that the benefit of DDD adoption appears to be greater for plants that delegate decision making to frontline workers. The JP-MOPS consists of similar questions to those in the US-MOPS to make international comparison possible. This design allows us to explore the relative importance and interaction between management practice and DDD.

Many of the past empirical studies of innovation are centered on the manufacturing sector. Those studies typically adopt the knowledge production function framework, where R&D activities are the important factors of product innovation (Griliches 1979). Due attention was not paid to the service industries since their low R&D intensity and patent application (Salter & Tether, 2006). In fact, the average ratios of internal R&D expenditures to sales in Japanese firms are 0.37 percent for transport and postal services and 0.44 percent for

wholesale trade, which are negligible compared to 4.18 percent for manufacturing, according to the Survey of Research and Development (Ministry of Internal Affairs and Communications, 2019). At the same time, however, service industries are very heterogeneous in terms of innovation patterns. Vence and Trigo (2009), for example, identify three sub-sector groups based on several innovation attributes: low innovation-intensive sectors (LIIS, represented by transport and wholesale trade), technology-intensive and moderately innovation-intensive sectors (TIMIIS, financial services), and knowledge and innovation-intensive sectors (KIBS, business services).

The ICT boom in the late 1990s has helped shed light on the importance of service innovation. Hempell and Zwick (2008) find that ICT fosters product and process innovations by facilitating employee participation and outsourcing. Gago and Rubalcaba (2007) examine service firms in Madrid and concludes that ICT and clients–providers interactions are important factors in facilitating service innovation. Polder et al. (2009) show that ICT is a driver of innovation in both manufacturing and services. They also suggest that R&D investment contributes to product innovation in manufacturing but has no effect on innovation in service sectors. Spiezia (2011), using cross-country data, confirms that ICT is an enabler of innovation in both manufacturing and services though it does not increase their inventive capabilities. Álvarez (2016), based on Chilian data, shows that ICT contributes positively to innovation and productivity for the all-industry sample and for the services sector sample.

There are only a few empirical studies on the impact of DDD or data analytics on innovation. Lehrer et al. (2017), conducting case studies of four organizations from the insurance, banking, telecommunications, and e-commerce industries, suggest that big data analytics enables service innovation through automated service provision and IT-supported service delivery by human service actors. Wu et al. (2020), using survey data of 331 firms and patent data of more than 2,000 listed firms, suggest that data analytics are strongly associated with process innovation and innovation by diverse recombination. Our paper is most closely related to Niebel et al. (2018). They examine the relationship between firms' use of big data analytics and their innovative performance based on the survey data of 2,706 firms in Germany, of which 1,302 are services (158 retail trade, 129 wholesale trade, 149 transport services, 158 ICT services, for example). The survey includes a binary measure of product innovation broadly in line with the Oslo Manual by the OECD and Eurostat. They show that big data analytics is associated with a higher propensity to innovate and a higher innovation intensity in both manufacturing and

services. However, the positive effect disappears in the case of low IT-specific human capital.

3. Empirical Framework

3.1 The Impact of Data Activities on Innovation Performance

We first estimate the impact of data activities on innovation performance. We envisage that data can visualize and organize a significant amount of and many kinds of information and that analyzing them for business activity makes it effective to introduce new products/services and processes and improve existing ones. Hence, we consider that the establishments that use data intensively have a higher frequency of innovation than those that do not. We evaluate the impact of data activities on innovation performance by combining three different estimation methods.

3.1.1 Probit Model

First, we follow Niebel et al. (2018) and estimate the following model:

$$y_{1i} = \begin{cases} 1 & \text{if } y_{1i}^* > m \\ 0 & \text{if } y_{1i}^* \leq m \end{cases} \quad \text{where } y_{1i}^* = \beta ds_i + \gamma X'_i + \varepsilon_i \qquad (1)$$

y_{1i} is an observable variable that takes 1 if innovation realizes in establishment i. y_{1i}^* denotes the latent propensity to realize innovation in establishment i. We estimate it by the probit model, $\Pr(y_{1i} = 1) = F(\beta ds_i + \gamma X'_i + \varepsilon_i)$, $where\ F(\cdot)$ is a cumulative standard normal distribution function. ds_i denotes the data score (see Section 4 for details) of establishment i, X'_i denotes the vector of characteristics of establishment i. ε_i denotes an idiosyncratic error term and is assumed to be identically and independently normally distributed. In this model, the marginal effect means the propensity to realize innovation when the data score increases by 1.

3.1.2 Ordered Probit Model

Second, as the choice of the frequency of innovation realization has four options in the JP-MOPS, we extend the estimation model and use the following ordered probit model:

$$y_{2i} = \begin{cases} 3 & \text{if } m_3 < y_{2i}^* \\ 2 & \text{if } m_2 < y_{2i}^* \leq m_3 \\ 1 & \text{if } m_1 < y_{2i}^* \leq m_2 \\ 0 & \text{if } y_{2i}^* \leq m_1 \end{cases} \quad \text{where } y_{2i}^* = \beta ds_i + \gamma X'_i + \varepsilon_i \qquad (2)$$

y_{2i} is an observable variable that takes 3 if innovation realizes more than once a year in establishment *i*, takes 2 if it arises once a year, takes 1 if it arises once every few years, and takes 0 if no innovation realizes. m_1, m_2 and m_3 are cut points and y_{2i}^* denotes the latent propensity to realize innovation in establishment *i*. ds_i denotes the data score of establishment *i*, X'_i denotes the vector of characteristics of establishment *i*. ε_i denotes an idiosyncratic error term and is assumed to be identically and independently normally distributed.

3.1.3 Propensity Score Matching

Third, to evaluate the causal effect of data activities on innovation performance, we adopt another estimation method, propensity score matching, which is used for assessing the impact of different treatments (Rosenbaum and Rubin, 1983). It matches units by using propensity scores and can estimate the average marginal effect of a particular treatment while controlling for other characteristics. We consider two treatments, numbered 1 and 0. In our model, treatment 1 indicates that establishment *i* uses data intensively, i.e., the data score of establishment *i* is greater than its average within the industry, and treatment 0 indicates that the data score of establishment *i* is equal to or less than its average within the industry. The quantity to be estimated is the following average treatment effect,

$$\mathrm{E}\{r_1|b(X'), z=1\} - \mathrm{E}\{r_0|b(X'), z=0\} = \mathrm{E}\{r_1 - r_0|b(X')\} \quad (3)$$

where $\mathrm{E}(\cdot)$ denotes expectation, r_1 denotes a response that would have resulted if it had received treatment 1, and r_0 denotes a response that would have resulted if it had received treatment 0. r_{1i} and r_{0i} take 1 if innovation realizes in establishment *i*, and 0 if innovation realization is unobserved. $b(X')$ denotes a balancing score which is a function of the observed characteristics of establishment *i*, X'_i. $z_i = 1$ if establishment *i* is assigned to the experimental treatment and $z_i = 0$ if establishment *i* is assigned to the control treatment. The propensity score, the conditional probabilities of assignment to a particular treatment given a vector of observed covariates, is a balancing score. We estimate the propensity score by the probit model. This estimation method can extract the precise effect of data activities on innovation performance because it considers the causal relationship between data activities' intensiveness and innovation performance.

3.2 The Contribution of Data Activities to Innovation Performance Compared to that of Management

We then measure the relative contribution of data activities compared to management. Bloom et al. (2019) compare management practices to other factors that are commonly considered important drivers of productivity: R&D, ICT, and human capital. They find that management practices account for more than 20 percent of the variation in productivity, a similar or higher percentage compared to R&D, ICT, or human capital. In terms of innovation performance, management is a crucial driver because proper operational management, such as setting targets or giving incentives, leads employees to make more efforts and make good performances. This paper attempts to measure data activities' relative contribution to innovation performance compared to managerial activities following Bloom et al. (2019). We estimate the following equation by the Ordinary Least Square (OLS) to calculate the explained share of the 90-10 spread of innovation performance by each key factor:

$$y_{3i} = \beta ds_i + \gamma X'_i + \varepsilon_i \quad (4)$$

y_{3i}[1] is the variable which takes 4 if innovation realizes more than once a year in establishment i, takes 3 if it arises once a year, takes 2 if it arises once every few years, and takes 1 if no innovation realizes. ds_i denotes the data score of establishment i, X'_i denotes the vector of characteristics of establishment i. ε_i denotes an idiosyncratic error term and is assumed to be identically and independently normally distributed.

3.3 The Relationship between Data Activities and Innovation Outcome Depending on Establishment Characteristics

We finally examine how the relationship between data activities and innovation outcomes is different depending on establishment characteristics. We evaluate the change in the marginal effect in equation (1) by establishment characteristics. We conduct split sample analyses in equation (1).

We first estimate equations by establishment size and single- or multi-unit firms. Our hypothesis is the following: large-size establishments deal with various types and many tasks, and they can acquire data from them, which means that they have abundant resources for data analysis. Moreover, firms with a headquarter and branches (i.e., multi-

[1] Strictly speaking, y_{3i} is not ration scale but ordinal scale. Since the ordinary least square is better for comparing the relative effect than the ordered probit model and the frequency of innovation have four different choices, we assign the value to y_{3i} according to the frequency and treat it as quantitative data.

unit firms) can acquire data or reports between the headquarter and branches. Exchanging data or reports increases the information for coming up with good ideas, which lead to a high propensity to innovate. We test our hypothesis that when large-size establishments or establishments belonging to a multi-unit firm use data more effectively, this is associated with larger innovation performance improvement than small-size establishments or single-unit firms.

We then estimate equations by the degree of decentralization in decision making. The degree of decentralization is higher if headquarters are less involved in the decision making of branches. We test our hypothesis that additional data usage is associated with larger innovation performance improvement in establishments with decentralized decision making than in those with centralized decision making.

4. Data

We base our analysis on the JP-MOPS. There were two waves: in 2017 and 2018 (Table 1). It is an establishment-level survey, and the sample consists of those in Japan with 30 or more employees, derived from the Establishment Frame Database, the census of establishments in Japan. The survey was conducted in manufacturing and service establishments[2]. The targeted industries were manufacturing and two service industries, retail trade (food and beverages)[3] and information services in 2017 and other three service industries, road freight transport, wholesale trade, and medical and other health services in 2018. The 2017 JP-MOPS corresponds to the second wave of the US-MOPS. The number of respondents was 11,405 in manufacturing, 1,273 in retail trade, 936 in information services, 1,286 in road freight transport, 3,813 in wholesale trade, and 1,650 in medical and other health services. The surveys include management practice and organization sections whose structures are the same in the US-MOPS. They have other sections that vary depending on survey years and industries. In manufacturing, the survey has the uncertainty section. In the service sectors in the 2017 JP-MOPS, the survey has the data and decision-making section, and other characteristics section including innovation propensity and competitiveness. In the 2018 JP-MOPS, we followed the survey of the service sectors in the 2017 JP-MOPS, and we expanded the data and

[2] We divide industries based on the Japan standard industrial classification.

[3] Hereafter, “retail trade” represents “retail trade (food and beverages).”

decision-making section and added the section of the AI usage. The sections about data and decision making and other characteristics in the 2018 JP-MOPS have many common questions to the US-MOPS as well as original questions. In order to obtain information at two periods, many questions ask responses for both the survey year and five years earlier, specifically, 2015 (present) / 2010 (recall) in the 2017 JP-MOPS and 2018 (present) / 2013 (recall) in the 2018 JP-MOPS. Hereafter, we will focus on service industries.

4.1 Individual Variables

4.1.1 Innovation Outcomes

Both JP-MOPS have a question about the frequency of innovations. The definition of innovation broadly follows the Oslo Manual by the OECD and Eurostat. The types of innovations are product innovations and process innovations. They are categorized into five types of innovations: the development and introduction of new products/services ("innovation 1"), the improvement of existing products/services ("innovation 2"), the new combination of existing products/services ("innovation 3"), the introduction of new processes ("innovation 4"), and process improvements ("innovation 5"). The survey asks how frequently those five types of innovations are realized. The frequencies are divided into four categories: no innovations (1 is assigned as a score), once every few years (2), once a year (3), and more than once a year (4). We calculate average scores by taking a simple mean. We assign these four categories in the ordered probit model and the OLS estimation. In the probit model and the propensity score matching, we make binary indicators by diminishing four categories into no innovations ("d.innovation" = 0) and at least one innovation ("d.innovation" = 1). In Table 2 (a) and Table 2 (b), among other summary statistics, we show the means of "d.innovation 1" to "d.innovation 5," i.e., the proportion of establishments with at least one innovation in each innovation type. The number is higher in retail trade, information services, and wholesale trade.

4.1.2 Data Score

Data score is the most crucial variable in our analysis. We construct it to measure data activities from the questions in the data and decision-making section of the 2018 JP-MOPS. In the data and decision-making section, there are eight questions. We use the responses from seven questions to define a measure that we call *data score 1*, which is the unweighted average of the responses where each response is scored on a 0-1 scale[4].

[4] To construct the score we exclude question 22-2, which askes the problems about data

Hence, *data score 1* ranges between 0 and 1 (See Appendix 1-1 for details). In the propensity score matching, we construct a binary variable that takes 0 if the score is at or below the industry mean and takes 1 if it is above the industry mean. We call it *binary data score*.

We define another data score for comparative analysis among the five industries. Although there are some different questions in the 2017 JP-MOPS and the 2018 JP-MOPS, we construct a score called *data score 2* from the same questions in the data and decision-making section of both surveys (See Appendix 1-2 for details). We use it in analyzing the contribution of data activities on innovation performance among five industries.

Figure 1 plots the histogram of *data score 1* in each of the three industries in 2018. The histogram is near a normal distribution, and the use of data is most intensive in wholesale trade. Figure 2 indicates that the score becomes higher in five years in all three industries. Figure 3 plots the histogram of *data score 2* in each of the five industries. Since limited questions are available, the histogram is relatively non-smooth compared to *data score 1*. The industries surveyed in the 2018 JP-MOPS have both *data score 1* and *data score 2*, making it possible to compare them. The mean of *data score 2* is almost at the same level compared to that of *data score 1*, but the standard deviation of the former is higher due to the limited availability of questions.

4.1.3 Management Score

As previous studies such as Bloom et al. (2019) have already shown, management has a tight linkage to productivity, and we consider management is also one of the most critical factors influencing the propensity to innovate. We construct a variable called *management score* by using the questions in the JP-MOPS management section following Bloom et al. (2019)[5] (See Appendix 1-3 for details).

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usage by listing examples and is not a quantified question. We also exclude the response of the influence of "design of new products or services" activity in question 21-1(a) and 21-1(b) because the activity itself implies the implementation of innovation and those establishments which implement these activities have a high possibility to realize innovations.

[5] We exclude question 1, which askes how the establishment reacted to an exception in its process, because of the same reason as we exclude the influence of "design of new

Figure 4 plots the histogram of *management score* in each industry. As is the case for the data scores, the mean is the highest in wholesale trade. Figure 5 shows that the distribution of *management score* moves to the right, and its mean becomes higher in five years. However, the increment of the score in five years is less conspicuous than that of the data score.

4.1.4 The Difference in Characteristics depending on Headquarter/Branch Status and Establishment Size

Whether an establishment is a headquarter or a branch may affect data activities' impact on innovation outcomes. Table 2 depicts the number of establishments over headquarter/branch status and size. In road freight transport and retail trade, the number of branches exceeds that of headquarters. This situation reflects that transport firms tend to have several branches as transportation points or sales offices and that food retail companies often operate a network of supermarket stores. In wholesale trade and information services, the headquarters with 30-199 employees occupy a large portion of JP-MOPS respondents. In particular, the headquarters with 30-99 employees cover nearly half in wholesale trade.

Table 3 shows the means of *data score 1*, *data score 2*, and *management score* by headquarter/branch status and establishment size. In general, the scores are high in large-size establishments. Also, the branches' scores tend to be higher than those in headquarters in each category.

4.1.5 Decentralization Score

We produce a decentralization measure in decision making called *decentralization score* by using responses in the organization section. We calculate the score following the method of Bloom et al. (2019). The score takes between 0 (completely centralized) and 1 (completely decentralized). (For details in scoring, see Appendix 1-4.) Figure 6 plots the *decentralization score* in 2018. Note that this score is calculated only for branches. Overall, distributions are fat on the left side (i.e., decision making is centralized). In medical and other health services, decision making is decentralized compared to the other two industries.

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products or services" activity in question 21-1 (a) and 21-1 (b) in calculating *data score 1*.

4.1.6 Other Characteristics

The relationship between innovations and market competition has been a theoretical and empirical issue[6] (see Inui et al., 2008, for example). We therefore use the number of establishments directly competing with an establishment ("degree of competition"). The logged number of employees in an establishment ("establishment size") also serves as a proxy of the monopolistic power.

In addition, we exploit other establishment characteristics: the ratio of non-managers with a bachelor's degree and the ratio of managers with a bachelor's degree as proxy variables for general human capital; the presence of the Chief Information Officer (CIO) in question 29 in 2018 as a proxy for tangible and intangible ICT capital, including ICT-specific human capital because those firms with a CIO should have heavily invested in ICT infrastructure; respondents' recognitions about two aspects of the important skills in the establishment in question 34-1 (specialization or coordination) and 34-2 (creativity or efficiency) in the 2018 JP-MOPS (question 32-1 and 32-2 in the 2017 JP-MOPS). We use them to control the difference in tasks in each establishment. The questions about skills are made based on the theories in organizational economics, arguing the relationship between communications, skills, and organization structures (Garicano and Prat (2013), Garicano and Rayo (2016), Sugihara (2016)).

Our analysis does not use R&D investment at the establishment level due to the data limitation[7]. Only in wholesale trade, we use the disaggregated industry group dummies as a proxy of the intensity of R&D investment because the ratio of R&D investment relative to sales varies in disaggregated industries taken from "the Basic Survey of

[6] There are two different theories regarding to the relationship between innovation and market competition. One is that the monopolistic firms tend to have a high innovation performance due to the abundant capital resource and stability (Schumpeter,1934). The other one is that the market competition causes the high innovation outcomes (Aghion et al., 2005, Aghion and Griffith, 2005).

[7] There are few firms that record or publicize the accounting information about the amount of R&D investment at the establishment level. It is our future work to find the appropriate proxy variables for the amount of R&D investment in analyzing the innovation performance at the establishment level.

Japanese Business Structure and Activities in 2018," published by the Ministry of Economy, Trade and Industry, in the estimations of the probit and ordered probit models[8].

4.2 Summary Statistics of Variables in Our Analysis

Table 4 (a) (b) show the summary statistics of variables in estimations. In the JP-MOPS survey, many questions have responses in both the survey year and the recall year (five years before the survey year): 2018 (survey) / 2013 (recall) in the 2018 JP-MOPS, and 2015 (survey) / 2010 (recall) in the 2017 JP-MOPS. We choose the establishments with at least ten responses in the management section following Bloom et al. (2019). In addition, we exclude the establishments that respond "Do not need to use data" in question 22-2 of the 2018 JP-MOPS. Finally, we exclude those with missing values in explanatory variables used in this paper or with no responses in all five types of innovations. After this screening, sample sizes used in estimations become 907 in road freight transport, 3,115 in wholesale trade, 1,255 in medical and other health services, 1,042 in retail trade, and 818 in information services. We use the responses in the survey year because establishment size, competitiveness, CIO presence, and the characteristics of tasks in the establishment do not have recall answers and because recall answers, especially those related to rapidly-changing data activities, may have large measurement errors. To check whether an endogeneity problem arises, we also estimate the probit model using the recall year's data if they exist.

4.3 Characteristics of Establishments that Use Data Intensively

Before estimating the relationship between data activities and innovation performance, we examine the characteristics of establishments that use data intensively by regression analysis. We estimate the following model:

$$ds_i = \beta X'_i + \varepsilon_i, \qquad (5)$$

[8] There are 22 disaggregated industries within wholesale trade. According to the statistics in the Basic Survey of Japanese Business Structure and Activities (BSJBSA), the ratio of R&D investment relative to sales varies from 0.08 percent to 6.29 percent in 2017 by those disaggregated industries in wholesale trade. We do not include these dummies in the other industries because they are not the surveyed industries in the BSJBSA and the data is unavailable. Because of multicollinearity problem, we exclude them in OLS estimation.

where ds_i denotes *data score* of establishment *i*, and X'_i denotes the characteristics of establishment *i*, namely *management score*, headquarter/branch status, establishment size, degree of competition, the ratio of managers with a bachelor's degree, the ratio of non-managers with a bachelor's degree, the presence of CIO, and characteristics of tasks in the establishment. ε_i denotes an idiosyncratic error term and is assumed to be identically and independently normally distributed.

Table 5 shows the estimation results. It provides the OLS estimation results of regressing *data score* 1 on *management score* and other characteristics by industry in the 2018 JP-MOPS. In all three industries, *management score* is positively associated with *data score 1*. The establishment size is also positively associated. In wholesale trade and medical and other health services, the ratio of non-managers with a bachelor's degree is positively associated and statistically significant. These two results are similar to Brijolfsson and McElheran (2016), which find that the establishment size and the ratio of employees with a bachelor's degree are positively correlated with DDD. Also, the presence of a CIO is an important factor. This result is quite natural because data-driven decision making can be effectively introduced on the foundation of rich ICT infrastructure, which is proxied by a CIO.

4.4 The Correlation between Innovation Outcomes and Data Activities and Management

Table 6 shows the correlation between innovation outcomes and *data score 1*, *data score 2*, and *management score* of industries in both the 2017 JP-MOPS and the 2018 JP-MOPS. There exist consistently positive relationships between innovation outcomes and *data score* or *management score*. Correlation coefficients range from 0.23 to 0.53 and are relatively stable from industry to industry. In estimating the effect of data activities on innovation performance, controlling management's effect would be desirable. We see the estimation results and interpret them in the next section[9].

5. Results

[9] Due to the non-negligible non-profit aspect of its activities, we think we should analyze medical and other health services differently from other industries surveyed in the 2018 JP-MOPS. This paper focuses more on other industries (i.e., road freight transport and wholesale trade).

5.1 The Impact of Data Activities on Innovation Performance

Table 7 shows the estimation results of regressing innovation performance on data activities, management, and other characteristics in industries surveyed in the 2018 JP-MOPS. It shows a relationship that establishments with intensive data use have better innovation performance. Column 1 and column 2 report the average marginal effect of data activities and management, respectively, in equation (1) for the probit model with other explanatory variables of establishments' characteristics. The difference between column 1 and column 2 is that the equation used to obtain the result in column 1 does not include *management score* as an explanatory variable, while the equation used to obtain the result of column 2 includes it. We will explain the case of *innovation 1* in road freight transport as an example. Column 1 indicates that every 0.1 point increase in *data score 1* is associated with the increase in the propensity to innovate by 10.07 percentage points. Column 2 indicates that every 0.1 point increase in *data score 1* is associated with the increase in propensity to innovate by 7.09 percentage points. Since the inclusion of *management score*, which is statistically significant, decreases the marginal effects of data score by about 3 percentage points, management must be taken into consideration when analyzing the impact of data activities on innovation performance. In addition, as *data score 1* has a sample mean of 0.48 and a standard deviation of 0.16, a one-standard-deviation change in data activities is associated with 11.34 (=7.09*0.16/0.1) percentage points higher propensity to innovate. Column 3 reports the estimation result when the following explanatory variables are changed from those in the survey year to those in the recall year: *data score 1*, *management score*, the ratio of non-managers with a bachelor's degree, and the ratio of managers with a bachelor's degree. It indicates that every 0.1 point increase in *data score 1* is associated with the increase in the propensity to innovate by 4.09 percentage points. The association of the data activities with innovation realization drops compared to that in column 2 but still economically and statistically significant. This reduction may indicate that parameters in column 2 are biased upward due to an endogeneity problem.

Table 8 reports the estimation results of the ordered probit model, which also indicates that data activities are positively associated with the propensity to innovate. Table 9 is the result of the propensity score matching method, which is useful for analyzing causal effects, showing the average marginal effect of data activities on innovation realization, the propensity to innovate when *binary data score* changes from 0 (below the average) to

1 (above the average). It indicates that more intensive data activities are, on average, associated with 8 to 15 percentage points higher propensity to innovate[10].

In summary, the estimates in Tables 7, 8, and 9 validate our hypothesis that establishments that use data intensively have better innovation performance[11]. Our empirical result is consistent with the results in the previous study. Niebel et al. (2018) find that the application of big data analytics is associated with 6.5 – 6.7 percentage points higher innovation propensity over all samples[12].

5.2 The Contribution of Data Activities to Innovation Performance Compared to that of Management

Table 10 report the estimation results of regressing innovation performance on data activities, management, and other characteristics by OLS and the contributions of data activities and management to innovation performance. We use the three-sector dataset from the 2018 JP-MOPS in conjunction with *data score 1* in Table 10 (a), and the five-sector dataset from the 2017 JP-MOPS and the 2018 JP-MOPS with *data score 2* in Table 10 (b), respectively.

Table 10 (a) shows that the contributions of data activities and management to the 90-10 spread of the innovation performance in the three industries surveyed in the 2018 JP-

[10] See the result of balancing check in Table 9. With only two exceptions out of 135 independent variables (CIO in *innovation 2* and *innovation 3* in medical and other healthcare services), the absolute values of standardized differences are below 0.1 across industries.

[11] While we are interested in whether complementarity between data activities and management on innovation performance exists, we find that the interaction term between *data score 1* (or *data score 2*) and *management score* is in general not statistically significant in each industry. See Appendix 3 as an example of estimation results by the ordered probit model.

[12] The data they use is different from ours, besides industries, in the following three aspects: (i) their survey year is 2015 and there is a three-year gap from our survey year; (ii) we do not limit data activities to the use of big data; (iii) we examine the impact of data activities on both product and process innovation.

MOPS [13]. In road freight transport, the data activities' contribution is less than management's contribution but close to that in process innovation categories. For example, data activities' contribution is 24.3 percent, and management's contribution is 27.5 percent in *innovation 1, and* data activities' contribution is 27.7 percent, and management's contribution is 28.5 percent in *innovation 4*. In wholesale trade, data activities' contribution is higher than management's contribution in all innovation categories except for *innovation 5*. In medical and other healthcare services, results are mixed.

Table 10 (b) reports that the contribution of data activities and management to the 90-10 spread of the innovation performance in the five industries surveyed in the 2017 JP-MOPS and the 2018 JP-MOPS. In road freight transport, wholesale trade, and medical and other healthcare services, results are similar to those in Table 10 (a). For example, in *innovation 1*, data activities' contribution is 21.3 percent, and management's contribution is 22.7 percent in road freight transport. In retail trade and information services, data activities' contribution exceeds management's contribution in all innovation categories. For example, in *innovation 1*, data activities' contribution is 29.7 percent, and management's contribution is 12.6 percent in retail trade.

These exercises suggest that the impact of data activities on innovation is comparable in magnitude to that of the "good" management practice.

5.3 The Relationship between Data Activities and Innovation Outcomes Depending on the Establishment Characteristics

Table 11 and Table 12 show the subsample analysis of equation (1) using the probit model in the three industries surveyed in the 2018 JP-MOPS. They show that the relationship between data activities and innovation outcomes are different by industry and establishment characteristics. Table 11(a) and Table 11(b) report the average marginal effects on *innovation 1* to *innovation 3* and *innovation 4* to *innovation 5*, respectively. Column 1 and column 2 show the estimation results by using the samples divided into relatively small-size establishments ("Small") and relatively large-size ones ("Large"). We classify the establishments that are at or below the industry median of the logged number of employees (i.e., "lemp") as "Small." We classify the others as "Large."

[13] The 90th percentile of the innovation performance is 3 or 4 and the 10th percentile is 1 in the results reported in Table 10 (a) and Table 10 (b).

Column 3 and column 4 show the estimation results by using the subsample of branches ("Branch") and headquarters ("Hq"). Column 5 and column 6 show the estimation results by using the subsample of headquarters divided into two according to the number of employees. Since we cannot identify whether an establishment is a single-unit status or multi-unit status from JP-MOPS responses, we assume that the proportion of establishments of single-unit status is high in the small-size establishments. Hence, we classify the establishments that are headquarters and have at or below the industry median of "lemp" as "Hq-sm," as a proxy of establishments of single-unit status in column 5. We classify the others as "Hq-lg," as a proxy of establishments of multi-unit status in column 6. Table 12 reports the average marginal effects on innovation realization by the degree of decentralization in decision making. The samples are divided into two, relatively centralized ("Centralized") or relatively decentralized ("Decentralized"). We classify the establishments at or below the industry median of decentralization score as "Centralized." We classify the others as "Decentralized."[14]

5.3.1 Establishment Size and Single- or Multi-Unit Firms

In the case of road freight transport, the estimates in Table 11 are consistent with our hypothesis that the impact of data activities on innovation performance in large establishments is higher than in small ones. Column 2 in Table 11 (a) indicates that every 0.1 point increase in *data score 1* relates to an increase in the propensity to innovate by 9.26 percentage points in large-size establishments in *innovation 1*. The estimate is higher than that in the whole sample, 7.09 percentage points. The other innovation categories have similar results. Therefore, large establishments have the advantage of raising the propensity to innovate by using data intensively compared to small establishments in road freight transport.

However, in wholesale trade, the estimates except *innovation 2* in Table 11 are not consistent with our hypothesis. For example, columns 1 and 5 in Table 11 (a) indicate that every 0.1 point increase in *data score 1* relates to an increase in the propensity to innovate by 6 to 7 percentage points in small-size establishments and small-size headquarters (as a proxy of single-unit firms) in *innovation 1*. It shows that the effect of data activities on innovation performance is higher in small-size establishments or establishments with single-unit status in wholesale trade. Similar results are observed in

[14] Those median numbers we use in dividing the samples are calculated among establishments with at least ten responses in the management section (see Section 4.2).

the case of medical and other health services. Further analysis is necessary for the relationship between establishment size and innovation outcome.

5.3.2 Degree of Decentralization in Decision Making

In road freight transport, the estimates in Table 12 are consistent with our hypothesis that the impact of data activity on innovation performance is large in establishments of decentralized decision making in terms of the development and introduction of new products/services and processes. Columns (2) in Table 12 indicate that every 0.1 point increase in *data score 1* relates to the increase in the propensity to innovate by 8.31 percentage points in *innovation 1* and 6.47 percentage points in *innovation 4*, which are nearly equal or higher than the estimates in all branch samples, 7.25 percentage points and 6.48 percentage points, respectively. The estimation results in wholesale trade show similar relationships in *innovation 1* and *innovation 4*, although the results are less evident in medical and other health services. From the analysis above, we interpret that decentralization in decision making may relate to more frequent innovations in terms of introducing new products/services (i.e., *innovation 1*) and process (i.e., *innovation 4*).

However, the estimates in *innovation 2* and *innovation 5* in Table 11 in all three industries are not consistent with our hypothesis. The estimates indicate that centralized decision making may relate to more frequent innovations in terms of existing products/services and processes. These types of innovations are incremental in nature, and less creative than those measured by *innovation 1, innovation 3* and *innovation 4*, and therefore can be efficiently realized by performing data analysis routinely and even mechanically. Based on the above result, this situation is applicable to the branches operating under the headquarters' tight control.

6. Conclusion

This paper examines the impact of data activities on innovation performance in service industries. In the age of digitalization, accumulating and using data effectively is essential to introduce new tools such as AI and increase productivity. Japan faces low productivity, particularly in service industries. Measuring the effect of data usage and finding how to use data effectively are worth investigating for researchers, and obtained knowledge is beneficial for policymakers.

We use the large-scale establishment-level data, which cover five service industries and have rich responses, for the first time in Japan, about the use of data and relevant characteristics of establishments. We find that (i) establishments that use data intensively have a better performance on innovation outcomes. The impact is consistent with previous research, and the results are robust to alternative specifications and econometric models. We also find that (ii) the impact of data activities on innovations is comparable in magnitude to that of the 'good' management practice and that (iii) the relationship between the intensiveness of data activities and the innovation outcomes varies depending on industries, establishment size and the degree of decentralization in decision making. For example, more decentralization in decision making may relate to being connected with more frequent innovations in terms of introducing new products/services and processes.

Analysis in this paper is the first step in examining the relationship between data activities and establishment performance in the age of digitalization. There is much room for further investigation. First, in this paper, performance indicators are the innovation outcomes. In future research, labor productivity or total factor productivity (TFP) indicators derived from other sources can be used to augment our analysis. Also, this paper's empirical analysis does not use the amount of ICT or R&D capital due to the data limitation. Matching the JP-MOPS dataset with other statistics and taking into account them make it possible to estimate the effect of data activities more precisely. Finally, we conduct empirical analysis in some limited types of service industries. Examining the impact of data activity on the establishment/firm's performance in other services industries is valuable for further research.

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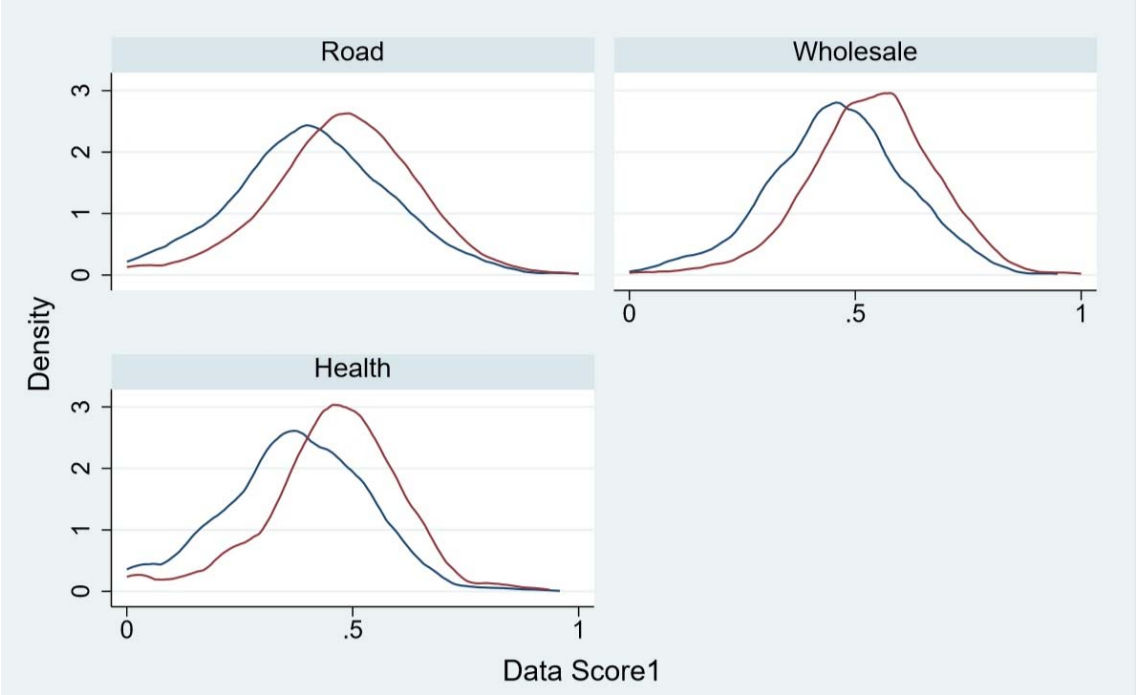
Figures and Tables

Figure 1: The Histogram of *Data Score 1* in Three Industries in 2018

Figure 2: The Distribution of *Data Score 1* in Three Industries in 2013 and 2018



*Blue lines denote the recall year, and red lines denote the present year.

Figure 3: The Histogram of *Data Score 2* in Five Industries in the Present Year

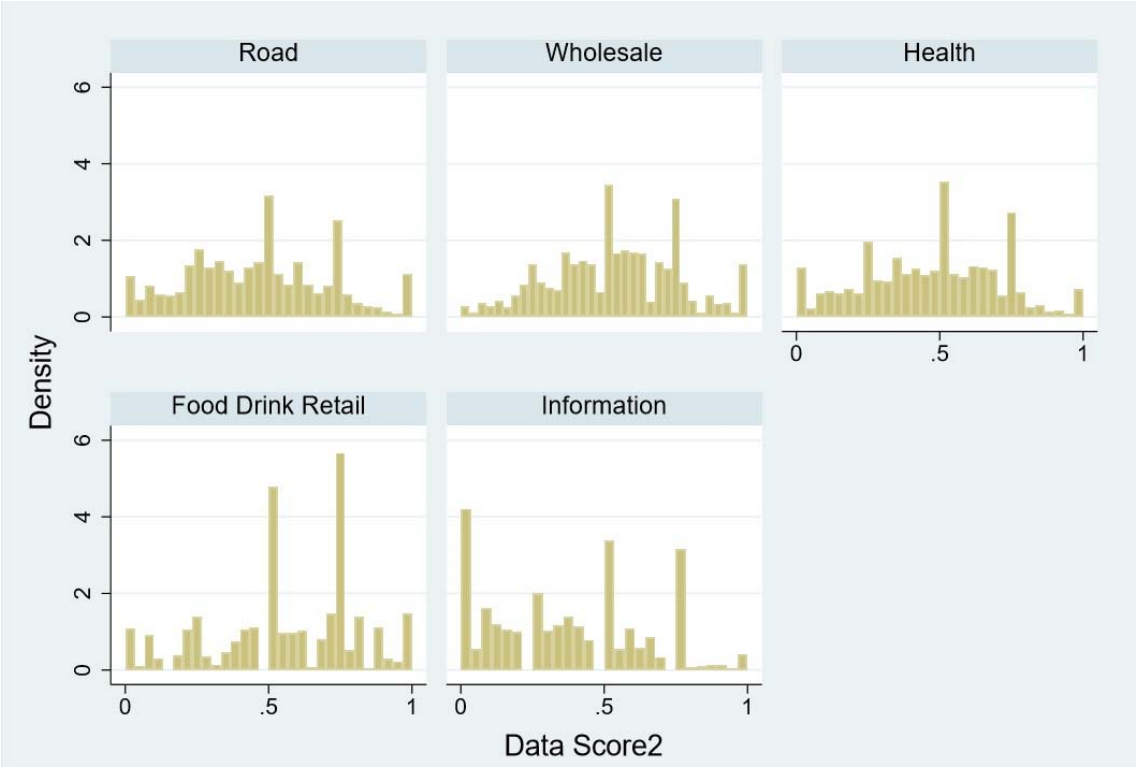


Figure 4: The Histogram of *Management Score* in Five Industries in the Present Year

Figure 5: The Distribution of *Management Score* in Five Industries in the Recall and the Present Year

*Blue lines denote the recall year, and red lines denote the present year.

Figure 6: The Histogram of Decentralization Score in Decision Making in Three Industries in 2018

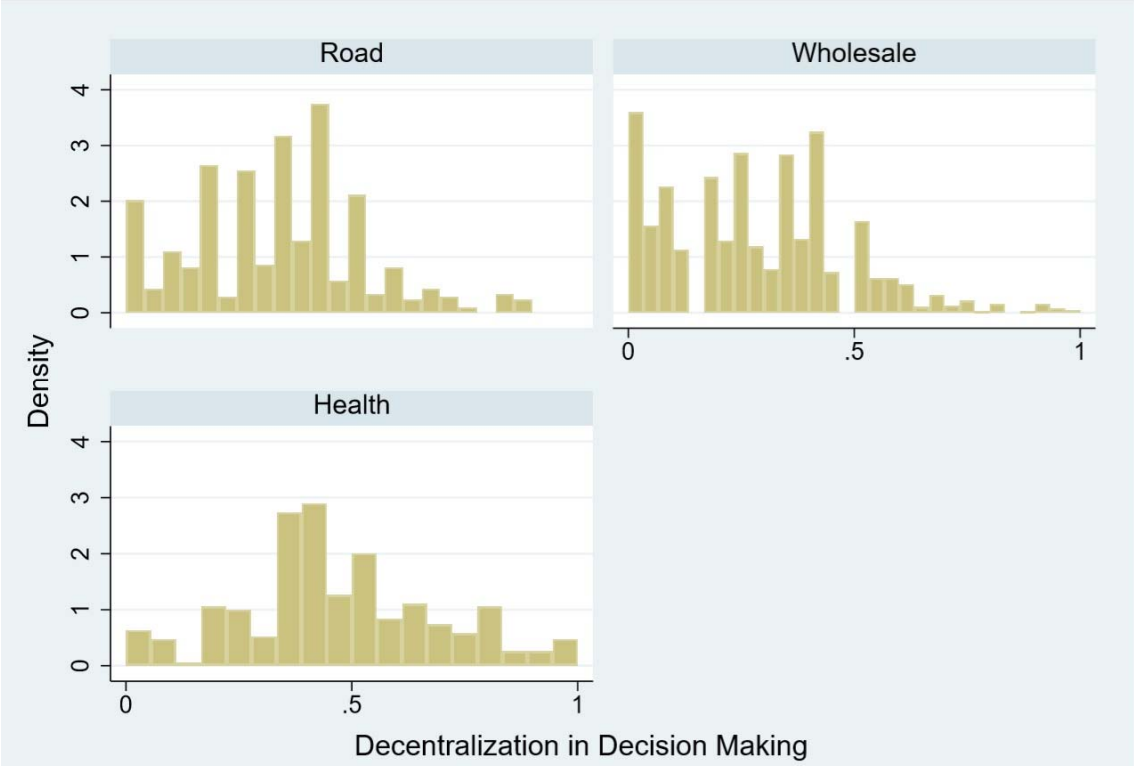


Table1: Basic Characteristics of Two Waves of JP-MOPS

	Survey Year	Recall Year	Industries (Division and Group Code)*	Number of Mailout Samples	Number of Responses (Response Rate)	Contents in Each Section	Timing of Survey
2017 JP-MOPS	2015	2010	Manufacturing (E 09-32)	36,052	11,405 (31.6%)	A: Management Practices B: Organization C: Uncertainty D: Background Characteristics	2017
			Retail Trade(Food and Beverages) (I 58)	3,573	1,273 (35.6%)	A: Management practices B: Organization C: Data and Decision Making D: Background Characteristics	
			Information Services (G 39)	3,503	936 (26.7%)		
2018 JP-MOPS	2018	2013	Road Freight Transport (H 44)	3,725	1,286 (34.5%)	A: management practices B: Organization C: Data and Decision Making D: Aritificial Intelligence(AI) E: Background Characteristics	2018
			Wholesale Trade (I 50-55)	12,277	3,813 (31.1%)		
			Medical and Other Health Services (P 83)	5,161	1,650 (32.0%)		

* We follow the Japanese Standard Industry Classification.

Table 2: Number of Establishments by Headquarter/Branch Status and Size

Road Freight Transport

Size	Branch	Hq	Total
30-49	152	146	298
50-99	156	127	283
100-199	136	103	239
200-299	37	14	51
300-	28	8	36
Total	509	398	907

Wholesale Trade

Size	Branch	Hq	Total
30-49	487	874	1,361
50-99	366	660	1,026
100-199	207	316	523
200-299	32	60	92
300-	38	75	113
Total	1,130	1,985	3,115

Medical and Other Health Services

Size	Branch	Hq	Total
30-49	64	228	292
50-99	51	221	272
100-199	63	183	246
200-299	68	163	231
300-	104	110	214
Total	350	905	1,255

Retail Trade

Size	Branch	Hq	Total
30-49	146	120	266
50-99	263	77	340
100-199	249	86	335
200-299	31	43	74
300-	8	19	27
Total	697	345	1,042

Information Services

Size	Branch	Hq	Total
30-49	74	181	255
50-99	85	161	246
100-199	56	119	175
200-299	14	57	71
300-	29	42	71
Total	258	560	818

Table 3: Mean of *Data Score 1*, *Data Score 2*, and *Management Score* by Headquarter/Branch Status and Establishment Size

Road Freight Transport

	Data Score 1		Data Score 2		Management Score	
Size	Branch	Hq	Branch	Hq	Branch	Hq
30-49	0.47	0.41	0.44	0.38	0.48	0.36
50-99	0.48	0.45	0.50	0.40	0.54	0.41
100-199	0.53	0.50	0.53	0.45	0.56	0.44
200-299	0.51	0.47	0.50	0.45	0.57	0.45
300-	0.59	0.50	0.62	0.49	0.64	0.63

Retail Trade

	Data Score 2		Management Score	
Size	Branch	Hq	Branch	Hq
30-49	0.46	0.50	0.51	0.36
50-99	0.61	0.49	0.54	0.47
100-199	0.62	0.59	0.60	0.52
200-299	0.59	0.50	0.58	0.48
300-	0.49	0.57	0.47	0.59

Wholesale Trade

	Data Score 1		Data Score 2		Management Score	
Size	Branch	Hq	Branch	Hq	Branch	Hq
30-49	0.55	0.50	0.54	0.48	0.55	0.47
50-99	0.57	0.53	0.57	0.50	0.58	0.50
100-199	0.58	0.54	0.61	0.55	0.60	0.54
200-299	0.59	0.56	0.60	0.60	0.59	0.56
300-	0.62	0.60	0.58	0.70	0.65	0.61

Information Services

	Data Score 2		Management Score	
Size	Branch	Hq	Branch	Hq
30-49	0.36	0.26	0.49	0.39
50-99	0.42	0.34	0.54	0.44
100-199	0.43	0.38	0.53	0.49
200-299	0.58	0.43	0.54	0.53
300-	0.60	0.50	0.59	0.55

Medical and Other Health Services

	Data Score 1		Data Score 2		Management Score	
Size	Branch	Hq	Branch	Hq	Branch	Hq
30-49	0.45	0.44	0.44	0.44	0.37	0.35
50-99	0.47	0.40	0.53	0.38	0.43	0.33
100-199	0.46	0.43	0.52	0.43	0.46	0.39
200-299	0.48	0.48	0.53	0.50	0.50	0.47
300-	0.53	0.52	0.58	0.55	0.52	0.50

Notes*: Data score 1, data score 2*, and *management score* are calculated by the present year's responses.

Table 4 (a): Summary Statistics - Road Freight Transport, Wholesale Trade, and Medical and Other Health Services

Road Freight Transport							
2018	N	mean	sd	10% point	median	90% point	90-10 spread
Innovation 1	866	1.63	0.87	1	1	3	2
Innovation 2	869	1.88	0.98	1	2	3	2
Innovation 3	860	1.83	0.97	1	2	3	2
Innovation 4	870	1.76	0.95	1	1	3	2
Innovation 5	871	1.97	1.03	1	2	4	3
d.Innovation 1	866	0.42	0.49	0	0	1	1
d.Innovation 2	869	0.54	0.50	0	1	1	1
d.Innovation 3	860	0.51	0.50	0	1	1	1
d.Innovation 4	870	0.47	0.50	0	0	1	1
d.Innovation 5	871	0.57	0.50	0	1	1	1
Data Score	907	0.48	0.16	0.27	0.49	0.68	0.41
Data Score 2	897	0.46	0.25	0.13	0.47	0.75	0.63
Management Score	907	0.48	0.19	0.21	0.49	0.73	0.51
d.Data Score	907	0.56	0.50	0	1	1	1
lemp	907	4.34	0.71	3.53	4.20	5.25	1.72
dumhq	907	0.44	0.50	0	0	1	1
cmp	907	3.21	1.48	1	3	5	4
univm	907	1.69	1.26	1	1	4	3
unive	907	2.32	0.88	1	2	4	3
CIO	907	1.27	0.59	1	1	2	1
Q34_1score	907	2.17	0.80	1	2	3	2
Q34_2score	907	2.33	0.76	1	3	3	2
Decentralization Score	508	0.33	0.19	0.06	0.33	0.58	0.52
2013							
Data Score	869	0.41	0.17	0.18	0.41	0.63	0.45
Data Score 2	858	0.39	0.26	0.06	0.38	0.75	0.69
Management Score	869	0.45	0.19	0.19	0.45	0.70	0.51
d.Data Score	869	0.52	0.50	0	1	1	1
dumhq	869	0.44	0.50	0	0	1	1
univm	869	1.61	1.21	1	1	4	3
unive	869	2.24	0.89	1	2	4	3
Wholesale Trade							
2018	N	mean	sd	10% point	median	90% point	90-10 spread
Innovation 1	3047	2.20	1.10	1	2	4	3
Innovation 2	3036	2.33	1.10	1	2	4	3
Innovation 3	3027	2.19	1.09	1	2	4	3
Innovation 4	3037	1.98	0.95	1	2	3	2
Innovation 5	3043	2.17	1.02	1	2	4	3
d.Innovation 1	3047	0.67	0.47	0	1	1	1
d.Innovation 2	3036	0.71	0.45	0	1	1	1
d.Innovation 3	3027	0.66	0.47	0	1	1	1
d.Innovation 4	3037	0.64	0.48	0	1	1	1
d.Innovation 5	3043	0.69	0.46	0	1	1	1
Data Score	3115	0.54	0.14	0.36	0.54	0.71	0.35
Data Score 2	3093	0.53	0.23	0.25	0.53	0.79	0.54
Management Score	3115	0.53	0.16	0.31	0.53	0.73	0.41
d.Data Score	3115	0.52	0.50	0	1	1	1
lemp	3115	4.17	0.69	3.47	3.99	5.06	1.60
dumhq	3115	0.64	0.48	0	1	1	1
cmp	3115	3.65	1.44	1	4	5	4
univm	3115	3.28	1.61	1	4	5	4
unive	3115	3.46	0.87	2	4	4	2
CIO	3115	1.26	0.55	1	1	2	1
Q34_1score	3115	2.05	0.79	1	2	3	2

Q34_2score	3115	2.07	0.76	1	2	3	2
Decentralization Score	1109	0.28	0.20	0	0.25	0.54	0.54
2013							
Data Score	3025	0.46	0.15	0.28	0.46	0.66	0.38
Data Score 2	2999	0.49	0.24	0.19	0.50	0.75	0.56
Management Score	3025	0.51	0.16	0.29	0.51	0.71	0.42
d.Data Score	3025	0.50	0.50	0	1	1	1
dumhq	3025	0.64	0.48	0	1	1	1
univm	3025	3.18	1.64	1	3	5	4
unive	3025	3.40	0.91	2	4	4	2
	Medical and Other Health Services						
2018	N	mean	sd	10% point	median	90% point	90-10 spread
Innovation 1	1204	1.67	0.84	1	1	3	2
Innovation 2	1200	1.87	0.95	1	2	3	2
Innovation 3	1193	1.71	0.90	1	1	3	2
Innovation 4	1196	1.73	0.88	1	1	3	2
Innovation 5	1200	1.96	1.00	1	2	3.5	2.5
d.Innovation 1	1204	0.47	0.50	0	0	1	1
d.Innovation 2	1200	0.55	0.50	0	1	1	1
d.Innovation 3	1193	0.46	0.50	0	0	1	1
d.Innovation 4	1196	0.50	0.50	0	0	1	1
d.Innovation 5	1200	0.58	0.49	0	1	1	1
Data Score	1255	0.45	0.15	0.25	0.46	0.63	0.38
Data Score 2	1240	0.47	0.24	0.13	0.50	0.75	0.63
Management Score	1255	0.41	0.18	0.17	0.41	0.64	0.47
d.Data Score	1255	0.58	0.49	0	1	1	1
lemp	1255	4.80	0.97	3.56	4.78	6.07	2.51
dumhq	1255	0.72	0.45	0	1	1	1
cmp	1255	3.61	1.34	2	4	5	3
univm	1255	2.72	1.57	1	2	5	4
unive	1255	2.97	0.93	2	3	4	2
CIO	1255	1.10	0.37	1	1	1	0
Q34_1score	1255	1.99	0.77	1	2	3	2
Q34_2score	1255	2.23	0.74	1	2	3	2
Decentralization Score	341	0.46	0.22	0.19	0.42	0.79	0.60
2013							
Data Score	1195	0.37	0.16	0.16	0.38	0.56	0.40
Data Score 2	1176	0.42	0.24	0.06	0.44	0.75	0.69
Management Score	1195	0.38	0.17	0.15	0.38	0.61	0.46
d.Data Score	1195	0.55	0.50	0	1	1	1
dumhq	1195	0.74	0.44	0	1	1	1
univm	1195	2.65	1.57	1	2	5	4
unive	1195	2.88	0.95	2	3	4	2

Source: The JP-MOPS(2018)

Notes: Innovations 1, 2, 3, 4, and 5 denote the development and introduction of new products/services, the improvement of existing products/services, the new combination of existing products/services, the introduction of new processes, and process improvements, respectively.

Table 4 (b): Summary Statistics - Retail Trade and Information Services

Retail Trade							
2015	N	mean	sd	10% point	median	90% point	90-10 spread
Innovation 1	1018	3.22	1.12	1	4	4	3
Innovation 2	1018	3.22	1.08	1	4	4	3
Innovation 3	993	3.08	1.13	1	4	4	3
Innovation 4	1013	2.60	1.08	1	3	4	3
Innovation 5	1012	2.75	1.12	1	3	4	3
d.Innovation 1	1018	0.86	0.35	0	1	1	1
d.Innovation 2	1018	0.87	0.33	0	1	1	1
d.Innovation 3	993	0.84	0.37	0	1	1	1
d.Innovation 4	1013	0.79	0.41	0	1	1	1
d.Innovation 5	1012	0.80	0.40	0	1	1	1
Data Score 2	1042	0.56	0.25	0.22	0.57	0.85	0.64
Management Score	1042	0.52	0.17	0.29	0.52	0.74	0.45
lemp	1042	4.41	0.67	3.56	4.41	5.28	1.72
dumhq	1042	0.33	0.47	0	0	1	1
cmp	1042	3.11	1.03	2	3	5	3
univm	1042	3.05	1.71	1	3	5	4
unive	1042	2.96	1.07	1	3	4	3
Q34_1score	1042	2.13	0.78	1	2	3	2
Q34_2score	1042	2.23	0.75	1	2	3	2
2010							
Data Score 2	984	0.51	0.25	0.15	0.50	0.82	0.68
Management Score	984	0.49	0.17	0.26	0.50	0.71	0.45
dumhq	984	0.32	0.47	0	0	1	1
univm	984	2.88	1.74	1	3	5	4
unive	984	2.86	1.07	1	3	4	3
Information Services							
2015	N	mean	sd	10% point	median	90% point	90-10 spread
Innovation 1	807	2.13	0.94	1	2	4	3
Innovation 2	803	2.55	1.10	1	3	4	3
Innovation 3	801	2.21	1.04	1	2	4	3
Innovation 4	808	2.15	0.97	1	2	4	3
Innovation 5	809	2.51	1.02	1	2	4	3
d.Innovation 1	807	0.73	0.44	0	1	1	1
d.Innovation 2	803	0.79	0.41	0	1	1	1
d.Innovation 3	801	0.70	0.46	0	1	1	1
d.Innovation 4	808	0.71	0.45	0	1	1	1
d.Innovation 5	809	0.81	0.39	0	1	1	1
Data Score 2	818	0.37	0.27	0	0.36	0.75	0.75
Management Score	818	0.48	0.16	0.25	0.48	0.68	0.43
lemp	818	4.47	0.85	3.53	4.29	5.61	2.08
dumhq	818	0.68	0.46	0	1	1	1
cmp	818	2.98	1.63	1	3	5	4
univm	818	3.55	1.48	1	4	5	4
unive	818	3.77	0.60	3	4	4	1
Q34_1score	818	1.82	0.77	1	2	3	2
Q34_2score	818	1.92	0.76	1	2	3	2
2010							
Data Score 2	794	0.33	0.26	0	0.29	0.75	0.75
Management Score	794	0.44	0.16	0.22	0.44	0.66	0.43
dumhq	794	0.70	0.46	0	1	1	1
univm	794	3.45	1.52	1	4	5	4
unive	794	3.70	0.68	3	4	4	1

Source: The JP-MOPS(2017)

Table 5: Characteristics of Establishments that Use Data Intensively

	Data		
	(1)	(2)	(3)

management	0.365***	0.301***	0.298***
	(0.0285)	(0.0154)	(0.0244)
dumhq	0.00451	-0.0134***	-0.00311
	(0.0101)	(0.00489)	(0.00898)
univm	-0.00610	0.00228	0.00343
	(0.00407)	(0.00183)	(0.00289)
unive	0.00641	0.0107***	0.0120**
	(0.00594)	(0.00340)	(0.00505)
lemp	0.0165**	0.0126***	0.00931**
	(0.00693)	(0.00342)	(0.00443)
cmp	0.00798**	0.00272*	0.00613**
	(0.00321)	(0.00158)	(0.00293)
Q34_1score	0.00641	-0.000383	0.00358
	(0.00595)	(0.00289)	(0.00508)
Q34_2score	-0.0122**	-0.00463	-0.00781
	(0.00620)	(0.00301)	(0.00526)
CIO	0.0154*	0.0287***	0.0439***
	(0.00849)	(0.00426)	(0.0107)
_cons	0.195***	0.254***	0.184***
	(0.0377)	(0.0197)	(0.0312)
N	907	3115	1255
adj. R-sq	0.244	0.203	0.186
F	33.51	89.26	32.86

Notes: OLS coefficients with standard errors in parentheses. The dependent variable is *data score 1*. Columns 1, 2, and 3 report the estimation results in road freight transport, wholesale trade, and medical and other health services, respectively. Management denotes *management score*. Dumhq denotes the dummy of headquarter status, which takes 1 if the establishment is a headquarter. Univm and unive denote the ratio of managers and non-managers with a bachelor's degree, respectively. Lemp denotes the logged number of employees. Cmp denotes the number of establishments directly competing with an establishment. Q34_1score (from 1 (specialization) to 3 (coordination)) and Q34_2score (from 1 (creativity) to 3 (efficiency)) denote characteristics of jobs. CIO denotes the presence of the CIO. All results shown in Appendices follow the same definitions. N denotes the number of observations.
*** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.

Table 6: The Correlation between Innovation Outcomes and *Data Score 1*, *Data Score 2*, and *Management Score*

Road Freight Transport	Innovation 1	Innovation 2	Innovation 3	Innovation 4	Innovation 5
Data Score 1	0.38	0.36	0.36	0.38	0.39
Data Score 2	0.39	0.38	0.39	0.39	0.39
Management Score	0.40	0.39	0.40	0.40	0.41
Wholesale Trade	Innovation 1	Innovation 2	Innovation 3	Innovation 4	Innovation 5
Data Score 1	0.27	0.28	0.30	0.32	0.31
Data Score 2	0.30	0.32	0.31	0.31	0.31
Management Score	0.25	0.27	0.28	0.29	0.32
Medical and Other Health Services	Innovation 1	Innovation 2	Innovation 3	Innovation 4	Innovation 5
Data Score 1	0.28	0.31	0.30	0.30	0.34
Data Score 2	0.31	0.31	0.31	0.30	0.28
Management Score	0.29	0.27	0.28	0.28	0.31
Retail Trade	Innovation 1	Innovation 2	Innovation 3	Innovation 4	Innovation 5
Data Score 2	0.38	0.39	0.41	0.48	0.53
Management Score	0.23	0.23	0.23	0.27	0.34
Information Services	Innovation 1	Innovation 2	Innovation 3	Innovation 4	Innovation 5
Data Score 2	0.47	0.45	0.44	0.43	0.39
Management Score	0.29	0.33	0.32	0.33	0.32

Notes: *Data score 1, data score 2*, and *management score* are calculated by the present year's responses.

Table 7: Data Activities and Innovation Performance by the Probit Model

	Innovation 1			Innovation 2			Innovation 3			Innovation 4			Innovation 5		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Road Freight Transport															
data	1.007***	0.709***	0.409***	0.984***	0.676***	0.314**	1.015***	0.702***	0.342***	0.894***	0.608***	0.319**	0.871***	0.599***	0.262**
	(0.126)	(0.135)	(0.127)	(0.125)	(0.135)	(0.127)	(0.129)	(0.139)	(0.129)	(0.125)	(0.135)	(0.128)	(0.122)	(0.132)	(0.124)
management		0.759***	0.787***		0.828***	0.822***		0.840***	0.820***		0.720***	0.670***		0.677***	0.702***
		(0.122)	(0.126)		(0.122)	(0.125)		(0.126)	(0.128)		(0.122)	(0.125)		(0.119)	(0.122)
Pseudo R^2	0.151	0.185	0.159	0.132	0.171	0.138	0.148	0.187	0.152	0.133	0.163	0.138	0.124	0.151	0.129
N	866	866	833	869	869	835	860	860	827	870	870	837	871	871	837
Wholesale Trade															
data	0.679***	0.529***	0.379***	0.676***	0.531***	0.337***	0.766***	0.606***	0.389***	0.927***	0.751***	0.502***	0.786***	0.598***	0.348***
	(0.0669)	(0.0704)	(0.0664)	(0.0634)	(0.0667)	(0.0628)	(0.0684)	(0.0718)	(0.0670)	(0.0711)	(0.0744)	(0.0689)	(0.0663)	(0.0693)	(0.0645)
management		0.429***	0.419***		0.416***	0.436***		0.482***	0.486***		0.542***	0.474***		0.575***	0.533***
		(0.0643)	(0.0656)		(0.0607)	(0.0623)		(0.0653)	(0.0666)		(0.0669)	(0.0678)		(0.0632)	(0.0643)
Pseudo R^2	0.088	0.099	0.089	0.089	0.103	0.088	0.097	0.111	0.095	0.104	0.121	0.098	0.100	0.123	0.097
N	3047	3047	2961	3028	3028	2945	3027	3027	2943	3028	3028	2947	3043	3043	2959
Medical and Other Health Services															
data	0.852***	0.629***	0.378***	0.849***	0.648***	0.383***	0.880***	0.675***	0.422***	0.896***	0.683***	0.440***	0.968***	0.740***	0.496***
	(0.108)	(0.114)	(0.108)	(0.106)	(0.112)	(0.107)	(0.109)	(0.114)	(0.108)	(0.109)	(0.114)	(0.108)	(0.107)	(0.113)	(0.107)
management		0.675***	0.665***		0.604***	0.561***		0.622***	0.572***		0.655***	0.564***		0.718***	0.601***
		Yes	(0.105)		(0.100)	(0.103)		(0.101)	(0.104)		(0.101)	(0.104)		(0.101)	(0.103)
Pseudo R^2	0.072	0.099	0.082	0.071	0.093	0.072	0.071	0.095	0.072	0.076	0.102	0.077	0.087	0.118	0.087
N	1204	1204	1151	1200	1200	1148	1193	1193	1141	1196	1196	1142	1200	1200	1148

Notes: Marginal effects with the standard errors in parentheses. Dependent variables are the dummy variables of innovation outcomes constructed from the responses in question 33, which take 1 if the innovation realizes at least once in five years (2013-2018). Columns 1 and 2 show the marginal effects by the probit model without and with management score, respectively. Column 3 shows the marginal effects by the probit model, which uses independent variables in the recall year if they exist (i.e., data score 1 (data), management score (management), the dummy of headquarter status, the ratio of managers with a bachelor's degree, the ratio of non-managers with a bachelor's degree). Independent variables are data score 1 (data), management score (management), the dummy of headquarter status, the ratio of managers with a bachelor's degree, the ratio of non-managers with a bachelor's degree, the logged number of employees, the number of establishments directly competing with an establishment, characteristics of jobs, and the presence of the CIO. In wholesale trade, disaggregated industry group dummies are also included. See Appendix 2-1 for the full results of all dependent variables. Pseudo R2 denotes McFadden's pseudo R-squared, and N denotes the number of observations.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Table 8: Data Activities and Innovation Performance by the Ordered Probit Model

	Road Freight Transport					Wholesale Trade					Medical and Other Health Services				
	Innovation 1	Innovation 2	Innovation 3	Innovation 4	Innovation 5	Innovation 1	Innovation 2	Innovation 3	Innovation 4	Innovation 5	Innovation 1	Innovation 2	Innovation 3	Innovation 4	Innovation 5
Coefficients															
data	2.023***	1.773***	1.728***	1.975***	1.885***	1.483***	1.567***	1.693***	1.927***	1.756***	1.641***	1.880***	1.828***	1.789***	2.052***
	(0.313)	(0.289)	(0.295)	(0.302)	(0.288)	(0.163)	(0.163)	(0.164)	(0.166)	(0.163)	(0.258)	(0.250)	(0.261)	(0.254)	(0.249)
management	1.814***	1.642***	1.746***	1.642***	1.537***	1.127***	1.165***	1.150***	1.309***	1.551***	1.438***	1.258***	1.424***	1.434***	1.552***
	(0.282)	(0.262)	(0.272)	(0.271)	(0.260)	(0.149)	(0.148)	(0.149)	(0.150)	(0.149)	(0.225)	(0.217)	(0.225)	(0.222)	(0.216)
Marginal Effects															
data															
1._predict	-0.781***	-0.703***	-0.689***	-0.785***	-0.736***	-0.528***	-0.511***	-0.610***	-0.714***	-0.606***	-0.653***	-0.743***	-0.725***	-0.714***	-0.800***
	(0.120)	(0.114)	(0.118)	(0.120)	(0.113)	(0.058)	(0.053)	(0.059)	(0.062)	(0.057)	(0.103)	(0.099)	(0.103)	(0.101)	(0.097)
2._predict	0.383***	0.186***	0.208***	0.289***	0.144***	-0.005	-0.092***	-0.013	0.146***	-0.019	0.310***	0.186***	0.265***	0.281***	0.144***
	(0.067)	(0.039)	(0.043)	(0.052)	(0.034)	(0.010)	(0.014)	(0.011)	(0.020)	(0.013)	(0.054)	(0.033)	(0.044)	(0.046)	(0.029)
3._predict	0.286***	0.310***	0.303***	0.315***	0.315***	0.165***	0.192***	0.238***	0.298***	0.283***	0.228***	0.346***	0.317***	0.293***	0.368***
	(0.050)	(0.055)	(0.056)	(0.054)	(0.054)	(0.020)	(0.022)	(0.026)	(0.029)	(0.029)	(0.039)	(0.051)	(0.049)	(0.045)	(0.050)
4._predict	0.112***	0.207***	0.179***	0.180***	0.276***	0.367***	0.412***	0.385***	0.270***	0.342***	0.115***	0.212***	0.143***	0.140***	0.288***
	(0.023)	(0.038)	(0.035)	(0.033)	(0.046)	(0.041)	(0.043)	(0.038)	(0.025)	(0.033)	(0.022)	(0.032)	(0.025)	(0.024)	(0.039)
management															
1._predict	-0.700***	-0.651***	-0.697***	-0.652***	-0.600***	-0.401***	-0.380***	-0.414***	-0.485***	-0.535***	-0.572***	-0.497***	-0.565***	-0.572***	-0.605***
	(0.109)	(0.104)	(0.108)	(0.107)	(0.101)	(0.053)	(0.049)	(0.054)	(0.056)	(0.052)	(0.089)	(0.086)	(0.089)	(0.089)	(0.084)
2._predict	0.343***	Yes	0.210***	0.241***	0.118***	-0.004	-0.069***	-0.009	0.099***	-0.017	0.272***	0.124***	0.206***	0.225***	0.109***
	(0.060)	(0.036)	(0.041)	(0.047)	(0.029)	(0.008)	(0.012)	(0.008)	(0.016)	(0.012)	(0.047)	(0.026)	(0.037)	(0.040)	(0.023)
3._predict	0.257***	0.287***	0.306***	0.262***	0.257***	0.126***	0.142***	0.162***	0.203***	0.250***	0.200***	0.232***	0.247***	0.235***	0.279***
	(0.044)	(0.050)	(0.052)	(0.047)	(0.048)	(0.018)	(0.020)	(0.022)	(0.025)	(0.026)	(0.034)	(0.042)	(0.042)	(0.039)	(0.042)
4._predict	0.100***	0.192***	0.181***	0.150***	0.225***	0.279***	0.307***	0.262***	0.183***	0.302***	0.100***	0.142***	0.112***	0.112***	0.218***
	(0.021)	(0.035)	(0.033)	(0.029)	(0.041)	(0.037)	(0.039)	(0.034)	(0.022)	(0.030)	(0.019)	(0.027)	(0.021)	(0.021)	(0.033)
Pseudo R^2	0.127	0.100	0.109	0.115	0.106	0.062	0.070	0.069	0.075	0.070	0.069	0.066	0.069	0.069	0.077
N	866	869	860	870	871	3047	3036	3027	3037	3043	1204	1200	1193	1196	1200

Notes: Coefficients and marginal effects with the standard errors in parentheses. Dependent variables are innovation outcomes constructed from the responses in question 33, which takes 0 if the innovation unrealizes, 1 if it realizes once every few years, 2 if it realizes once a year, 3 if it realizes more than once a year. Independent variables are data score 1 (data), management score (management), the dummy of headquarter status, the ratio of managers with a bachelor's degree, the ratio of non-managers with a bachelor's degree, the logged number of employees, the number of establishments directly competing with an establishment, characteristics of jobs, and the presence of the CIO. In wholesale trade, disaggregated industry group dummies are also included. See Appendix 2-2 for the full results of all dependent variables. Pseudo R2 denotes McFadden's pseudo R-squared, and N denotes the number of observations.

*** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.

Table 9: Data Activities and Innovation Performance by the Propensity Score Matching

	Road Freight Transport					Wholesale Trade					Medical and Other Health Services				
	Innovation 1	Innovation 2	Innovation 3	Innovation 4	Innovation 5	Innovation 1	Innovation 2	Innovation 3	Innovation 4	Innovation 5	Innovation 1	Innovation 2	Innovation 3	Innovation 4	Innovation 5
Average Marginal Effect															
data	0.112**	0.125***	0.147***	0.114**	0.0918**	0.124***	0.0847***	0.129***	0.147***	0.118***	0.101**	0.109***	0.0863**	0.110***	0.104***
	(0.0452)	(0.0419)	(0.0403)	(0.0478)	(0.0395)	(0.0210)	(0.0197)	(0.0217)	(0.0208)	(0.0199)	(0.0395)	(0.0393)	(0.0352)	(0.0356)	(0.0385)
Standardized Differences															
management	-0.04	-0.01	-0.01	-0.05	-0.01	-0.01	-0.01	0.01	-0.01	0.00	0.05	0.06	0.05	-0.01	0.03
dumhq	-0.02	0.00	-0.08	-0.01	0.02	-0.02	0.02	0.05	-0.01	-0.01	0.02	0.02	0.01	0.00	0.04
univm	0.01	0.02	0.08	-0.01	-0.03	0.01	0.05	-0.02	0.01	0.02	0.01	-0.02	0.01	0.07	0.01
unive	-0.01	0.00	0.00	0.08	-0.04	-0.02	0.03	0.02	0.00	0.03	0.04	0.04	0.10	0.10	0.05
lemp	0.07	0.03	0.01	0.09	0.01	0.01	0.04	0.05	0.02	0.02	-0.04	-0.03	-0.02	-0.01	-0.04
cmp	0.09	0.01	0.09	0.04	0.04	-0.05	-0.06	-0.01	-0.02	0.02	-0.03	0.02	0.03	0.07	0.04
Q34_1score	0.10	0.04	0.05	0.05	0.01	0.01	0.04	0.03	-0.01	0.06	0.02	0.02	0.07	0.02	0.02
Q34_2score	-0.02	-0.02	0.04	-0.04	0.00	-0.07	0.01	0.00	-0.03	0.02	-0.02	-0.03	-0.03	-0.01	-0.01
CIO	-0.06	-0.03	0.00	-0.02	0.01	-0.04	-0.03	0.00	-0.01	-0.05	-0.07	-0.11	-0.12	-0.04	-0.05
N	866	869	860	870	871	3047	3036	3027	3037	3043	1204	1200	1193	1196	1200

Notes: Average marginal effects with the standard errors in parentheses. Outcome variables are the dummy variables of innovation outcomes constructed from the responses in question 33, which take 1 if the innovation realizes at least once in five years (2013-2018). We construct a binary variable (called binary data score) that takes 0 if data score 1 is at or below the industry mean and takes 1 if it is above the industry mean. The Table shows the average marginal effect of data activities on innovation realization, the propensity to innovate when binary data score (data) changes from 0 to 1. The propensity score is calculated by the estimated probit model whose independent variables include management score, the dummy of headquarter status, the ratio of managers with a bachelor's degree, the ratio of non-managers with a bachelor's degree, the logged number of employees, the number of establishments directly competing with an establishment, characteristics of jobs and the presence of the CIO. N denotes the number of observations. Standardized Differences show standardized differences of independent variables after matched for dependent variables. In wholesale trade, they are below 0.1 for all disaggregated industry group dummies (not shown in the Table).

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Table 10 (a): The Contribution of Data Activities Compared to that of Management in Three Industries

	Innovation 1			Innovation 2			Innovation 3			Innovation 4			Innovation 5		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Road Freight Transport															
data	1.643***		1.185***	1.781***		1.277***	1.704***		1.195***	1.831***		1.359***	1.971***		1.462***
	(0.182)		(0.191)	(0.198)		(0.211)	(0.202)		(0.215)	(0.192)		(0.202)	(0.194)		(0.207)
management		1.509***	1.063***		1.655***	1.182***		1.639***	1.192***		1.614***	1.106***		1.732***	1.189***
		(0.166)	(0.172)		(0.181)	(0.192)		(0.183)	(0.196)		(0.181)	(0.188)		(0.191)	(0.201)
adj. R-sq	0.179	0.176	0.212	0.162	0.162	0.194	0.170	0.174	0.203	0.183	0.174	0.213	0.194	0.184	0.223
F	21.26	24.00	25.08	20.29	21.74	25.41	21.78	26.00	27.99	23.25	24.86	27.16	26.63	26.95	31.71
N	866	866	866	869	869	869	860	860	860	870	870	870	871	871	871
Share of 90-10 explained															
data	33.7%		24.3%	36.2%		26.0%	34.8%		24.4%	37.3%		27.7%	26.5%		19.7%
management		39.0%	27.5%		42.8%	30.6%		42.2%	30.7%		41.6%	28.5%		29.8%	20.5%
Wholesale Trade															
data	1.638***		1.304***	1.724***		1.378***	1.799***		1.457***	1.750***		1.416***	1.886***		1.425***
	(0.139)		(0.148)	(0.138)		(0.147)	(0.135)		(0.143)	(0.117)		(0.125)	(0.124)		(0.134)
management		1.306***	0.909***		1.351***	0.928***		1.373***	0.930***		1.338***	0.911***		1.687***	1.257***
		(0.127)	(0.134)		(0.128)	(0.136)		(0.125)	(0.132)		(0.106)	(0.113)		(0.114)	(0.122)
adj. R-sq	0.100	0.090	0.112	0.121	0.110	0.134	0.127	0.113	0.141	0.132	0.115	0.150	0.120	0.118	0.149
F	44.53	41.45	48.23	54.27	49.22	56.86	57.92	51.52	60.16	57.48	49.05	62.37	54.03	51.99	65.57
N	3047	3047	3047	3036	3036	3036	3027	3027	3027	3037	3037	3037	3043	3043	3043
Share of 90-10 explained															
data	19.1%		15.2%	20.2%		16.2%	21.1%		17.1%	30.8%		24.9%	22.0%		16.6%
management		18.0%	12.5%		18.7%	12.9%		19.0%	12.9%		28.0%	19.1%		23.3%	17.4%
Medical and Other Health Services															
data	1.375***		1.028***	1.778***		1.424***	1.609***		1.235***	1.545***		1.184***	2.026***		1.571***
	(0.153)		(0.167)	(0.161)		(0.177)	(0.158)		(0.169)	(0.153)		(0.164)	(0.171)		(0.182)
management		1.255***	0.944***		1.393***	0.963***		1.392***	1.018***		1.353***	0.994***		1.723***	1.248***
		(0.147)	(0.160)		(0.170)	(0.183)		(0.155)	(0.165)		(0.154)	(0.163)		(0.176)	(0.186)
adj. R-sq	0.097	0.098	0.125	0.113	0.095	0.136	0.104	0.098	0.133	0.101	0.096	0.130	0.129	0.118	0.164
F	15.49	15.01	19.68	20.60	14.98	23.07	17.96	15.28	21.46	18.28	15.33	21.97	25.08	19.32	29.56
N	1204	1204	1204	1200	1200	1200	1193	1193	1193	1196	1196	1196	1200	1200	1200
Share of 90-10 explained															
data	26.2%		19.6%	33.9%		27.1%	30.7%		23.6%	29.7%		22.7%	31.0%		24.0%
management		29.8%	22.4%		33.0%	22.8%		33.0%	24.1%		32.1%	23.6%		32.5%	23.5%

Notes: OLS coefficients with the standard errors in parentheses. Dependent variables are innovation outcomes constructed from the responses in question 33. Key independent variables are data score 1 in column 1, management score in column 2, and both in column 3. All regressions also include as independent variables the dummy of headquarter status, the ratio of managers with a bachelor's degree, the ratio of non-managers with a bachelor's degree, the logged number of employees, the number of establishments directly competing with an establishment, characteristics of jobs and, the presence of the CIO. OLS coefficients of data score 1 (data) and management score (management) are shown. Share of 90-10 explained is calculated by multiplying the estimated coefficient by the 90-10 spread of each key variable and dividing it by the 90-10 spread of innovation outcome. N denotes the number of observations.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Table 10 (b): The Contribution of Data Activities Compared to that of Management in Five Industries

	Innovation 1			Innovation 2			Innovation 3			Innovation 4			Innovation 5		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Road Freight Transport															
data2	1.178***		0.853***	1.285***		0.942***	1.314***		0.975***	1.284***		0.954***	1.365***		1.009***
	(0.112)		(0.121)	(0.127)		(0.135)	(0.125)		(0.134)	(0.118)		(0.123)	(0.128)		(0.136)
management		1.645***	1.178***		1.760***	1.249***		1.776***	1.244***		1.742***	1.217***		1.870***	1.323***
		(0.160)	(0.173)		(0.179)	(0.190)		(0.178)	(0.192)		(0.175)	(0.183)		(0.186)	(0.197)
adj. R-sq	0.169	0.167	0.212	0.163	0.158	0.202	0.176	0.167	0.215	0.177	0.167	0.215	0.187	0.180	0.226
F	24.99	25.17	29.97	25.14	23.65	29.71	28.09	27.79	34.72	25.49	26.43	30.27	27.74	29.73	33.93
N	858	858	858	861	861	861	852	852	852	862	862	862	862	862	862
Share of 90-10 explained															
data	29.4%		21.3%	32.1%		23.6%	32.9%		24.4%	40.1%		29.8%	28.4%		21.0%
management		31.7%	22.7%		33.9%	24.1%		34.2%	23.9%		44.5%	31.1%		31.8%	22.5%
Wholesale Trade															
data2	1.284***		1.104***	1.388***		1.205***	1.295***		1.097***	1.157***		0.958***	1.268***		1.005***
	(0.0871)		(0.0918)	(0.0850)		(0.0894)	(0.0858)		(0.0898)	(0.0763)		(0.0798)	(0.0801)		(0.0842)
management		1.399***	0.947***		1.445***	0.950***		1.486***	1.038***		1.426***	1.033***		1.777***	1.363***
		(0.126)	(0.131)		(0.128)	(0.132)		(0.125)	(0.130)		(0.106)	(0.110)		(0.114)	(0.118)
adj. R-sq	0.112	0.083	0.126	0.137	0.100	0.152	0.127	0.101	0.145	0.127	0.107	0.150	0.117	0.111	0.153
F	54.19	41.73	60.23	69.30	48.07	72.64	62.58	49.81	68.98	58.06	50.14	67.29	56.01	53.43	74.43
N	3020	3020	3020	3008	3008	3008	3000	3000	3000	3007	3007	3007	3013	3013	3013
Share of 90-10 explained															
data	23.0%		19.7%	24.6%		21.3%	22.9%		19.4%	30.7%		25.4%	22.4%		17.8%
management		19.3%	13.1%		20.0%	13.2%		20.6%	14.4%		29.7%	21.5%		24.5%	18.8%
Medical and Other Services															
data2	0.973***		0.755***	1.133***		0.894***	1.082***		0.835***	1.023***		0.783***	1.069***		0.730***
	(0.101)		(0.110)	(0.110)		(0.118)	(0.108)		(0.117)	(0.106)		(0.114)	(0.119)		(0.126)
management		1.294***	0.936***		1.441***	1.013***		1.451***	1.051***		1.397***	1.020***		1.783***	1.431***
		(0.148)	(0.159)		(0.171)	(0.182)		(0.157)	(0.167)		(0.155)	(0.165)		(0.177)	(0.190)
adj. R-sq	0.105	0.096	0.133	0.108	0.093	0.133	0.104	0.096	0.135	0.100	0.093	0.129	0.093	0.115	0.139
F	18.15	16.66	22.67	20.40	16.29	23.14	18.76	17.10	23.50	18.20	16.57	22.33	17.21	20.13	23.40
N	1193	1193	1193	1190	1190	1190	1183	1183	1183	1186	1186	1186	1190	1190	1190
Share of 90-10 explained															
data	30.4%		23.6%	35.4%		27.9%	33.8%		26.1%	32.0%		24.5%	22.3%		15.2%
management		30.7%	22.2%		34.2%	24.0%		34.4%	24.9%		33.1%	24.2%		28.2%	22.6%
Retail Trade															
data2	1.523***		1.393***	1.504***		1.385***	1.701***		1.597***	1.789***		1.664***	2.027***		1.826***
	(0.142)		(0.148)	(0.139)		(0.145)	(0.140)		(0.146)	(0.128)		(0.134)	(0.129)		(0.137)
management		1.349***	0.774***		1.280***	0.704**		1.296***	0.689**		1.430***	0.750***		1.949***	1.202***
		(0.240)	(0.228)		(0.229)	(0.219)		(0.242)	(0.230)		(0.226)	(0.215)		(0.218)	(0.204)
adj. R-sq	0.170	0.099	0.180	0.176	0.099	0.185	0.188	0.089	0.195	0.264	0.150	0.273	0.316	0.200	0.340
F	27.57	14.24	25.18	28.86	14.29	26.58	31.79	13.51	29.34	48.74	25.00	44.33	61.89	33.64	59.89
N	1018	1018	1018	1018	1018	1018	993	993	993	1013	1013	1013	1012	1012	1012
Share of 90-10 explained															
data	32.5%		29.7%	64.2%		59.2%	36.3%		34.1%	38.2%		35.5%	43.3%		39.0%
management		21.9%	12.6%		41.7%	22.9%		21.3%	11.3%		23.2%	12.2%		31.5%	19.4%
Information Services															
data2	1.429***		1.371***	1.625***		1.454***	1.513***		1.358***	1.315***		1.175***	1.250***		1.070***
	(0.122)		(0.133)	(0.134)		(0.142)	(0.132)		(0.140)	(0.123)		(0.135)	(0.130)		(0.140)
management		1.081***	0.299		1.715***	0.894***		1.585***	0.813***		1.400***	0.732**		1.541***	0.927***
		(0.215)	(0.214)		(0.246)	(0.246)		(0.228)	(0.224)		(0.214)	(0.226)		(0.229)	(0.238)
adj. R-sq	0.249	0.135	0.250	0.228	0.144	0.240	0.213	0.130	0.223	0.228	0.157	0.237	0.185	0.140	0.199
F	33.59	17.95	30.85	34.78	20.14	32.89	30.09	18.95	29.66	36.32	22.88	36.25	27.19	18.46	26.35
N	807	807	807	803	803	803	801	801	801	808	808	808	809	809	809
Share of 90-10 explained															
data	28.8%		27.6%	49.1%		43.9%	30.5%		27.3%	26.5%		23.7%	37.8%		32.3%
management		11.1%	3.1%		26.3%	13.7%		16.2%	8.3%		14.3%	7.5%		23.2%	14.0%

Notes: OLS coefficients with the standard errors in parentheses. Dependent variables are innovation outcomes constructed from the responses in question 33. Key independent variables are data score 2 (data) in column 1, management score (management) in column 2, and both in column 3. All regressions also include as independent variables the dummy of headquarter status, the ratio of managers with a bachelor's degree, the ratio of non-managers with a bachelor's degree, the logged number of employees, the number of establishments directly competing with an establishment, and characteristics of jobs. Share of 90-10 explained is calculated by multiplying the estimated coefficient by the 90-10 spread of each key variable and dividing it by the 90-10 spread of innovation outcome. N denotes the number of observations.

*** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.

Table 11 (a): Subsample Analysis (Establishment Size and Single- or Multi-Unit Firms: Innovation 1, 2, and 3)

	Innovation1						Innovation2						Innovation3					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
	Small	Large	Branch	Hq	Hq-sm	Hq-lg	Small	Large	Branch	Hq	Hq-sm	Hq-lg	Small	Large	Branch	Hq	Hq-sm	Hq-lg
Road Freight Transport																		
data	0.477**	0.926***	0.725***	0.610***	0.342	0.900***	0.681***	0.661***	0.533***	0.759***	0.582**	0.913***	0.665***	0.742***	0.523***	0.851***	0.649**	1.026***
	(0.196)	(0.187)	(0.186)	(0.192)	(0.262)	(0.295)	(0.208)	(0.173)	(0.171)	(0.209)	(0.293)	(0.308)	(0.213)	(0.181)	(0.176)	(0.212)	(0.285)	(0.327)
management	0.916***	0.573***	0.928***	0.523***	0.599***	0.354	0.790***	0.836***	1.014***	0.586***	0.609***	0.594**	0.900***	0.741***	0.944***	0.660***	0.803***	0.407
	(0.164)	(0.174)	(0.180)	(0.156)	(0.189)	(0.260)	(0.169)	(0.170)	(0.171)	(0.167)	(0.207)	(0.277)	(0.174)	(0.174)	(0.173)	(0.170)	(0.209)	(0.280)
Pseudo R^2	0.207	0.171	0.199	0.149	0.130	0.171	0.175	0.154	0.165	0.153	0.145	0.156	0.212	0.159	0.168	0.175	0.169	0.178
N	412	454	488	378	200	178	413	456	490	379	201	178	410	450	487	373	200	173
Wholesale Trade																		
data	0.624***	0.453***	0.513***	0.560***	0.730***	0.432***	0.505***	0.583***	0.357***	0.659***	0.679***	0.702***	0.653***	0.576***	0.364***	0.775***	0.851***	0.718***
	(0.0984)	(0.104)	(0.109)	(0.0922)	(0.127)	(0.140)	(0.0926)	(0.0995)	(0.100)	(0.0884)	(0.122)	(0.136)	(0.101)	(0.105)	(0.108)	(0.0958)	(0.132)	(0.145)
management	0.369***	0.531***	0.390***	0.460***	0.362***	0.675***	0.468***	0.407***	0.401***	0.430***	0.414***	0.517***	0.429***	0.588***	0.449***	0.492***	0.381***	0.684***
	(0.0906)	(0.0929)	(0.104)	(0.0825)	(0.113)	(0.124)	(0.0853)	(0.0876)	(0.0955)	(0.0785)	(0.108)	(0.117)	(0.0920)	(0.0939)	(0.104)	(0.0840)	(0.115)	(0.126)
Pseudo R^2	0.103	0.113	0.110	0.102	0.103	0.125	0.110	0.107	0.105	0.110	0.107	0.126	0.104	0.129	0.106	0.119	0.119	0.137
N	1553	1478	1099	1937	1004	917	1550	1458	1093	1930	1004	911	1551	1455	1093	1927	1002	910
Medical and Other Health Services																		
data	0.657***	0.576***	0.876***	0.569***	0.581***	0.493**	0.712***	0.550***	1.046***	0.546***	0.657***	0.330	0.745***	0.588***	1.274***	0.528***	0.662***	0.309
	(0.152)	(0.170)	(0.234)	(0.130)	(0.166)	(0.209)	(0.153)	(0.166)	(0.230)	(0.129)	(0.169)	(0.204)	(0.155)	(0.169)	(0.254)	(0.130)	(0.169)	(0.204)
management	0.573***	0.573***	0.690***	0.681***	0.562***	0.781***	0.643***	0.634***	0.751***	0.594***	0.529***	0.680***	0.662***	0.585***	0.805***	0.598***	0.606***	0.545***
	(0.142)	(0.144)	(0.208)	(0.116)	(0.156)	(0.173)	(0.147)	(0.139)	(0.206)	(0.116)	(0.162)	(0.170)	(0.144)	(0.141)	(0.217)	(0.115)	(0.158)	(0.169)
Pseudo R^2	0.094	0.106	0.124	0.094	0.086	0.107	0.118	0.088	0.149	0.089	0.107	0.084	0.115	0.083	0.168	0.088	0.096	0.085
N	577	627	336	868	458	410	574	626	335	865	455	410	569	624	334	859	450	409

Notes: Marginal effects with the standard errors in parentheses. Dependent variables are the dummy variables of innovation outcomes constructed from the responses in question 33, which take 1 if the innovation realizes at least once in five years (2013-2018). Independent variables are data score 1, management score, the dummy of headquarter status, the ratio of managers with a bachelor's degree, the ratio of non-managers with a bachelor's degree, the logged number of employees, the number of establishments directly competing with an establishment, characteristics of jobs. In wholesale trade, disaggregated industry group dummies are also included. The marginal effects of data score 1 (data) and management score (management) are shown. See the full results of all dependent variables in Appendix2-3, 2-4, and 2-5. Column 1 and Column 2 show the marginal effects by the probit model in samples below the median of the logged number of employees (Small) and above the median (Large). Column 3 and Column 4 show the marginal effects by the probit model in samples in branches (Branch) and headquarters (Hq). Columns 5 and 6 show the marginal effects by the probit model using samples of headquarters, at or below the median of the logged number of employees (Hq-sm) and above the median (Hq-Lg). Pseudo R2 denotes McFadden's pseudo R-squared, and N denotes the number of observations.

*** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.

Table 11 (b): Subsample Analysis (Establishment Size and Single- or Multi-Unit Firms: Innovation 4 and 5)

	Innovation 4						Innovation 5					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
	Small	Large	Branch	Hq	Hq-sm	Hq-lg	Small	Large	Branch	Hq	Hq-sm	Hq-lg
Road Freight Transport												
data	0.468**	0.721***	0.648***	0.487**	0.545**	0.517*	0.425**	0.717***	0.502***	0.587***	0.389	0.804**
	(0.198)	(0.184)	(0.178)	(0.196)	(0.277)	(0.292)	(0.200)	(0.174)	(0.163)	(0.206)	(0.286)	(0.315)
management	0.759***	0.642***	0.755***	0.613***	0.736***	0.441*	0.632***	0.710***	0.829***	0.456***	0.457**	0.539*
	(0.165)	(0.174)	(0.173)	(0.161)	(0.200)	(0.265)	(0.164)	(0.169)	(0.163)	(0.167)	(0.207)	(0.278)
Pseudo R^2	0.161	0.161	0.149	0.150	0.176	0.124	0.139	0.160	0.144	0.127	0.094	0.171
N	416	454	490	380	204	176	416	455	491	380	203	177
Wholesale Trade												
data	0.793***	0.705***	0.553***	0.849***	1.004***	0.675***	0.695***	0.499***	0.371***	0.725***	0.884***	0.553***
	(0.104)	(0.107)	(0.110)	(0.0987)	(0.137)	(0.146)	(0.0982)	(0.0992)	(0.0989)	(0.0941)	(0.132)	(0.138)
management	0.597***	0.535***	0.408***	0.622***	0.549***	0.782***	0.594***	0.569***	0.441***	0.655***	0.581***	0.768***
	(0.0953)	(0.0935)	(0.105)	(0.0863)	(0.119)	(0.127)	(0.0903)	(0.0883)	(0.0954)	(0.0833)	(0.115)	(0.121)
Pseudo R^2	0.126	0.120	0.107	0.122	0.134	0.126	0.127	0.124	0.111	0.125	0.133	0.129
N	1548	1473	1086	1932	1002	922	1560	1481	1102	1933	1006	926
Medical and Other Health Services												
data	0.643***	0.734***	1.076***	0.583***	0.570***	0.559***	0.812***	0.648***	1.037***	0.665***	0.703***	0.574***
	(0.152)	(0.173)	(0.240)	(0.130)	(0.167)	(0.210)	(0.155)	(0.166)	(0.235)	(0.130)	(0.168)	(0.207)
management	0.681***	0.681***	0.651***	0.683***	0.658***	0.693***	0.660***	0.820***	0.777***	0.729***	0.624***	0.847***
	(0.144)	(0.145)	(0.210)	(0.117)	(0.160)	(0.174)	(0.148)	(0.140)	(0.207)	(0.117)	(0.162)	(0.173)
Pseudo R^2	0.102	0.116	0.137	0.106	0.097	0.121	0.132	0.118	0.157	0.119	0.118	0.131
N	575	621	335	861	454	407	573	627	336	864	454	410

Notes: See Table 11 (a).

Table 12: Subsample Analysis (Degree of Decentralization in Decision-Making)

	Innovation 1		Innovation 2		Innovation 3		Innovation 4		Innovation 5	
	(1) Centralized	(2) Decentralized	(1) Centralized	(2) Decentralized	(1) Centralized	(2) Decentralized	(1) Centralized	(2) Decentralized	(1) Centralized	(2) Decentralized
Road Freight Transport										
data	0.661***	0.831***	0.550**	0.521*	0.420*	0.616**	0.619***	0.647**	0.606***	0.331
	(0.253)	(0.293)	(0.224)	(0.285)	(0.234)	(0.285)	(0.239)	(0.280)	(0.215)	(0.260)
management	1.007***	0.853***	0.826***	1.294***	0.966***	0.911***	0.859***	0.606**	0.679***	0.957***
	(0.256)	(0.261)	(0.231)	(0.269)	(0.239)	(0.261)	(0.244)	(0.253)	(0.220)	(0.251)
Pseudo R^2	0.230	0.183	0.159	0.225	0.186	0.187	0.173	0.138	0.147	0.169
N	278	209	280	209	277	209	277	212	279	211
Wholesale Trade										
data	0.449***	0.531***	0.359**	0.283*	0.285*	0.326**	0.344**	0.792***	0.367***	0.363**
	(0.162)	(0.160)	(0.153)	(0.147)	(0.161)	(0.161)	(0.153)	(0.178)	(0.140)	(0.158)
management	0.486***	0.381**	0.483***	0.447***	0.772***	0.275*	0.446***	0.426***	0.466***	0.457***
	(0.159)	(0.149)	(0.155)	(0.138)	(0.166)	(0.152)	(0.158)	(0.165)	(0.143)	(0.151)
Pseudo R^2	0.110	0.156	0.104	0.151	0.126	0.131	0.113	0.155	0.140	0.126
N	538	524	519	510	525	511	519	500	515	512
Medical and Other Health Services										
data	1.106***	0.584*	1.105***	0.978***	1.311***	1.209***	0.930***	1.173***	1.165***	0.901***
	(0.335)	(0.332)	(0.324)	(0.326)	(0.353)	(0.378)	(0.320)	(0.357)	(0.337)	(0.323)
management	0.813***	0.607**	0.978***	0.561**	1.045***	0.595*	0.876***	0.500*	0.805***	0.769***
	(0.302)	(0.285)	(0.310)	(0.272)	(0.316)	(0.308)	(0.297)	(0.295)	(0.300)	(0.279)
Pseudo R^2	0.164	0.164	0.186	0.124	0.214	0.143	0.140	0.145	0.198	0.143
N	173	156	173	155	172	155	172	154	173	156

Notes: Marginal effects with the standard errors in parentheses. Dependent variables are the dummy variables of innovation outcomes constructed from the responses in question 33, which take 1 if the innovation realizes at least once in five years (2013-2018). Independent variables are data score 1, management score, the dummy of headquarter status, the ratio of managers with a bachelor's degree, the ratio of non-managers with a bachelor's degree, the logged number of employees, the number of establishments directly competing with an establishment, characteristics of jobs. In wholesale trade, disaggregated industry group dummies are also included. The marginal effects of data score 1 (data) and management score (management) are shown. See the full results of all dependent variables in Appendix 2-6. Columns 1 and 2 show the marginal effects by the probit model in samples at or below the median of the decentralization score in decision-making (Centralized) and above the median (Decentralized). Pseudo R2 denotes McFadden's pseudo R-squared, and N denotes the number of observations.

*** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.

Appendix 1-1 Scoring JP-MOPS Survey Questions - *Data Score 1*

Question	Text		Response	Score
19-1	In 2013 and 2018, what best describes the availability of data to support decision making at this establishment?		Data to support decision making are not available	0
			A small amount of data to support decision making is available	1/4
			A moderate amount of data to support decision making is available	1/2
			A great deal of data to support decision making is available	3/4
			All the data we need to support decision making is available	1
19-2	Following up on Question 19-1 regarding data to support decision-making: In 2018, how much is the data collected as "systematically organized electronic data"? Mark one box for the data with the longest accumulation period.		Not being collected at all	0
			Has been collected for the past year	1/5
			Has been collected for the past 2 years	2/5
			Has been collected for the past 3 to 5 years	3/5
			Has been collected for the past 6 to 10 years	4/5
			Has been collected for more than 10 years	1
20	In 2013 and 2018, what best describes the use of data to support decision making at this establishment?		Decision making does not use data	0
			Decision making relies slightly on data	1/4
			Decision making relies moderately on data	1/2
			Decision making relies heavily on data	3/4
			Decision making relies entirely on data	1
21	Consider each of the following sources of data and rate how frequently each source is used in decision making at this establishment in 2018 and was used in 2013.	Basic Performance indicators (e.g., sales, costs, inventories, etc.)	Daily	1
			Weekly	3/4
			Monthly	1/2
			Yearly	1/4
			Never	0
		Formal or informal feedback from managers	See above	
		Formal or informal feedback from non-managers	See above	
		Data from outside the firm (suppliers, customers, outside data providers)	See above	
22-1	How frequently is/was each of these activities influenced by data analysis at this establishment? Mark one box for each year.	Demand forecasting	Never	0
			Slightly	1/4
			Moderately	1/2
			Generally	3/4
			Entirely	1
		Investment decisions (e.g., regarding capital equipment, new branches)	See above	
		Advertising	See above	
		Purchasing, shipping, inventory control, distribution	See above	
		Back office tasks (e.g., human resources, accounting)	See above	
23-1	How frequently does this establishment typically rely on predictive analytics (statistical models that provide forecasts in areas such as demand, production, or human resources)?		Daily	1
			Weekly	3/4
			Monthly	1/2
			Yearly	1/4
			Never	0
23-2	Following up on Question 23-1, is artificial intelligence (AI; for details, see Section D on the next page) used for predictive analytics? Please choose the most appropriate answer below.		Used	1
			Not used	0

(Notes) Question numbers and texts in the 2018 JP-MOPS are shown.

Appendix 1-2 Scoring JP-MOPS Survey Questions - *Data Score 2*

Question (2017)	Text		Question (2018)	Question Text		Response	Score
24	Consider each of the following sources of data and rate how frequently each source is used in decision making at this establishment in 2015 and was used in 2010.	Key Performance Indicator	21	Consider each of the following sources of data and rate how frequently each source is used in decision making at this establishment in 2018 and was used in 2013.	Basic Performance indicators (e.g., sales, costs, inventories, etc.)	Daily	1
						Weekly	3/4
						Monthly	1/2
						Yearly	1/4
						Never	0
		Formal or informal feedback from managers			Formal or informal feedback from managers	See above	
		Formal or informal feedback from non-managers			Formal or informal feedback from non-managers	See above	
		Data from outside the firm (suppliers, customers, outside data providers)			Data from outside the firm (suppliers, customers, outside data providers)	See above	
25	How frequently is/was each of these activities influenced by data analysis at this establishment? Mark one box for each year.	Demand forecasting	22_1	How frequently is/was each of these activities influenced by data analysis at this establishment? Mark one box for each year.	Demand forecasting	Never	0
						Slightly	1/4
						Moderately	1/2
						Generally	3/4
						Entirely	1
		Supply chain management			Purchasing, shipping, inventory control, distribution	See above	
		Advertising			Advertising	See above	

Appendix 1-3 Scoring JP-MOPS Survey Questions - *Management Score*

Question	Text	Response	Score
2	In 2013 and 2018, how many key performance indicators (KPIs) were monitored at this establishment?	1-2 key performance indicators	1/3
		3-9 key performance indicators	2/3
		10 or more key performance indicators	1
		No key performance indicators (if no key performance indicators in both years, SKIP to Question 5)	0
3(a) and 3(b)	During 2013 and 2018, how frequently were the key performance indicators reviewed by (a) managers and (b) non-managers at this establishment?	Yearly	1/6
		Quarterly	1/3
		Monthly	1/2
		Weekly	2/3
		Daily	5/6
		Hourly or more frequently	1
		Never	0
4	During 2013 and 2018, where were the display boards showing KPIs located at this establishment?	All display boards were located in one place (e.g., at the sales place, the backyard, the office)	1/2
		Display boards were located in multiple places	1
		We did not have any display boards	0
5	In 2013 and 2018, what best describes the time frame of sales targets at this establishment?	Main focus was on short-term (less than one year) sales targets	1/3
		Main focus was on long-term(more than one year) sales targets	2/3
		Combination of short-term and long-term sales targets	1
		No sales targets (If no sales targets in both years, SKIP to Question 10)	0
6	How much effort was required (or is expected to be required) for this establishment to meet its sales targets? Please choose the most appropriate answer below.	Possible to achieve without much effort	0
		Possible to achieve with some effort	1/4
		Possible to achieve with normal amount of effort	1/2
		Possible to achieve with more than normal effort	3/4
		Only possible to achieve with extraordinary effort	1
7	At this establishment, who was aware of the sales targets? Please choose the most appropriate answer below.	Only senior managers (e.g., general managers, directors)	0
		Most managers and some non-managers	1/3
		Most managers and most non-managers	2/3
		All managers and most non-managers	1
8(a) and 8(b)	In 2013 and 2018, what were (a) non-managers' and (b) managers' performance bonuses usually based on at this establishment?	Their own performance as measured by sales targets	1
		Their team or group performance as measured by sales targets	3/4
		Their establishment's performance as measured by sales targets	1/2
		Their company's performance as measured by sales targets	1/4
		No performance bonuses	0
9(a) and 9(b)	In 2013 and 2018, when sales targets were achieved, what percentage of employees received (or is expected to receive) a bonus based on the degree to which sales targets were achieved at this establishment? Please choose the most appropriate answer for (a) non-managers and (b) managers.	0%	1/5
		1-33%	2/5
		34-66%	3/5
		67-99%	4/5
		100%	1
		Sales targets not met	0
10(a) and 10(b)	In 2013 and 2018, what were (a) non-managers' and (b) managers' performance bonuses usually based on at this establishment? At this establishment, when deciding whether to promote an employee, what is the decision mainly based on? Please choose the most appropriate answer for (a) non-managers and (b) managers.	Promotions were based solely on performance and ability	1
		Promotions were based partly on performance and ability, and partly on other factors (e.g., tenure or family connections)	2/3
		Promotions were based mainly on factors other than performance and ability (e.g., tenure or family connections)	1/3
		Non-managers/Managers are normally not promoted	0
11(a) and 11(b)	At this establishment, if an employee is found to be doing a poor job, how long does it take for them to be transferred to another position or be dismissed? Please choose the most appropriate answer for (a) non-managers and (b) managers.	Less than six months	1
		More than six months	1/2
		There were few or no cases in which employees were transferred or dismissed.	0

(Notes) Question numbers and texts in the 2018 JP-MOPS are shown.

Appendix 1-4 Scoring JP-MOPS Survey Questions - Decentralization Score

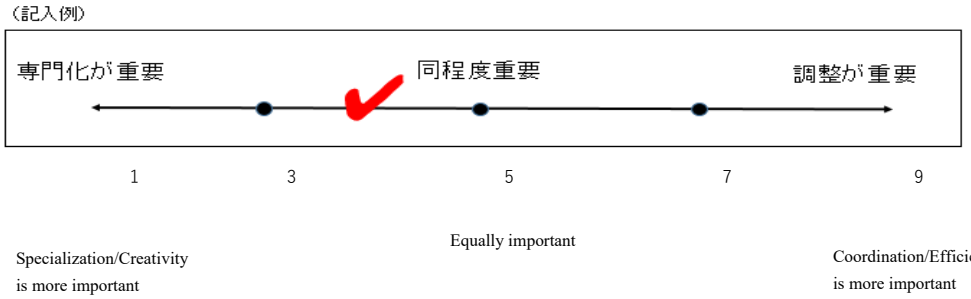
Question	Text	Response	Score
13	In 2013 and 2018, where were decisions on hiring permanent full-time employees made for this establishment? Mark one box for each year.	Only at this establishment	1
		Only at headquarters	0
		Both at this establishment and at headquarters	1/2
		Other	-
14	In 2013 and 2018, where were decisions to give an employee a pay increase of at least 10% made for this establishment? Mark one box for each year.	Only at this establishment	1
		Only at headquarters	0
		Both at this establishment and at headquarters	1/2
		Other	-
15	In 2013 and 2018, where were decisions on new products/services introductions made for this establishment? Mark one box for each year.	Only at this establishment	1
		Only at headquarters	0
		Both at this establishment and at headquarters	1/2
		Other	-
16	In 2013 and 2018, where were product/service pricing decisions made for this establishment? Mark one box for each year.	Only at this establishment	1
		Only at headquarters	0
		Both at this establishment and at headquarters	1/2
		Other	-
17	In 2013 and 2018, where were advertising decisions for products/services made for this establishment? Mark one box for each year.	Only at this establishment	1
		Only at headquarters	0
		Both at this establishment and at headquarters	1/2
		Other	-
18	In 2013 and 2018, what was the yen amount that could be used to purchase a fixed/capital asset for this establishment without prior authorization from headquarters? Mark one box for each year.	Under 100,000 yen	0
		100,000 to 1 million yen	1/4
		1 million to 10 million yen	1/2
		10 million to 100 million yen	3/4
		100 million yen or more	1

(Notes) Question numbers and texts in the 2018 JP-MOPS are shown.

Appendix 1-5 Scoring JP-MOPS Questions - Other Categorical Variables

Variable Name	Question (2018)	Text	Response	Score
The dummy of headquarter status	12	Was the headquarters for this company at the same location as this establishment? Mark one box for each year.	Yes (If yes in both years, SKIP to Question 19)	1
			No	0
The number of establishments directly competing with an establishment	31	At present, in 2018, about how many establishments are directly competing with this establishment to win customers, etc. Please choose the most appropriate answer (one answer only).	0	1
			1–2 establishments	2
			3–5 establishments	3
			6–10 establishments	4
			More than 10 establishments	5
The ratio of managers with a bachelor's degree	28(a)	At this establishment, roughly what percentage of employees had a university degree? Please choose the most appropriate answer for (a) managers and (b) non-managers.	Less than 20%	1
			20% or more, but less than 40%	2
			40% or more, but less than 60%	3
			60% or more, but less than 80%	4
			80% or more	5
The ratio of non-managers with a bachelor's degree	28(b)		0%	1
			Less than 10%	2
			10% or more, but less than 20%	3
			20% or more	4
The presence of CIO	29	At present in 2018, does the firm to which this establishment belongs have a CIO? Please choose the most appropriate answer (one answer only).	Has a full-time CIO	3
			Has a CIO who concurrently holds other positions	2
			Does not have a CIO	1
			Do not know	-
Specialization or coordination	34-1	Which of the following do you feel is more important for the performance of this establishment?	Specialization is more important	1
			Equally important	2
			Coordination is more important	3
Creativity or efficiency	34-2	Which do you feel is more important in this establishment, employees' creativity or the efficiency of performing tasks?	Creativity is more important	1
			Equally important	2
			Efficiency is more important	3

(Notes) Question numbers and texts in the 2018 JP-MOPS are shown. In questions 34-1 and 34-2, establishments are asked to mark somewhere on the line in the figure below. We give a numerical number of 1-9 from the points where the establishments mark. We categorize 1-4 as "specialization/creativity is more important," 5 as "equally important," and 6-9 as "coordination/efficiency is more important."



Appendix 2-1: Data Activities and Innovation Performance by the Probit Model - Marginal Effects in All Independent Variables

Road Freight Transport

	Innovation 1			Innovation 2			Innovation 3			Innovation 4			Innovation 5		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
data	2.598***	1.836***	1.049***	2.487***	1.709***	0.796**	2.546***	1.761***	0.858***	2.249***	1.530***	0.800**	2.231***	1.536***	0.676**
	(0.326)	(0.351)	(0.327)	(0.316)	(0.341)	(0.322)	(0.323)	(0.348)	(0.325)	(0.314)	(0.339)	(0.320)	(0.313)	(0.338)	(0.321)
management		1.964***	2.020***		2.094***	2.084***		2.107***	2.059***		1.812***	1.681***		1.737***	1.809***
		(0.316)	(0.325)		(0.309)	(0.318)		(0.315)	(0.321)		(0.307)	(0.314)		(0.306)	(0.316)
dumhq	-0.160*	-0.018	-0.008	-0.256***	-0.106	-0.109	-0.281***	-0.136	-0.132	-0.276***	-0.150	-0.130	-0.305***	-0.181*	-0.130
	(0.097)	(0.101)	(0.101)	(0.094)	(0.099)	(0.099)	(0.096)	(0.100)	(0.100)	(0.094)	(0.098)	(0.099)	(0.094)	(0.097)	(0.099)
univm	-0.046	-0.080*	-0.079*	-0.019	-0.055	-0.047	-0.034	-0.072*	-0.073*	-0.040	-0.072*	-0.062	0.024	-0.005	0.014
	(0.041)	(0.042)	(0.044)	(0.040)	(0.041)	(0.043)	(0.040)	(0.041)	(0.043)	(0.040)	(0.041)	(0.043)	(0.041)	(0.041)	(0.043)
unive	0.182***	0.139**	0.101*	0.132**	0.089	0.055	0.117**	0.071	0.054	0.119**	0.079	0.065	0.101*	0.065	0.035
	(0.059)	(0.060)	(0.061)	(0.058)	(0.060)	(0.060)	(0.059)	(0.060)	(0.060)	(0.058)	(0.059)	(0.059)	(0.058)	(0.060)	(0.060)
lemp	0.096	0.030	0.048	0.102	0.026	0.042	0.082	0.004	0.021	0.032	-0.032	-0.014	0.032	-0.037	-0.018
	(0.067)	(0.070)	(0.070)	(0.067)	(0.070)	(0.070)	(0.068)	(0.070)	(0.070)	(0.066)	(0.068)	(0.068)	(0.067)	(0.069)	(0.070)
cmp	0.081**	0.065**	0.069**	0.065**	0.047	0.066**	0.105***	0.089***	0.103***	0.111***	0.098***	0.124***	0.067**	0.052*	0.076**
	(0.032)	(0.033)	(0.033)	(0.031)	(0.032)	(0.032)	(0.031)	(0.032)	(0.032)	(0.031)	(0.032)	(0.032)	(0.031)	(0.031)	(0.032)
Q34_1score	-0.082	-0.059	-0.050	-0.025	-0.003	-0.007	-0.005	0.021	0.021	-0.056	-0.036	-0.034	-0.051	-0.033	-0.028
	(0.058)	(0.060)	(0.060)	(0.058)	(0.059)	(0.059)	(0.058)	(0.059)	(0.060)	(0.057)	(0.058)	(0.059)	(0.058)	(0.059)	(0.059)
Q34_2score	-0.127**	-0.118*	-0.145**	-0.094	-0.085	-0.111*	-0.101*	-0.093	-0.109*	-0.087	-0.077	-0.100	-0.034	-0.024	-0.051
	(0.061)	(0.062)	(0.062)	(0.060)	(0.062)	(0.062)	(0.060)	(0.062)	(0.062)	(0.060)	(0.061)	(0.061)	(0.061)	(0.062)	(0.062)
CIO	0.367***	0.265***	0.260***	0.284***	0.168*	0.162*	0.368***	0.257***	0.244***	0.371***	0.276***	0.302***	0.345***	0.254***	0.281***
	(0.085)	(0.088)	(0.088)	(0.088)	(0.091)	(0.092)	(0.090)	(0.092)	(0.092)	(0.086)	(0.087)	(0.088)	(0.091)	(0.092)	(0.094)
Constant term	-2.423***	-2.528***	-1.967***	-1.966***	-2.030***	-1.436***	-2.187***	-2.268***	-1.688***	-1.889***	-1.952***	-1.548***	-1.601***	-1.622***	-1.241***
	(0.391)	(0.401)	(0.394)	(0.381)	(0.389)	(0.382)	(0.385)	(0.393)	(0.386)	(0.376)	(0.382)	(0.377)	(0.377)	(0.382)	(0.380)
Pseudo R^2	0.151	0.185	0.159	0.132	0.171	0.138	0.148	0.187	0.152	0.133	0.163	0.138	0.124	0.151	0.129
N	866	866	833	869	869	835	860	860	827	870	870	837	871	871	837

Wholesale Trade

	Innovation 1			Innovation 2			Innovation 3			Innovation 4			Innovation 5		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
data	1.907***	1.490***	1.066***	2.053***	1.619***	1.020***	2.128***	1.687***	1.083***	2.503***	2.030***	1.355***	2.287***	1.748***	1.013***
	(0.188)	(0.198)	(0.187)	(0.193)	(0.204)	(0.191)	(0.190)	(0.200)	(0.186)	(0.192)	(0.201)	(0.186)	(0.193)	(0.203)	(0.188)
management		1.207***	1.177***		1.270***	1.322***		1.342***	1.353***		1.465***	1.279***		1.681***	1.550***
		(0.181)	(0.185)		(0.185)	(0.189)		(0.182)	(0.185)		(0.181)	(0.183)		(0.185)	(0.187)
dumhq	-0.113**	-0.068	-0.063	-0.134**	-0.087	-0.091	-0.154***	-0.107*	-0.087	-0.208***	-0.154***	-0.165***	-0.188***	-0.129**	-0.138**
	(0.054)	(0.055)	(0.056)	(0.056)	(0.057)	(0.058)	(0.055)	(0.055)	(0.056)	(0.054)	(0.055)	(0.056)	(0.056)	(0.056)	(0.057)
univm	0.042**	0.032	0.017	0.052**	0.042**	0.026	0.032	0.021	0.011	0.039*	0.028	0.015	0.043**	0.029	0.021
	(0.020)	(0.020)	(0.020)	(0.021)	(0.021)	(0.021)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.021)	(0.021)
unive	0.034	0.008	0.015	0.000	-0.028	-0.035	0.029	0.000	0.003	0.012	-0.021	-0.002	0.025	-0.012	-0.011
	(0.037)	(0.037)	(0.036)	(0.038)	(0.038)	(0.037)	(0.037)	(0.037)	(0.036)	(0.037)	(0.038)	(0.036)	(0.037)	(0.038)	(0.036)
lemp	0.044	0.017	0.030	0.059	0.028	0.057	0.100**	0.069*	0.089**	0.145***	0.111***	0.145***	0.116***	0.078*	0.101**
	(0.039)	(0.040)	(0.040)	(0.041)	(0.041)	(0.042)	(0.040)	(0.040)	(0.041)	(0.040)	(0.040)	(0.041)	(0.041)	(0.042)	(0.042)
cmp	0.043**	0.040**	0.048***	0.051***	0.047***	0.052***	0.060***	0.057***	0.063***	0.026	0.022	0.028	0.030*	0.025	0.032*
	(0.017)	(0.017)	(0.017)	(0.018)	(0.018)	(0.018)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.018)	(0.018)	(0.018)
Q34_1score	-0.101***	-0.096***	-0.101***	-0.074**	-0.068**	-0.067**	-0.069**	-0.063**	-0.058*	-0.081**	-0.073**	-0.070**	-0.088***	-0.083**	-0.075**
	(0.032)	(0.032)	(0.032)	(0.032)	(0.033)	(0.033)	(0.032)	(0.032)	(0.032)	(0.031)	(0.032)	(0.032)	(0.032)	(0.032)	(0.032)
Q34_2score	-0.132***	-0.124***	-0.137***	-0.160***	-0.152***	-0.166***	-0.143***	-0.133***	-0.139***	-0.095***	-0.084**	-0.100***	-0.046	-0.034	-0.052
	(0.033)	(0.033)	(0.033)	(0.034)	(0.034)	(0.034)	(0.033)	(0.033)	(0.033)	(0.033)	(0.033)	(0.033)	(0.033)	(0.034)	(0.034)
CIO	0.211***	0.190***	0.209***	0.186***	0.165***	0.180***	0.241***	0.217***	0.237***	0.199***	0.174***	0.197***	0.257***	0.229***	0.249***
	(0.050)	(0.050)	(0.051)	(0.052)	(0.053)	(0.052)	(0.051)	(0.051)	(0.051)	(0.050)	(0.050)	(0.050)	(0.053)	(0.053)	(0.053)
Constant term	-1.351**	-1.605***	-1.284**	-1.404**	-1.653***	-1.314**	-1.848***	-2.137***	-1.826***	-1.635***	-1.963***	-1.532**	-1.454**	-1.825***	-1.466**
	(0.550)	(0.556)	(0.558)	(0.559)	(0.565)	(0.568)	(0.555)	(0.561)	(0.564)	(0.596)	(0.601)	(0.610)	(0.568)	(0.574)	(0.610)
Pseudo R^2	0.088	0.099	0.089	0.089	0.103	0.088	0.097	0.111	0.095	0.104	0.121	0.098	0.100	0.123	0.097
N	3047	3047	2961	3028	3028	2945	3027	3027	2943	3028	3028	2947	3043	3043	2959

	Medical and Other Health Services														
	Innovation 1			Innovation 2			Innovation 3			Innovation 4			Innovation 5		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
data	2.142***	1.580***	0.952***	2.148***	1.640***	0.968***	2.218***	1.700***	1.064***	2.245***	1.712***	1.103***	2.479***	1.899***	1.270***
	(0.272)	(0.286)	(0.272)	(0.269)	(0.283)	(0.271)	(0.274)	(0.288)	(0.272)	(0.272)	(0.286)	(0.272)	(0.275)	(0.289)	(0.275)
management		1.695***	1.671***		1.528***	1.420***		1.568***	1.440***		1.643***	1.414***		1.844***	1.538***
		(0.254)	(0.263)		(0.254)	(0.262)		(0.254)	(0.261)		(0.254)	(0.261)		(0.259)	(0.265)
dumhq	-0.207**	-0.161*	-0.205**	-0.169*	-0.127	-0.174*	-0.083	-0.040	-0.076	-0.128	-0.081	-0.078	0.015	0.077	0.042
	(0.086)	(0.087)	(0.089)	(0.087)	(0.088)	(0.090)	(0.086)	(0.087)	(0.089)	(0.086)	(0.087)	(0.089)	(0.088)	(0.089)	(0.091)
univm	0.005	0.012	0.027	0.025	0.031	0.038	-0.001	0.005	0.006	-0.009	-0.003	0.005	0.024	0.035	0.042
	(0.028)	(0.028)	(0.029)	(0.028)	(0.028)	(0.029)	(0.028)	(0.028)	(0.029)	(0.028)	(0.028)	(0.029)	(0.028)	(0.029)	(0.029)
unive	0.093*	0.069	0.061	0.087*	0.067	0.071	0.112**	0.091*	0.088*	0.117**	0.096*	0.084*	0.082*	0.055	0.027
	(0.048)	(0.049)	(0.049)	(0.048)	(0.049)	(0.049)	(0.048)	(0.049)	(0.049)	(0.049)	(0.049)	(0.049)	(0.049)	(0.050)	(0.049)
lemp	0.007	-0.075*	-0.053	-0.023	-0.098**	-0.077*	-0.012	-0.087**	-0.058	-0.017	-0.095**	-0.051	0.011	-0.077*	-0.026
	(0.041)	(0.043)	(0.044)	(0.042)	(0.044)	(0.044)	(0.041)	(0.043)	(0.044)	(0.041)	(0.043)	(0.044)	(0.042)	(0.045)	(0.045)
cmp	0.055*	0.036	0.049*	0.047*	0.029	0.056*	0.070**	0.051*	0.068**	0.093***	0.074**	0.094***	0.078***	0.057*	0.077***
	(0.028)	(0.029)	(0.029)	(0.028)	(0.029)	(0.029)	(0.029)	(0.029)	(0.029)	(0.028)	(0.029)	(0.029)	(0.028)	(0.029)	(0.029)
Q34_1score	0.021	0.024	0.035	0.054	0.059	0.057	0.017	0.024	0.021	-0.038	-0.034	-0.025	0.064	0.073	0.071
	(0.049)	(0.050)	(0.050)	(0.049)	(0.050)	(0.050)	(0.049)	(0.050)	(0.051)	(0.049)	(0.050)	(0.051)	(0.050)	(0.051)	(0.051)
Q34_2score	-0.129**	-0.129**	-0.105**	-0.166***	-0.166***	-0.152***	-0.141***	-0.139***	-0.109**	-0.127**	-0.126**	-0.129**	-0.164***	-0.164***	-0.157***
	(0.051)	(0.051)	(0.052)	(0.051)	(0.051)	(0.052)	(0.051)	(0.052)	(0.052)	(0.051)	(0.051)	(0.052)	(0.052)	(0.052)	(0.053)
CIO	0.101	0.100	0.131	0.029	0.030	0.052	0.067	0.064	0.089	0.054	0.052	0.094	0.061	0.066	0.095
	(0.104)	(0.107)	(0.106)	(0.105)	(0.107)	(0.105)	(0.104)	(0.106)	(0.104)	(0.105)	(0.107)	(0.105)	(0.107)	(0.109)	(0.107)
Constant term	-1.285***	-1.258***	-1.064***	-0.874***	-0.850***	-0.600*	-1.365***	-1.353***	-1.111***	-1.216***	-1.207***	-1.032***	-1.403***	-1.412***	-1.119***
	(0.308)	(0.312)	(0.309)	(0.309)	(0.312)	(0.309)	(0.312)	(0.316)	(0.311)	(0.311)	(0.315)	(0.311)	(0.315)	(0.320)	(0.314)
Pseudo R^2	0.072	0.099	0.082	0.071	0.093	0.072	0.071	0.095	0.072	0.076	0.102	0.077	0.087	0.118	0.087
N	1204	1204	1151	1200	1200	1148	1193	1193	1141	1196	1196	1142	1200	1200	1148

(Notes) See Table 7.

Appendix 2-2: Data Activities and Innovation Performance by the Ordered Probit Model - Coefficients in All Independent Variables

	Road Freight Transport					Wholesale Trade					Medical and Other Healthcare Services				
	Innovation1	Innovation2	Innovation3	Innovation4	Innovation5	Innovation1	Innovation2	Innovation3	Innovation4	Innovation5	Innovation1	Innovation2	Innovation3	Innovation4	Innovation5
Coefficients															
data	2.023***	1.773***	1.728***	1.975***	1.885***	1.483***	1.567***	1.693***	1.927***	1.756***	1.641***	1.880***	1.828***	1.789***	2.052***
	(0.313)	(0.289)	(0.295)	(0.302)	(0.288)	(0.163)	(0.163)	(0.164)	(0.166)	(0.163)	(0.258)	(0.250)	(0.261)	(0.254)	(0.249)
management	1.814***	1.642***	1.746***	1.642***	1.537***	1.127***	1.165***	1.150***	1.309***	1.551***	1.438***	1.258***	1.424***	1.434***	1.552***
	(0.282)	(0.262)	(0.272)	(0.271)	(0.260)	(0.149)	(0.148)	(0.149)	(0.150)	(0.149)	(0.225)	(0.217)	(0.225)	(0.222)	(0.216)
dumhq	-0.004	-0.046	-0.078	-0.115	-0.146*	-0.099**	-0.122***	-0.114**	-0.181***	-0.106**	-0.162**	-0.081	-0.055	-0.082	0.027
	(0.090)	(0.085)	(0.086)	(0.087)	(0.084)	(0.044)	(0.044)	(0.044)	(0.045)	(0.044)	(0.076)	(0.075)	(0.077)	(0.076)	(0.075)
univm	-0.066*	-0.037	-0.043	-0.043	0.017	0.026	0.047***	0.026	-0.006	0.010	-0.008	0.015	-0.007	-0.027	-0.010
	(0.037)	(0.034)	(0.035)	(0.035)	(0.034)	(0.017)	(0.016)	(0.017)	(0.017)	(0.016)	(0.025)	(0.024)	(0.025)	(0.025)	(0.024)
unive	0.100*	0.098**	0.081	0.070	0.061	0.001	-0.024	0.001	-0.001	-0.006	0.066	0.067	0.072*	0.088**	0.070
	(0.053)	(0.050)	(0.051)	(0.051)	(0.049)	(0.031)	(0.031)	(0.031)	(0.032)	(0.031)	(0.044)	(0.042)	(0.044)	(0.044)	(0.043)
lemp	0.009	0.029	0.011	-0.021	-0.001	0.037	0.052*	0.074**	0.090***	0.066**	-0.066*	-0.103***	-0.093**	-0.108***	-0.108***
	(0.059)	(0.056)	(0.057)	(0.058)	(0.057)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.038)	(0.037)	(0.038)	(0.037)	(0.037)
cmp	0.063**	0.055**	0.080***	0.098***	0.080***	0.038***	0.039***	0.055***	0.041***	0.023*	0.043*	0.051**	0.055**	0.079***	0.060**
	(0.029)	(0.027)	(0.028)	(0.028)	(0.027)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.026)	(0.025)	(0.026)	(0.026)	(0.025)
Q34_1score	-0.039	-0.008	0.015	-0.003	0.029	-0.083***	-0.082***	-0.074***	-0.068***	-0.055**	0.015	0.062	0.043	0.024	0.116***
	(0.052)	(0.049)	(0.050)	(0.051)	(0.049)	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)	(0.044)	(0.043)	(0.045)	(0.044)	(0.043)
Q34_2score	-0.078	-0.039	-0.055	-0.036	0.009	-0.093***	-0.145***	-0.122***	-0.104***	-0.049*	-0.146***	-0.159***	-0.126***	-0.081*	-0.142***
	(0.054)	(0.051)	(0.052)	(0.052)	(0.051)	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)	(0.046)	(0.044)	(0.046)	(0.045)	(0.044)
CIO	0.187***	0.113*	0.161**	0.156**	0.147**	0.166***	0.182***	0.193***	0.155***	0.153***	0.082	0.082	0.121	0.103	0.132
	(0.070)	(0.069)	(0.069)	(0.069)	(0.068)	(0.038)	(0.038)	(0.038)	(0.038)	(0.038)	(0.091)	(0.089)	(0.091)	(0.090)	(0.088)
Cut															
cut1	2.426***	2.002***	2.143***	2.200***	2.061***	1.690***	1.896***	2.114***	1.526***	1.638***	1.105***	0.967***	1.367***	1.296***	1.324***
	(0.347)	(0.323)	(0.328)	(0.334)	(0.321)	(0.471)	(0.477)	(0.473)	(0.467)	(0.438)	(0.276)	(0.269)	(0.280)	(0.276)	(0.269)
cut2	3.357***	2.910***	3.008***	3.072***	2.964***	2.627***	2.795***	2.969***	2.687***	2.657***	2.169***	1.874***	2.225***	2.284***	2.202***
	(0.353)	(0.328)	(0.333)	(0.339)	(0.326)	(0.472)	(0.477)	(0.474)	(0.468)	(0.439)	(0.279)	(0.271)	(0.283)	(0.279)	(0.272)
cut3	4.156***	3.685***	3.803***	3.825***	3.686***	3.145***	3.443***	3.627***	3.356***	3.377***	2.899***	2.695***	3.071***	3.089***	2.983***
	(0.363)	(0.335)	(0.340)	(0.347)	(0.333)	(0.473)	(0.478)	(0.475)	(0.469)	(0.440)	(0.285)	(0.276)	(0.289)	(0.286)	(0.276)
Pseudo R^2	0.127	0.100	0.109	0.115	0.106	0.062	0.070	0.069	0.075	0.070	0.069	0.066	0.069	0.069	0.077
N	866	869	860	870	871	3047	3036	3027	3037	3043	1204	1200	1193	1196	1200

(Notes) See Table 8. *Cut* denotes the estimated cutpoints.

Appendix 2-3: Subsample Analysis (Establishment Size and Single- or Multi-Unit Firms) - Full Results in Road Freight Transport

	Innovation 1						Innovation 2					
	Small	Large	Branch	Hq	Hq-sm	Hq-lg	Small	Large	Branch	Hq	Hq-sm	Hq-lg
data	1.321**	2.332***	1.821***	1.730***	1.072	2.366***	1.709***	1.735***	1.426***	1.927***	1.543**	2.290***
	(0.544)	(0.470)	(0.467)	(0.549)	(0.826)	(0.781)	(0.523)	(0.453)	(0.457)	(0.530)	(0.781)	(0.771)
management	2.535***	1.442***	2.328***	1.482***	1.878***	0.931	1.983***	2.193***	2.714***	1.488***	1.616***	1.489**
	(0.459)	(0.438)	(0.452)	(0.444)	(0.599)	(0.685)	(0.423)	(0.447)	(0.458)	(0.425)	(0.550)	(0.695)
dumhq	-0.031	-0.038					-0.139	-0.085				
	(0.150)	(0.138)					(0.142)	(0.138)				
univm	-0.073	-0.098*	-0.124**	0.045	-0.017	0.156	-0.032	-0.078	-0.075	0.003	-0.022	0.078
	(0.061)	(0.058)	(0.050)	(0.080)	(0.105)	(0.141)	(0.060)	(0.057)	(0.049)	(0.078)	(0.099)	(0.142)
unive	0.118	0.175**	0.142*	0.122	0.095	0.162	0.056	0.106	0.020	0.174*	0.224*	0.110
	(0.089)	(0.085)	(0.077)	(0.098)	(0.136)	(0.149)	(0.086)	(0.084)	(0.076)	(0.097)	(0.133)	(0.145)
lemp			-0.010	0.082					-0.017	0.089		
			(0.086)	(0.121)					(0.088)	(0.118)		
cmp	0.114**	0.019	0.116**	0.011	0.043	-0.019	0.086*	0.009	0.049	0.042	0.029	0.061
	(0.048)	(0.045)	(0.045)	(0.048)	(0.070)	(0.069)	(0.046)	(0.045)	(0.045)	(0.046)	(0.066)	(0.067)
Q34_1score	-0.177**	0.055	-0.054	-0.058	-0.141	0.071	0.009	-0.020	-0.016	0.016	0.102	-0.058
	(0.087)	(0.083)	(0.079)	(0.092)	(0.126)	(0.140)	(0.084)	(0.084)	(0.080)	(0.090)	(0.123)	(0.136)
Q34_2score	-0.054	-0.188**	-0.087	-0.167*	-0.211	-0.131	-0.096	-0.076	-0.077	-0.091	-0.220	0.024
	(0.092)	(0.085)	(0.082)	(0.096)	(0.141)	(0.133)	(0.091)	(0.085)	(0.082)	(0.094)	(0.138)	(0.132)
CIO	0.181	0.349***	0.216**	0.436**	0.363	0.463	0.230	0.127	0.080	0.488**	0.578**	0.217
	(0.135)	(0.116)	(0.101)	(0.185)	(0.251)	(0.295)	(0.140)	(0.121)	(0.103)	(0.205)	(0.264)	(0.332)
constant_term	-2.349***	-2.456***	-2.652***	-2.563***	-1.728***	-2.789***	-2.044***	-1.762***	-1.703***	-2.887***	-2.436***	-2.463***
	(0.454)	(0.457)	(0.514)	(0.639)	(0.625)	(0.802)	(0.437)	(0.453)	(0.494)	(0.631)	(0.633)	(0.774)
Pseudo R^2	0.207	0.171	0.199	0.149	0.130	0.171	0.175	0.154	0.165	0.153	0.145	0.156
N	412	454	488	378	200	178	413	456	490	379	201	178
	Innovation 4						Innovation 5					
data	1.206**	1.811***	1.642***	1.319**	1.581*	1.334*	1.068**	1.905***	1.403***	1.478***	1.002	2.018**
	(0.509)	(0.461)	(0.450)	(0.533)	(0.809)	(0.756)	(0.502)	(0.461)	(0.455)	(0.520)	(0.739)	(0.791)
management	1.956***	1.610***	1.914***	1.659***	2.136***	1.139*	1.589***	1.886***	2.318***	1.149***	1.178**	1.353*
	(0.426)	(0.438)	(0.438)	(0.438)	(0.588)	(0.685)	(0.412)	(0.450)	(0.457)	(0.420)	(0.535)	(0.698)
dumhq	-0.168	-0.140					-0.265*	-0.113				
	(0.140)	(0.137)					(0.138)	(0.139)				
univm	-0.036	-0.116**	-0.070	-0.052	-0.044	0.006	0.023	-0.040	-0.040	0.099	0.066	0.174
	(0.059)	(0.058)	(0.048)	(0.078)	(0.101)	(0.134)	(0.059)	(0.058)	(0.049)	(0.076)	(0.093)	(0.149)
unive	0.090	0.078	0.004	0.187*	0.109	0.261*	0.063	0.070	-0.001	0.139	0.135	0.170
	(0.086)	(0.083)	(0.075)	(0.096)	(0.133)	(0.144)	(0.085)	(0.085)	(0.078)	(0.095)	(0.126)	(0.148)
lemp			-0.086	0.062					-0.117	0.098		
			(0.084)	(0.117)					(0.088)	(0.115)		
cmp	0.115**	0.073*	0.118***	0.079*	0.050	0.104	0.073	0.031	0.060	0.048	0.028	0.084
	(0.046)	(0.044)	(0.044)	(0.047)	(0.068)	(0.067)	(0.045)	(0.045)	(0.044)	(0.046)	(0.063)	(0.068)
Q34_1score	-0.086	0.015	-0.065	-0.003	0.042	-0.057	-0.056	-0.014	-0.011	-0.074	-0.063	-0.048
	(0.083)	(0.083)	(0.077)	(0.090)	(0.125)	(0.134)	(0.083)	(0.084)	(0.080)	(0.089)	(0.118)	(0.137)
Q34_2score	-0.020	-0.135	-0.058	-0.103	-0.155	-0.091	-0.039	-0.006	-0.004	-0.044	-0.196	0.131
	(0.088)	(0.085)	(0.079)	(0.096)	(0.141)	(0.133)	(0.089)	(0.086)	(0.082)	(0.094)	(0.134)	(0.137)
CIO	0.187	0.373***	0.194*	0.554***	0.681***	0.317	0.252*	0.259**	0.184*	0.502**	0.511**	0.365
	(0.128)	(0.121)	(0.100)	(0.187)	(0.247)	(0.306)	(0.136)	(0.126)	(0.106)	(0.200)	(0.257)	(0.348)
constant_term	-2.055***	-2.083***	-1.584***	-2.869***	-2.797***	-2.349***	-1.469***	-2.050***	-1.305***	-2.541***	-1.520***	-3.046***
	(0.425)	(0.449)	(0.474)	(0.633)	(0.627)	(0.757)	(0.419)	(0.456)	(0.484)	(0.618)	(0.589)	(0.793)
Pseudo R^2	0.161	0.161	0.149	0.150	0.176	0.124	0.139	0.160	0.144	0.127	0.094	0.171
N	416	454	490	380	204	176	416	455	491	380	203	177

(Notes) See Tables 11 (a) and (b).

Appendix 2-4: Subsample Analysis (Establishment Size and Single- or Multi-Unit Firms) - Full Results in Wholesale Trade

	Innovation 1						Innovation 2						Innovation 3					
	Small	Large	Branch	Hq	Hq-sm	Hq-lg	Small	Large	Branch	Hq	Hq-sm	Hq-lg	Small	Large	Branch	Hq	Hq-sm	Hq-lg
data	1.707***	1.320***	1.589***	1.518***	1.929***	1.206***	1.494***	1.839***	1.235***	1.915***	1.904***	2.122***	1.739***	1.695***	1.120***	2.073***	2.203***	2.000***
	(0.269)	(0.303)	(0.339)	(0.250)	(0.336)	(0.393)	(0.274)	(0.315)	(0.348)	(0.257)	(0.341)	(0.411)	(0.268)	(0.310)	(0.333)	(0.256)	(0.342)	(0.404)
management	1.010***	1.546***	1.207***	1.248***	0.956***	1.886***	1.385***	1.285***	1.386***	1.248***	1.162***	1.563***	1.144***	1.729***	1.384***	1.315***	0.987***	1.906***
	(0.248)	(0.271)	(0.322)	(0.224)	(0.298)	(0.348)	(0.253)	(0.277)	(0.331)	(0.228)	(0.303)	(0.353)	(0.245)	(0.277)	(0.319)	(0.225)	(0.297)	(0.352)
dumhq	-0.098	-0.030					-0.134	-0.030					-0.108	-0.086				
	(0.079)	(0.079)					(0.082)	(0.082)					(0.078)	(0.081)				
univm	0.045	0.007	0.019	0.032	0.063*	-0.004	0.053*	0.023	0.046	0.045*	0.079**	0.003	0.020	0.017	0.009	0.030	0.050	0.006
	(0.028)	(0.031)	(0.034)	(0.026)	(0.035)	(0.040)	(0.029)	(0.031)	(0.035)	(0.027)	(0.036)	(0.042)	(0.028)	(0.031)	(0.034)	(0.026)	(0.035)	(0.040)
unive	-0.015	0.032	0.038	-0.019	-0.007	-0.048	-0.071	0.011	-0.008	-0.062	-0.072	-0.055	-0.011	0.015	0.034	-0.033	-0.038	-0.013
	(0.049)	(0.060)	(0.070)	(0.045)	(0.059)	(0.076)	(0.050)	(0.061)	(0.072)	(0.046)	(0.061)	(0.077)	(0.049)	(0.061)	(0.070)	(0.046)	(0.060)	(0.076)
lemp			-0.109	0.073					-0.097	0.084					-0.003	0.092*		
			(0.069)	(0.050)					(0.071)	(0.053)					(0.070)	(0.051)		
cmp	0.012	0.063**	0.042	0.037*	0.025	0.045	0.034	0.061**	0.046	0.050**	0.041	0.058*	0.055**	0.059**	0.068**	0.056**	0.050	0.061*
	(0.025)	(0.025)	(0.030)	(0.022)	(0.031)	(0.032)	(0.026)	(0.025)	(0.031)	(0.023)	(0.032)	(0.033)	(0.025)	(0.025)	(0.030)	(0.022)	(0.031)	(0.032)
Q34_1score	-0.102**	-0.092*	-0.135**	-0.076*	-0.093*	-0.052	-0.094**	-0.025	-0.086	-0.062	-0.062	-0.047	-0.093**	-0.011	-0.059	-0.068*	-0.095*	-0.018
	(0.043)	(0.048)	(0.056)	(0.039)	(0.053)	(0.061)	(0.045)	(0.049)	(0.058)	(0.040)	(0.054)	(0.062)	(0.043)	(0.049)	(0.056)	(0.040)	(0.054)	(0.061)
Q34_2score	-0.126***	-0.140***	-0.143**	-0.108***	-0.112**	-0.121*	-0.128***	-0.190***	-0.118*	-0.162***	-0.142**	-0.207***	-0.111**	-0.169***	-0.105*	-0.144***	-0.164***	-0.131**
	(0.046)	(0.050)	(0.058)	(0.041)	(0.056)	(0.064)	(0.047)	(0.051)	(0.060)	(0.042)	(0.057)	(0.065)	(0.045)	(0.050)	(0.058)	(0.041)	(0.056)	(0.064)
CIO	0.224***	0.158**	0.257***	0.136*	0.206*	0.076	0.228***	0.107	0.236***	0.088	0.206*	0.005	0.192***	0.221***	0.270***	0.149**	0.181*	0.112
	(0.077)	(0.068)	(0.074)	(0.071)	(0.110)	(0.097)	(0.081)	(0.070)	(0.078)	(0.074)	(0.115)	(0.101)	(0.074)	(0.072)	(0.075)	(0.072)	(0.108)	(0.100)
constant_term	-1.178*	-1.677***	4.886***	-2.239***	-1.539	-1.770**	-0.402	-1.712***	4.808***	-2.283***	-1.523	-1.821***	-1.403*	-2.072***	4.036***	-2.641***	-2.067**	-2.516***
	(0.628)	(0.578)	(0.683)	(0.653)	(1.129)	(0.689)	(0.809)	(0.585)	(0.799)	(0.663)	(1.158)	(0.694)	(0.723)	(0.587)	(0.793)	(0.657)	(0.899)	(0.695)
Pseudo R^2	0.103	0.113	0.110	0.102	0.103	0.125	0.110	0.107	0.105	0.110	0.107	0.126	0.104	0.129	0.106	0.119	0.119	0.137
N	1553	1478	1099	1937	1004	917	1550	1458	1093	1930	1004	911	1551	1455	1093	1927	1002	910

	Innovation 4						Innovation 5					
	Small	Large	Branch	Hq	Hq-sm	Hq-lg	Small	Large	Branch	Hq	Hq-sm	Hq-lg
data	2.061***	2.026***	1.696***	2.198***	2.541***	1.822***	1.935***	1.560***	1.289***	1.985***	2.337***	1.598***
	(0.271)	(0.307)	(0.337)	(0.255)	(0.346)	(0.393)	(0.273)	(0.311)	(0.343)	(0.258)	(0.348)	(0.400)
management	1.552***	1.537***	1.251***	1.610***	1.390***	2.110***	1.653***	1.781***	1.530***	1.794***	1.537***	2.218***
	(0.247)	(0.269)	(0.322)	(0.223)	(0.301)	(0.342)	(0.252)	(0.277)	(0.332)	(0.228)	(0.305)	(0.351)
dumhq	-0.140*	-0.159**					-0.131	-0.135*				
	(0.078)	(0.080)					(0.080)	(0.082)				
univm	0.024	0.034	0.056*	0.016	0.004	0.024	0.015	0.041	0.065*	0.017	0.015	0.018
	(0.028)	(0.030)	(0.034)	(0.026)	(0.035)	(0.039)	(0.028)	(0.031)	(0.035)	(0.026)	(0.036)	(0.040)
unive	-0.054	0.025	-0.031	-0.020	-0.011	-0.038	-0.011	0.018	0.010	-0.029	-0.005	-0.016
	(0.050)	(0.060)	(0.070)	(0.046)	(0.060)	(0.075)	(0.050)	(0.061)	(0.071)	(0.046)	(0.061)	(0.076)
lemp			0.169**	0.081					0.056	0.082		
			(0.072)	(0.050)					(0.075)	(0.051)		
cmp	0.023	0.020	0.016	0.030	0.037	0.016	0.037	0.015	0.006	0.034	0.041	0.022
	(0.025)	(0.025)	(0.030)	(0.022)	(0.031)	(0.032)	(0.025)	(0.025)	(0.031)	(0.022)	(0.032)	(0.032)
Q34_1score	-0.116***	-0.007	-0.090	-0.068*	-0.111**	-0.014	-0.158***	0.016	-0.092	-0.082**	-0.150***	0.006
	(0.043)	(0.048)	(0.056)	(0.039)	(0.053)	(0.060)	(0.044)	(0.049)	(0.058)	(0.040)	(0.054)	(0.061)
Q34_2score	-0.108**	-0.060	-0.034	-0.101**	-0.122**	-0.092	-0.010	-0.060	0.061	-0.072*	-0.064	-0.091
	(0.045)	(0.049)	(0.058)	(0.041)	(0.056)	(0.063)	(0.046)	(0.050)	(0.060)	(0.042)	(0.057)	(0.064)
CIO	0.219***	0.138**	0.170**	0.171**	0.258**	0.116	0.246***	0.220***	0.217***	0.225***	0.339***	0.151
	(0.076)	(0.068)	(0.073)	(0.071)	(0.110)	(0.098)	(0.080)	(0.073)	(0.079)	(0.074)	(0.115)	(0.100)
constant_term	-0.950	-1.691***	3.126***	-2.283***	-1.497**	-1.893***	-1.346**	-1.577***	4.009***	-2.386***	-2.056*	-2.013***
	(0.657)	(0.617)	(0.700)	(0.673)	(0.715)	(0.703)	(0.657)	(0.595)	(0.763)	(0.678)	(1.173)	(0.706)
Pseudo R^2	0.126	0.120	0.107	0.122	0.134	0.126	0.127	0.124	0.111	0.125	0.133	0.129
N	1548	1473	1086	1932	1002	922	1560	1481	1102	1933	1006	926

(Notes) See Tables 11 (a) and (b).

Appendix 2-5: Subsample Analysis (Establishment Size and Single- or Multi-Unit Firms) - Full Results in Medical and Other Health Services

	Innovation 1						Innovation 2						Innovation 3					
	Small	Large	Branch	Hq	Hq-sm	Hq-lg	Small	Large	Branch	Hq	Hq-sm	Hq-lg	Small	Large	Branch	Hq	Hq-sm	Hq-lg
data	1.670***	1.444***	2.231***	1.447***	1.489***	1.244**	1.793***	1.400***	2.806***	1.370***	1.649***	0.829	1.893***	1.475***	3.197***	1.340***	1.692***	0.779
	(0.388)	(0.427)	(0.595)	(0.330)	(0.426)	(0.527)	(0.384)	(0.422)	(0.615)	(0.325)	(0.424)	(0.513)	(0.395)	(0.423)	(0.637)	(0.330)	(0.432)	(0.515)
management	1.458***	1.986***	1.760***	1.731***	1.440***	1.973***	1.620***	1.614***	2.015***	1.492***	1.329***	1.707***	1.681***	1.469***	2.021***	1.517***	1.549***	1.375***
	(0.361)	(0.361)	(0.531)	(0.294)	(0.400)	(0.438)	(0.371)	(0.355)	(0.553)	(0.292)	(0.407)	(0.427)	(0.366)	(0.354)	(0.545)	(0.292)	(0.402)	(0.428)
dumhq	-0.033	-0.239**					0.008	-0.222*					0.029	-0.070				
	(0.138)	(0.113)					(0.140)	(0.113)					(0.140)	(0.112)				
univm	-0.000	0.018	0.057	-0.007	0.013	-0.041	0.015	0.046	0.089	0.010	0.010	0.015	-0.017	0.020	0.080	-0.022	-0.011	-0.044
	(0.038)	(0.043)	(0.059)	(0.032)	(0.041)	(0.053)	(0.038)	(0.043)	(0.062)	(0.032)	(0.041)	(0.052)	(0.038)	(0.043)	(0.061)	(0.032)	(0.042)	(0.052)
unive	0.066	0.058	-0.153	0.127**	0.078	0.183**	0.079	0.039	-0.257**	0.145***	0.120*	0.151*	0.066	0.114	-0.227**	0.169***	0.113	0.243***
	(0.063)	(0.076)	(0.104)	(0.056)	(0.070)	(0.092)	(0.064)	(0.076)	(0.109)	(0.056)	(0.071)	(0.091)	(0.065)	(0.076)	(0.107)	(0.056)	(0.071)	(0.092)
lemp			0.078	-0.155***					0.061	-0.175***					0.005	-0.140***		
			(0.076)	(0.054)					(0.079)	(0.054)					(0.078)	(0.054)		
cmp	0.016	0.054	0.065	0.024	-0.002	0.058	0.030	0.020	0.066	0.017	0.006	0.026	0.062	0.038	0.103*	0.037	0.020	0.064
	(0.041)	(0.041)	(0.054)	(0.035)	(0.047)	(0.052)	(0.041)	(0.041)	(0.056)	(0.034)	(0.046)	(0.051)	(0.042)	(0.041)	(0.056)	(0.035)	(0.047)	(0.052)
Q34_1score	-0.058	0.102	-0.160*	0.092	-0.013	0.207**	-0.052	0.166**	-0.071	0.099*	-0.027	0.233***	-0.057	0.101	-0.243**	0.112*	0.028	0.201**
	(0.072)	(0.070)	(0.096)	(0.059)	(0.082)	(0.086)	(0.073)	(0.070)	(0.099)	(0.059)	(0.082)	(0.085)	(0.073)	(0.070)	(0.099)	(0.059)	(0.083)	(0.085)
Q34_2score	-0.161**	-0.107	0.037	-0.171***	-0.225***	-0.128	-0.242***	-0.110	0.031	-0.217***	-0.323***	-0.118	-0.125	-0.155**	0.031	-0.176***	-0.169**	-0.200**
	(0.075)	(0.071)	(0.106)	(0.059)	(0.083)	(0.085)	(0.076)	(0.071)	(0.110)	(0.059)	(0.084)	(0.084)	(0.076)	(0.071)	(0.109)	(0.059)	(0.084)	(0.085)
CIO	0.235	-0.007	0.106	0.089	0.125	0.033	0.307*	-0.149	-0.225	0.140	0.248	0.016	0.175	-0.011	-0.114	0.130	0.046	0.212
	(0.166)	(0.140)	(0.187)	(0.132)	(0.186)	(0.189)	(0.178)	(0.139)	(0.185)	(0.134)	(0.199)	(0.187)	(0.169)	(0.137)	(0.183)	(0.131)	(0.188)	(0.184)
constant_term	-1.407***	-1.838***	-1.909***	-1.097***	-1.187***	-2.417***	-1.315***	-1.348***	-1.589***	-0.687**	-0.972**	-1.920***	-1.756***	-1.790***	-1.786***	-1.233***	-1.519***	-2.147***
	(0.404)	(0.399)	(0.566)	(0.349)	(0.419)	(0.473)	(0.411)	(0.394)	(0.579)	(0.347)	(0.423)	(0.464)	(0.419)	(0.395)	(0.591)	(0.351)	(0.432)	(0.467)
Pseudo R^2	0.094	0.106	0.124	0.094	0.086	0.107	0.118	0.088	0.149	0.089	0.107	0.084	0.115	0.083	0.168	0.088	0.096	0.085
N	577	627	336	868	458	410	574	626	335	865	455	410	569	624	334	859	450	409

	Innovation 4						Innovation 5					
	Small	Large	Branch	Hq	Hq-sm	Hq-lg	Small	Large	Branch	Hq	Hq-sm	Hq-lg
data	1.614***	1.840***	2.740***	1.467***	1.432***	1.408***	2.052***	1.698***	2.743***	1.695***	1.784***	1.471***
	(0.382)	(0.435)	(0.611)	(0.328)	(0.419)	(0.531)	(0.391)	(0.434)	(0.620)	(0.331)	(0.426)	(0.530)
management	1.711***	1.719***	1.658***	1.719***	1.653***	1.746***	1.669***	2.150***	2.056***	1.856***	1.583***	2.169***
	(0.363)	(0.362)	(0.535)	(0.295)	(0.402)	(0.439)	(0.374)	(0.367)	(0.547)	(0.299)	(0.411)	(0.443)
dumhq	0.146	-0.226**					0.331**	-0.092				
	(0.138)	(0.114)					(0.142)	(0.116)				
univm	-0.014	-0.004	0.042	-0.025	-0.022	-0.033	0.045	0.008	0.039	0.025	0.047	-0.014
	(0.038)	(0.044)	(0.060)	(0.033)	(0.041)	(0.053)	(0.039)	(0.044)	(0.061)	(0.033)	(0.042)	(0.054)
unive	0.062	0.137*	-0.145	0.159***	0.096	0.242**	0.030	0.088	-0.120	0.100*	0.020	0.212**
	(0.064)	(0.078)	(0.105)	(0.057)	(0.071)	(0.095)	(0.065)	(0.078)	(0.106)	(0.057)	(0.072)	(0.094)
lemp			0.105	-0.202***					0.096	-0.167***		
			(0.077)	(0.054)					(0.079)	(0.055)		
cmp	0.039	0.106**	0.032	0.088**	0.055	0.138***	0.053	0.055	0.058	0.058*	0.051	0.063
	(0.041)	(0.042)	(0.055)	(0.035)	(0.047)	(0.053)	(0.042)	(0.042)	(0.056)	(0.035)	(0.047)	(0.053)
Q34_1score	-0.086	0.023	-0.189*	0.022	-0.045	0.096	0.029	0.124*	-0.107	0.142**	0.105	0.187**
	(0.072)	(0.070)	(0.098)	(0.059)	(0.082)	(0.086)	(0.074)	(0.071)	(0.099)	(0.060)	(0.083)	(0.087)
Q34_2score	-0.172**	-0.094	0.084	-0.180***	-0.212**	-0.164*	-0.263***	-0.075	0.008	-0.207***	-0.292***	-0.122
	(0.075)	(0.072)	(0.106)	(0.059)	(0.084)	(0.085)	(0.077)	(0.072)	(0.108)	(0.060)	(0.085)	(0.087)
CIO	0.157	-0.032	-0.122	0.134	0.066	0.199	0.216	-0.050	-0.065	0.120	0.175	0.047
	(0.166)	(0.142)	(0.182)	(0.133)	(0.187)	(0.192)	(0.175)	(0.143)	(0.185)	(0.138)	(0.197)	(0.197)
constant_term	-1.372***	-2.112***	-1.894***	-0.967***	-1.157***	-2.750***	-1.704***	-1.991***	-2.124***	-1.033***	-1.240***	-2.455***
	(0.405)	(0.408)	(0.573)	(0.353)	(0.422)	(0.489)	(0.417)	(0.405)	(0.583)	(0.357)	(0.429)	(0.484)
Pseudo R^2	0.102	0.116	0.137	0.106	0.097	0.121	0.132	0.118	0.157	0.119	0.118	0.131
N	575	621	335	861	454	407	573	627	336	864	454	410

(Notes) See Tables 11 (a) and (b).

Appendix 2-6: Subsample Analysis (Degree of Decentralization in Decision-Making) - Full Results

Road Freight Trandsport	Innovation1 Centralized	Innovation1 Decentralized	Innovation2 Centralized	Innovation2 Decentralized	Innovation3 Centralized	Innovation3 Decentralized	Innovation4 Centralized	Innovation4 Decentralized	Innovation5 Centralized	Innovation5 Decentralized
data	1.658***	2.091***	1.487**	1.385*	1.102*	1.604**	1.580***	1.629**	1.739***	0.910
	(0.634)	(0.737)	(0.606)	(0.756)	(0.614)	(0.742)	(0.610)	(0.704)	(0.617)	(0.715)
management	2.524***	2.145***	2.233***	3.441***	2.530***	2.373***	2.193***	1.526**	1.949***	2.630***
	(0.642)	(0.656)	(0.626)	(0.715)	(0.626)	(0.679)	(0.623)	(0.637)	(0.633)	(0.689)
univm	-0.123**	-0.114	-0.024	-0.136	-0.063	-0.100	-0.073	-0.053	-0.022	-0.044
	(0.063)	(0.086)	(0.061)	(0.086)	(0.061)	(0.085)	(0.061)	(0.083)	(0.063)	(0.083)
unive	0.166*	0.093	0.071	-0.078	0.146	-0.181	0.050	-0.111	0.038	-0.110
	(0.098)	(0.132)	(0.096)	(0.134)	(0.099)	(0.133)	(0.096)	(0.127)	(0.100)	(0.132)
lemp	0.026	-0.043	0.083	-0.124	0.058	-0.219	-0.070	-0.099	-0.053	-0.191
	(0.111)	(0.144)	(0.112)	(0.154)	(0.113)	(0.149)	(0.109)	(0.141)	(0.113)	(0.148)
cmp	0.111*	0.132*	-0.010	0.185**	0.099*	0.146**	0.109*	0.147**	0.037	0.128*
	(0.060)	(0.072)	(0.059)	(0.075)	(0.059)	(0.072)	(0.058)	(0.069)	(0.059)	(0.071)
Q34_1score	0.124	-0.220*	0.148	-0.174	0.143	-0.096	0.085	-0.220**	0.135	-0.151
	(0.116)	(0.114)	(0.114)	(0.118)	(0.114)	(0.115)	(0.111)	(0.111)	(0.113)	(0.116)
Q34_2score	-0.211*	0.055	-0.199*	0.080	-0.135	0.039	-0.147	0.048	-0.132	0.127
	(0.115)	(0.123)	(0.115)	(0.128)	(0.113)	(0.123)	(0.112)	(0.118)	(0.116)	(0.124)
CIO	0.321**	0.061	0.140	-0.001	0.167	0.360*	0.205	0.204	0.166	0.270
	(0.130)	(0.165)	(0.128)	(0.179)	(0.130)	(0.184)	(0.128)	(0.165)	(0.134)	(0.183)
constant_term	-3.156***	-2.252***	-2.142***	-1.595*	-2.730***	-1.021	-1.993***	-1.124	-1.614**	-0.979
	(0.689)	(0.820)	(0.648)	(0.838)	(0.672)	(0.795)	(0.627)	(0.766)	(0.639)	(0.783)
Pseudo R^2	0.230	0.183	0.159	0.225	0.186	0.187	0.173	0.138	0.147	0.169
N	278	209	280	209	277	209	277	212	279	211
Wholesale Trade	Innovation1 Centralized	Innovation1 Decentralized	Innovation2 Centralized	Innovation2 Decentralized	Innovation3 Centralized	Innovation3 Decentralized	Innovation4 Centralized	Innovation4 Decentralized	Innovation5 Centralized	Innovation5 Decentralized
data	1.348***	1.746***	1.167**	1.036*	0.850*	1.034**	1.092**	2.320***	1.350***	1.177**
	(0.488)	(0.527)	(0.499)	(0.539)	(0.481)	(0.512)	(0.487)	(0.525)	(0.516)	(0.511)
management	1.460***	1.252**	1.568***	1.634***	2.299***	0.874*	1.418***	1.249***	1.715***	1.481***
	(0.477)	(0.490)	(0.505)	(0.507)	(0.495)	(0.482)	(0.503)	(0.484)	(0.526)	(0.492)
univm	0.003	0.049	0.053	0.063	-0.013	0.060	0.104**	0.055	0.118**	0.066
	(0.050)	(0.051)	(0.051)	(0.054)	(0.051)	(0.052)	(0.050)	(0.052)	(0.053)	(0.052)
unive	0.074	-0.002	-0.030	-0.047	0.152	-0.107	0.010	-0.112	-0.005	-0.048
	(0.106)	(0.105)	(0.108)	(0.111)	(0.105)	(0.107)	(0.107)	(0.107)	(0.111)	(0.105)
lemp	-0.132	-0.138	-0.138	-0.104	-0.062	0.045	0.188*	0.157	0.110	-0.046
	(0.093)	(0.114)	(0.096)	(0.118)	(0.095)	(0.117)	(0.104)	(0.115)	(0.111)	(0.115)
cmp	0.067	0.029	0.097**	0.021	0.112**	0.032	0.027	0.005	-0.018	0.041
	(0.043)	(0.045)	(0.045)	(0.046)	(0.044)	(0.044)	(0.046)	(0.044)	(0.048)	(0.045)
Q34_1score	-0.104	-0.175**	-0.152*	-0.025	-0.100	-0.027	-0.051	-0.148*	-0.084	-0.172**
	(0.082)	(0.085)	(0.086)	(0.089)	(0.083)	(0.084)	(0.085)	(0.084)	(0.090)	(0.084)
Q34_2score	-0.134	-0.136	-0.073	-0.167*	-0.037	-0.166*	-0.014	-0.058	0.114	0.012
	(0.084)	(0.088)	(0.089)	(0.092)	(0.086)	(0.088)	(0.088)	(0.087)	(0.094)	(0.087)
CIO	0.217**	0.313**	0.149	0.395***	0.220**	0.430***	0.167*	0.213*	0.150	0.362***
	(0.097)	(0.126)	(0.102)	(0.141)	(0.098)	(0.135)	(0.101)	(0.120)	(0.109)	(0.134)
constant_term	-0.952	4.854***	-0.854	4.682***	-1.672*	4.492***	-2.512**	3.050	-2.639**	4.550***
	(0.865)	(1.060)	(0.876)	(1.143)	(0.876)	(1.057)	(1.082)	(.)	(1.102)	(0.940)
Pseudo R^2	0.110	0.156	0.104	0.151	0.126	0.131	0.113	0.155	0.140	0.126
N	538	524	519	510	525	511	519	500	515	512
Medical and Other Health Services	Innovation1 Centralized	Innovation1 Decentralized	Innovation2 Centralized	Innovation2 Decentralized	Innovation3 Centralized	Innovation3 Decentralized	Innovation4 Centralized	Innovation4 Decentralized	Innovation5 Centralized	Innovation5 Decentralized
data	2.773***	1.600*	2.820***	2.908***	3.297***	3.078***	2.332***	3.214***	2.946***	2.682***
	(0.839)	(0.910)	(0.826)	(0.974)	(0.891)	(0.962)	(0.802)	(0.978)	(0.850)	(0.965)
management	2.037***	1.663**	2.495***	1.669**	2.629***	1.516*	2.196***	1.371*	2.036***	2.288***
	(0.756)	(0.781)	(0.791)	(0.812)	(0.794)	(0.784)	(0.744)	(0.811)	(0.760)	(0.836)
univm	0.075	-0.034	0.152*	-0.047	0.103	0.001	0.066	-0.028	0.121	-0.120
	(0.081)	(0.094)	(0.085)	(0.097)	(0.085)	(0.094)	(0.082)	(0.097)	(0.084)	(0.098)
unive	-0.094	-0.145	-0.280*	-0.144	-0.224	-0.160	-0.197	-0.019	-0.176	-0.005
	(0.139)	(0.172)	(0.146)	(0.178)	(0.145)	(0.171)	(0.140)	(0.175)	(0.142)	(0.176)
lemp	0.069	0.076	0.018	0.081	-0.057	0.092	0.099	0.066	0.183	-0.007
	(0.120)	(0.122)	(0.123)	(0.129)	(0.123)	(0.121)	(0.118)	(0.126)	(0.123)	(0.129)
cmp	0.055	0.050	0.059	0.040	0.146*	0.034	0.004	0.057	0.068	-0.004
	(0.076)	(0.083)	(0.078)	(0.086)	(0.081)	(0.083)	(0.076)	(0.086)	(0.078)	(0.088)
Q34_1score	-0.040	-0.235	-0.052	-0.090	-0.200	-0.323**	-0.086	-0.256*	-0.014	-0.139
	(0.138)	(0.148)	(0.140)	(0.153)	(0.146)	(0.150)	(0.137)	(0.154)	(0.139)	(0.157)
Q34_2score	0.039	0.077	0.045	0.057	0.035	0.072	0.035	0.126	-0.114	0.164
	(0.148)	(0.170)	(0.153)	(0.176)	(0.157)	(0.170)	(0.145)	(0.172)	(0.149)	(0.175)
CIO	0.130	0.258	-0.170	-0.189	-0.123	0.026	-0.123	-0.076	-0.008	-0.036
	(0.292)	(0.294)	(0.292)	(0.272)	(0.292)	(0.264)	(0.286)	(0.268)	(0.311)	(0.269)
constant_term	-2.873***	-1.166	-1.961**	-1.331	-2.235***	-1.700*	-1.931**	-1.912**	-2.842***	-1.429
	(0.845)	(0.887)	(0.824)	(0.926)	(0.865)	(0.919)	(0.805)	(0.932)	(0.867)	(0.921)
Pseudo R^2	0.164	0.093	0.186	0.124	0.214	0.143	0.140	0.145	0.198	0.143
N	173	156	173	155	172	155	172	154	173	156

(Notes) See Table 12.

Appendix 3: Data Activities and Innovation Performance by the Ordered Probit Model with the interaction term between data and management - Coefficients in All Independent Variables

	Road Freight Transport					Wholesale Trade					Medical and Other Healthcare Services				
	Innovation 1	Innovation 2	Innovation 3	Innovation 4	Innovation 5	Innovation 1	Innovation 2	Innovation 3	Innovation 4	Innovation 5	Innovation 1	Innovation 2	Innovation 3	Innovation 4	Innovation 5
Coefficients															
data	0.876	0.978	1.215	0.687	0.413	2.510***	2.303***	2.179***	1.705***	2.214***	1.261**	1.958***	1.558***	1.689***	2.078***
	(0.801)	(0.711)	(0.751)	(0.741)	(0.682)	(0.476)	(0.464)	(0.48)	(0.478)	(0.477)	(0.551)	(0.533)	(0.566)	(0.554)	(0.542)
management	0.715	0.87	1.252*	0.407	0.107	2.205***	1.939***	1.658***	1.076**	2.030***	0.982	1.352**	1.102*	1.312**	1.584**
	(0.764)	(0.686)	(0.719)	(0.706)	(0.657)	(0.492)	(0.479)	(0.495)	(0.495)	(0.493)	(0.627)	(0.611)	(0.642)	(0.636)	(0.619)
data*management	2.244	1.611	1.022	2.582*	3.036**	-2.022**	-1.457*	-0.952	0.435	-0.897	0.948	-0.196	0.666	0.25	-0.066
	(1.458)	(1.325)	(1.382)	(1.371)	(1.287)	(0.877)	(0.858)	(0.884)	(0.879)	(0.879)	(1.218)	(1.188)	(1.243)	(1.232)	(1.21)
dumhq	0.001	-0.043	-0.076	-0.107	-0.140*	-0.100**	-0.122***	-0.114**	-0.181***	-0.106**	-0.162**	-0.081	-0.055	-0.082	0.027
	(0.09)	(0.085)	(0.086)	(0.087)	(0.084)	(0.044)	(0.044)	(0.044)	(0.045)	(0.044)	(0.076)	(0.075)	(0.077)	(0.076)	(0.075)
univm	-0.065*	-0.038	-0.043	-0.042	0.016	0.026	0.047***	0.026	-0.006	0.01	-0.008	0.015	-0.007	-0.027	-0.01
	(0.037)	(0.034)	(0.035)	(0.035)	(0.034)	(0.017)	(0.016)	(0.017)	(0.017)	(0.016)	(0.025)	(0.024)	(0.025)	(0.025)	(0.024)
unive	0.100*	0.097*	0.08	0.068	0.059	-0.004	-0.028	-0.001	0	-0.008	0.067	0.067	0.073*	0.088**	0.07
	(0.053)	(0.05)	(0.05)	(0.051)	(0.049)	(0.032)	(0.031)	(0.031)	(0.032)	(0.031)	(0.044)	(0.042)	(0.044)	(0.044)	(0.043)
lemp	0.004	0.026	0.009	-0.026	-0.006	0.039	0.054*	0.075**	0.089***	0.067**	-0.066*	-0.103***	-0.093**	-0.108***	-0.108***
	(0.059)	(0.056)	(0.057)	(0.058)	(0.057)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.038)	(0.037)	(0.038)	(0.038)	(0.037)
cmp	0.063**	0.055**	0.080***	0.099***	0.081***	0.038***	0.039***	0.055***	0.041***	0.024*	0.044*	0.051**	0.055**	0.079***	0.060**
	(0.029)	(0.027)	(0.028)	(0.028)	(0.027)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.026)	(0.025)	(0.026)	(0.026)	(0.025)
Q34_1score	-0.039	-0.008	0.015	-0.002	0.03	-0.081***	-0.081***	-0.074***	-0.068***	-0.054**	0.016	0.062	0.044	0.024	0.116***
	(0.052)	(0.049)	(0.05)	(0.051)	(0.049)	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)	(0.044)	(0.043)	(0.045)	(0.044)	(0.043)
Q34_2score	-0.078	-0.039	-0.055	-0.037	0.006	-0.094***	-0.146***	-0.123***	-0.104***	-0.050*	-0.148***	-0.159***	-0.127***	-0.081*	-0.142***
	(0.054)	(0.051)	(0.052)	(0.052)	(0.051)	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)	(0.046)	(0.044)	(0.046)	(0.045)	(0.044)
CIO	0.187***	0.113	0.160**	0.151**	0.140**	0.170***	0.186***	0.195***	0.155***	0.155***	0.076	0.083	0.117	0.102	0.132
	(0.07)	(0.069)	(0.069)	(0.069)	(0.068)	(0.038)	(0.038)	(0.038)	(0.038)	(0.038)	(0.091)	(0.089)	(0.091)	(0.09)	(0.089)
Cut															
cut1	1.872***	1.626***	1.898***	1.584***	1.365***	2.236***	2.284***	2.372***	1.407***	1.884***	0.928***	1.003***	1.239***	1.249***	1.336***
	(0.495)	(0.446)	(0.465)	(0.463)	(0.433)	(0.528)	(0.529)	(0.531)	(0.525)	(0.5)	(0.357)	(0.349)	(0.368)	(0.362)	(0.351)
cut2	2.807***	2.534***	2.764***	2.458***	2.271***	3.174***	3.183***	3.228***	2.568***	2.903***	1.992***	1.910***	2.098***	2.237***	2.214***
	(0.498)	(0.448)	(0.467)	(0.466)	(0.435)	(0.529)	(0.53)	(0.531)	(0.526)	(0.501)	(0.359)	(0.35)	(0.369)	(0.364)	(0.353)
cut3	3.613***	3.314***	3.561***	3.220***	3.002***	3.692***	3.832***	3.885***	3.238***	3.622***	2.723***	2.731***	2.944***	3.041***	2.995***
	(0.501)	(0.451)	(0.47)	(0.469)	(0.438)	(0.53)	(0.531)	(0.532)	(0.526)	(0.502)	(0.363)	(0.354)	(0.373)	(0.368)	(0.355)
Pseudo R^2	0.128	0.101	0.109	0.116	0.109	0.062	0.071	0.069	0.075	0.07	0.07	0.066	0.07	0.069	0.077
N	866	869	860	870	871	3047	3036	3027	3037	3043	1204	1200	1193	1196	1200

(Notes) data*management denotes the interaction term between *data score 1* and *management score*.

Appendix 4 The 2018 JP-MOPS Survey Sheet

内 閣 府

政府統計

Management and Organizational Practices Survey

Survey Questionnaire

(Road Freight Transport/Wholesale Trade/Medical and Other Health Services)

This survey questionnaire will be treated with absolute confidentiality.
Moreover, responses will be used for statistical purposes only.

1. The reporting unit for this survey is an establishment. The aim of the survey is to understand the organizational and management practices at establishments and to examine the links with productivity growth. We estimate that this survey form will take an average of 30 minutes to complete.

2. Once you have completed the survey form, please put it in the enclosed envelope and post it no later than **November 30, 2018**.

3. A summary of the results of this survey will be sent to your establishment.

○ **About your establishment**

Corporate number ※1		Survey respondent	
Establishment name※2		Affiliation/Position	
Industry		Your name	
Address		Telephone	
		Email	
		Years of service	years

※ 1. If you know the 13-digit corporate number of the corporation to which your establishment belongs, please enter it here. For details about the corporate number, please refer to “Notification of Corporate Number” and further information on the website of the National Tax Agency (National Tax Agency Corporate Number Publication Site).

2. If your establishment belongs to a corporation, please enter the name of the corporation. If your establishment is a branch of a corporation, please enter the names of both the corporation and the establishment (such as the branch/store name).

Section A: **Management Practices**

Question 1. In 2013 and 2018, what best describes what happened at your establishment when a problem in the production process arose?

Examples: Finding a quality defect in service, problems with buying and stocking items, problems with serving customers or with equipment, issues with the transportation of items

※ Mark one box for each year

	2013	2018
We fixed it but did not take further action	☐	☐
We fixed it and took action to make sure that it did not happen again	☐	☐
We fixed it and took action to make sure that it did not happen again, and had a continuous improvement process to anticipate problems like these in advance	☐	☐
No action was taken	☐	☐

Question 2. In 2013 and 2018, how many key performance indicators (KPIs) were monitored at your establishment?

* KPIs are not the sales targets but indicators that show whether firm activities to achieve ultimate targets are proceeding smoothly, e.g., turnover, cost, waste, service quality, inventory, energy, on-time delivery, and customer satisfaction.

In the survey sheet in medical and other health services, KPIs are explained as follows:
KPIs are not the sales targets but indicators that show whether firm activities to achieve ultimate targets are proceeding smoothly, e.g., financial condition, number of patients, medical care quality such as procedure and outcomes (e.g., fatality rate), hospital days, patient satisfaction.

※Mark one box for each year

	2013	2018	
1-2 key performance indicators	☐	☐	Proceed to Question 3
3-9 key performance indicators	☐	☐	
10 or more key performance indicators	☐	☐	
No key performance indicators (if no key performance indicators in both years, SKIP to Question 5)	☐	☐	→ Proceed to Question 5

Question 3. During 2013 and 2018, how frequently were the key performance indicators reviewed by (a) managers[*1] and (b) non-managers[*2] at your establishment?

Note: If in Question 2 your response is "No key performance indicators" either for 2013 or 2018, you do not need to respond for that year.

(a) Managers

*1 A manager is someone who has employees directly reporting to them, with whom they meet on a regular basis, and whose pay and promotion they may be involved with, e.g., Marketing Manager, Human Resource Manager, Sales Manager, Finance Manager.

※ Mark all that apply

	2013	2018
Yearly	☐	☐
Quarterly	☐	☐
Monthly	☐	☐
Weekly	☐	☐
Daily	☐	☐
Hourly or more frequently	☐	☐
Never	☐	☐

(b) Non-managers

*2 Non-managers are all employees at the establishment who are not managers as defined in Question 3(a).

※ Mark all that apply

	2013	2018
Yearly	☐	☐
Quarterly	☐	☐
Monthly	☐	☐
Weekly	☐	☐
Daily	☐	☐
Hourly or more frequently	☐	☐
Never	☐	☐

Question 4. During 2013 and 2018, where were the display boards showing KPIs located at your establishment?

Note: If in Question 2 your response is "No key performance indicators" either for 2013 or 2018, you do not need to respond for that year here.

※Mark one box for each year

	2013	2018
All display boards were located in one place (e.g., at the sales place, the backyard, the office)	☐	☐
Display boards were located in multiple places	☐	☐
We did not have any display boards	☐	☐

Question 5. In 2013 and 2018, what best describes the time frame of sales targets at your establishment?

In the survey sheet in medical and other health services, the term "targets (such as earnings, revenues, and costs)" is used instead of the term "sales of targets."

※ Mark one box for each year

	2013	2018	
Main focus was on short-term (less than one year) sales targets	☐	☐	Proceed to Question 6
Main focus was on long-term(more than one year) sales targets	☐	☐	
Combination of short-term and long-term sales targets	☐	☐	
No sales targets (If no sales targets in both years, SKIP to Question 10)	☐	☐	→ Proceed to Question 10

Question 6. How much effort was required (or is expected to be required) for your establishment to meet its sales targets? Please choose the most appropriate answer below.

Note: If in Question 5 your response is "No production targets" either for 2013 or 2018, you do not need to respond for that year here.

※Mark one box for each year

	2013	2018
Possible to achieve without much effort	☐	☐
Possible to achieve with some effort	☐	☐
Possible to achieve with normal amount of effort	☐	☐
Possible to achieve with more than normal effort	☐	☐
Only possible to achieve with extraordinary effort	☐	☐

Question 7. At your establishment, who was aware of the sales targets? Please choose the most appropriate answer below.

Note: If in Question 5 your response is "No sales targets" either for 2013 or 2018, you do not need to respond for that year here.

※ Mark one box for each year

	2013	2018
Only senior managers (e.g., general managers, directors)	☐	☐
Most managers and some non-managers	☐	☐
Most managers and most non-managers	☐	☐
All managers and most non-managers	☐	☐

Question 8. In 2013 and 2018, what were (a) non-managers' and (b) managers' performance bonuses usually based on at your establishment?

Note: If in Question 5 your response is "No sales targets" either for 2013 or 2018, you do not need to respond for that year here.

(a) Non-managers

※ Mark all that apply

	2013	2018
Their own performance as measured by sales targets	☐	☐
Their team or group performance as measured by sales targets	☐	☐
Their establishment's performance as measured by sales targets	☐	☐
Their company's performance as measured by sales targets	☐	☐
No performance bonuses	☐	☐

(b) Managers

※ Mark all that apply

	2013	2018	
Their own performance as measured by sales targets	☐	☐	Proceed to Question 9
Their team or group performance as measured by sales targets	☐	☐	
Their establishment's performance as measured by sales targets	☐	☐	
Their company's performance as measured by sales targets	☐	☐	
No performance bonuses (If no performance bonuses in both years, SKIP to Question 10)	☐	☐	→ Proceed to Question 10

Question 9. In 2013 and 2018, when sales targets were achieved, what percentage of employees received (or is expected to receive) a bonus based on the degree to which sales targets were achieved at your establishment? Please choose the most appropriate answer for (a) non-managers and (b) managers.

Note: If in Question 5 your response is "No sales targets" either for 2013 or 2018, you do not need to respond for that year here.

(a) Non-managers

※ Mark one box for each year

	2013	2018
0%	☐	☐
1-33%	☐	☐
34-66%	☐	☐
67-99%	☐	☐
100%	☐	☐
Sales targets not met	☐	☐

(b) Managers

※ Mark one box for each year

	2013	2018
0%	☐	☐
1-33%	☐	☐
34-66%	☐	☐
67-99%	☐	☐
100%	☐	☐
Sales targets not met	☐	☐

Question 10. In 2013 and 2018, what were (a) non-managers' and (b) managers' performance bonuses usually based on at your establishment? At your establishment, when deciding whether to promote an employee, what is the decision mainly based on? Please choose the most appropriate answer for (a) non-managers and (b) managers.

(a) Non-managers

※Mark one box for each year

	2013	2018
Promotions were based solely on performance and ability	☐	☐
Promotions were based partly on performance and ability, and partly on other factors (e.g., tenure or family connections)	☐	☐
Promotions were based mainly on factors other than performance and ability (e.g., tenure or family connections)	☐	☐
Non-managers are normally not promoted	☐	☐

(b) Managers

※Mark one box for each year

	2013	2018
Promotions were based solely on performance and ability	☐	☐
Promotions were based partly on performance and ability, and partly on other factors (e.g., tenure or family connections)	☐	☐
Promotions were based mainly on factors other than performance and ability (e.g., tenure or family connections)	☐	☐
Managers are normally not promoted	☐	☐

Question 11. At your establishment, if an employee is found to be doing a poor job, how long does it take for them to be transferred to another position or be dismissed? Please choose the most appropriate answer for (a) non-managers and (b) managers.

(a) Non-managers

※ Mark one box for each year

	2013	2018
Less than six months	☐	☐
More than six months	☐	☐
There were few or no cases in which employees were transferred or dismissed.	☐	☐

(b) Managers

※Mark one box for each year

	2013	2018
Less than six months	☐	☐
More than six months	☐	☐
There were few or no cases in which employees were transferred or dismissed.	☐	☐

Section B: Organization

Question 12. Was the headquarters for this company at the same location as your establishment? Mark one box for each year.

※Mark one box for each year

	2013	2018
Yes (If yes in both years, SKIP to Question 19)	☐	☐
No	☐	☐

If no, what prefecture (if in Japan) or country (if abroad)?

2013:	2018:

Question 13. In 2013 and 2018, where were decisions on hiring permanent full-time employees made for your establishment? Mark one box for each year.

※Mark one box for each year

	2013	2018
Only at your establishment	☐	☐
Only at headquarters	☐	☐
Both at your establishment and at headquarters	☐	☐
Other	☐	☐

(If other, please specify.)

2013:	2018:

Question 14. In 2013 and 2018, where were decisions to give an employee a pay increase of at least 10% made for your establishment? Mark one box for each year.

※ Mark one box for each year

	2013	2018
Only at your establishment	☐	☐
Only at headquarters	☐	☐
Both at your establishment and at headquarters	☐	☐
Other	☐	☐

(If other, please specify.)

2013:	2018:

Question 15. In 2013 and 2018, where were decisions on new product/service introductions made for your establishment? Mark one box for each year.

※ Mark one box for each year

	2013	2018
Only at your establishment	☐	☐
Only at headquarters	☐	☐
Both at your establishment and at headquarters	☐	☐
Other	☐	☐

(If other, please specify.)

2013:	2018:

Question 16. In 2013 and 2018, where were product/service pricing decisions made for your establishment? Mark one box for each year.

※Mark one box for each year

	2013	2018
Only at your establishment	☐	☐
Only at headquarters	☐	☐
Both at your establishment and at headquarters	☐	☐
Other	☐	☐

(If other, please specify.)

2013:	2018:

Question 17. In 2013 and 2018, where were advertising decisions for products/services made for your establishment? Mark one box for each year.

※ Mark one box for each year

	2013	2018
Only at your establishment	☐	☐
Only at headquarters	☐	☐
Both at your establishment and at headquarters	☐	☐
Other	☐	☐

(If other, please specify.)

2013:	2018:

Question 18. In 2013 and 2018, what was the yen amount that could be used to purchase a fixed/capital asset for your establishment without prior authorization from headquarters? Mark one box for each year.

※Mark one box for each year

	2013	2018
Under 100,000 yen	☐	☐
100,000 to 1 million yen	☐	☐
1 million to 10 million yen	☐	☐
10 million to 100 million yen	☐	☐
100 million yen or more	☐	☐

Section C: Data and Decision-Making

- "Data" here refers to numerical values, characters, images, sounds, etc., represented in a formalized manner suitable for communication, interpretation, or processing.
- "Decision-making" here includes all decisions necessary for establishment activities, ranging from strategic decisions by management for the whole establishment to on-site decisions for the day-to-day activities of the establishment.

Question 19-1. In 2013 and 2018, what best describes the availability of data to support decision making at your establishment?

※ Mark one box for each year

	2013	2018
Data to support decision making are not available	☐	☐
A small amount of data to support decision making is available	☐	☐
A moderate amount of data to support decision making is available	☐	☐
A great deal of data to support decision making is available	☐	☐
All the data we need to support decision making is available	☐	☐

Question 19-2. Following up on Question 19-1 regarding data to support decision-making: In 2018, how much is the data collected as "systematically organized electronic data"*? Mark one box for the data with the longest accumulation period.

* "Systematically organized electronic data" here refers to electronic data that is systematically collected and organized to a certain extent, including information on individual customers and transaction data on individual products or services (for example, sales to individual customers, data on sales and inventories of individual products, etc.). It does not refer to accounting data such as sales and profits aggregated at the establishment level.

	2018
Not being collected at all	☐
Has been collected for the past year	☐
Has been collected for the past 2 years	☐
Has been collected for the past 3 to 5 years	☐
Has been collected for the past 6 to 10 years	☐
Has been collected for more than 10 years	☐

Question 20. In 2013 and 2018, what best describes the use of data to support decision making at your establishment?

※ Mark one box for each year

	2013	2018
Decision making does not use data	☐	☐
Decision making relies slightly on data	☐	☐
Decision making relies moderately on data	☐	☐
Decision making relies heavily on data	☐	☐
Decision making relies entirely on data	☐	☐

Question 21. Consider each of the following sources of data and rate how frequently each source is used in decision making at your establishment in 2018 and was used in 2013.

(a) At present in 2018

	Daily	Weekly	Monthly	Yearly	Never
Basic Performance indicators (e.g., sales, costs, inventories, etc.)	☐	☐	☐	☐	☐
Formal or informal feedback from managers	☐	☐	☐	☐	☐
Formal or informal feedback from non-managers	☐	☐	☐	☐	☐
Data from outside the firm (suppliers, customers, outside data providers)	☐	☐	☐	☐	☐

(b) In 2013

	Daily	Weekly	Monthly	Yearly	Never
Basic Performance indicators (e.g., sales, costs, inventories, etc.)	☐	☐	☐	☐	☐
Formal or informal feedback from managers	☐	☐	☐	☐	☐
Formal or informal feedback from non-managers	☐	☐	☐	☐	☐
Data from outside the firm (suppliers, customers, outside data providers)	☐	☐	☐	☐	☐

Question 22-1. How frequently is/was each of these activities influenced by data analysis at your establishment?
Mark one box for each year.

(a) At present in 2018

	Never	Slightly	Moderately	Generally	Entirely
Demand forecasting	☐	☐	☐	☐	☐
Investment decisions (e.g., regarding capital equipment, new branches)	☐	☐	☐	☐	☐
Design of new products or services	☐	☐	☐	☐	☐
Advertising	☐	☐	☐	☐	☐
Purchasing, shipping, inventory control, distribution	☐	☐	☐	☐	☐
Back office tasks (e.g., human resources, accounting)	☐	☐	☐	☐	☐

(b) In 2013

	Never	Slightly	Moderately	Generally	Entirely
Demand forecasting	☐	☐	☐	☐	☐
Investment decisions (e.g., regarding capital equipment, new branches)	☐	☐	☐	☐	☐
Design of new products or services	☐	☐	☐	☐	☐
Advertising	☐	☐	☐	☐	☐
Purchasing, shipping, inventory control, distribution	☐	☐	☐	☐	☐
Back office tasks (e.g., human resources, accounting)	☐	☐	☐	☐	☐

Question 22-2. Following up on Question 22-1, what issues does your establishment currently face when using data to support decision-making? Mark all that apply below.

	2018
Not collecting useful data	☐
Not cost-effective	☐
Insufficient human resources to use data	☐
Legal uncertainties regarding the use of data (regarding personal data protection, intellectual property rights, etc.)	☐
No issues in using data	☐
Do not need to use data	☐
Other	☐

(If other, please specify.)

Question 23-1. How frequently does your establishment typically rely on predictive analytics (statistical models that provide forecasts in areas such as demand, production, or human resources)?

* "Predictive analytics" refer to analytical methods that employ various kinds of data, including big data, as well as statistical models to specify the likelihood of future outcomes based on historical data with regard to business activities such as demand, sales, human resource management, etc.

※ Mark one box for each year

	2013	2018
Daily	☐	☐
Weekly	☐	☐
Monthly	☐	☐
Yearly	☐	☐
Never	☐	☐

Question 23-2. Following up on Question 23-1, is artificial intelligence (AI; for details, see Section D on the next page) used for predictive analytics? Please choose the most appropriate answer below.

※ Mark one box for each year

	2013	2018
Used	☐	☐
Not used	☐	☐

Section D: Artificial Intelligence (AI)

● Artificial intelligence (AI) refers to technology that achieves intellectual work performed by the human brain using a computer. Specific examples of applications include image and speech recognition, interactive processing through the understanding of natural language, demand forecasting, machine learning, inference making, and optimization.

* Examples of the use of AI (with examples of fields in parentheses)
The examples differ in business categories.
Road freight transport
- Proper inventory control through demand forecasting (corporate planning; products/services planning; research and development; purchasing, shipping, inventory control, distribution)
- Testing delivery route through inference and optimization (corporate planning; products/services planning; research and development; purchasing, shipping, inventory control, distribution)
- Shift management of staff at an establishment (human resources, workforce management, accounting)

Wholesale trade
- Purchasing and sales of goods through demand forecasting (corporate planning; products/services planning; research and development; purchasing, shipping, inventory control, distribution; advertising)
- Responding to questions using chatbots (customer services such as sales, inquiries, after-sales services)
- Shift management of staff at an establishment (human resources, workforce management, accounting)

Medical and other health services
- Diagnosis support system through similar cases (corporate planning; products/services planning; research and development)
- Calculating patient risk through predictive model (corporate planning; products/services planning; research and development)
- Shift management of nurse at an establishment (human resources, workforce management, accounting)

Question 24. What best describes the use of AI in 2018? Mark one box for each of these activities.

Note: The use of AI includes not only the use of AI technology (and software incorporating AI technology) itself but also that of machinery (hardware) such as automated robots operated by AI. It also includes the use of AI technology at the stage of demonstration experiments.

Proceed to Question 25-1

Proceed to Question 26 if all your answers fall into these categories.

	In use	In consideration of use	No plan to use	Does not apply	Do not know
Corporate planning; products/services planning; research and development	☐	☐	☐	☐	☐
Purchasing, shipping, inventory control, distribution	☐	☐	☐	☐	☐
Advertising	☐	☐	☐	☐	☐
Customer services (sales, inquiries, after-sales services, etc.)	☐	☐	☐	☐	☐
Human resources, workforce management, accounting	☐	☐	☐	☐	☐
Other	☐	☐	☐	☐	☐

(If other, please specify.)

This question is for those who replied "In use" or "In consideration of use" in at least one of the rows in Question 24 above.

Question 25-1. How much effect is the use of AI expected to have? Mark one box for each of these activities.

Note: For fields where the response is "No plan to use" or "Does not apply" in Question 24, mark "No plan to use/Does not apply."

	Large	Some	Little	No	No plan to use/Does not apply
Corporate planning; products/services planning; research and development	☐	☐	☐	☐	☐
Purchasing, shipping, inventory control, distribution	☐	☐	☐	☐	☐
Advertising	☐	☐	☐	☐	☐
Customer services (sales, inquiries, after-sales services, etc.)	☐	☐	☐	☐	☐
Human resources, workforce management, accounting	☐	☐	☐	☐	☐
Other	☐	☐	☐	☐	☐

Question 25-2. It is assumed that as technology advances AI will make a lot of things possible. Under this assumption, what is the role of AI expected to play at your establishment? Mark all that apply.

Create businesses with new values	☐
Increase the value (in terms of quality, customer satisfaction, etc.) of, or quantitatively expand the existing business	☐
Increase efficiency and productivity of the existing business	☐
Make up for labor shortages (due to tightness of the labor market, reduction of overtime, shortage of skilled workers, etc.)	☐
Promote business cooperation or rearrange business relationship with suppliers and clients	☐
Do not know	☐
Other	☐

(If other, please specify.)

Question 25-3. In order for AI to play the role indicated in Question 25-2, what initiatives are your establishment taking or planning to take in the future in terms of developing, securing, and allocating personnel. Please choose all answers that apply.

Educate and train employees within the establishment	☐
Use external personnel familiar with AI (temporary workers, etc.)	☐
Recruit new graduates or mid-career personnel familiar with AI	☐
Reassign personnel (that can be replaced by AI) within the establishment	☐
Do not know	☐
Other	☐

(If other, please provide more details in the box below.)

This question is for those who replied "No plan to use," "Does not apply," or "Do not know" in all the rows in Question 24 above.

Question 26. What are the main reasons that your establishment is not considering or planning to use AI? Please choose all answers that apply.

AI that could be used in the establishment's activities does not currently exist	☐
Difficulties exist in judging the usefulness of AI due to a lack of knowledge or the high degree of uncertainty with regard to AI	☐
Not cost-effective	☐
Low priority compared to other investment expenditure	☐
Insufficient personnel to handle AI	☐
Data necessary for the use of AI has not been collected	☐
Not used by others in the same industry	☐
Do not know	☐
Other	☐

(If other, please provide more details in the box below.)

Section E: Your establishment

Question 27. What was the number of regular employees* of your establishment as of June 1, 2018?

* "Regular employees" refer to those employed indefinitely or for a month or more, including full-time and part-time employees, etc. However, individual owner-managers, unpaid family employees, and dispatched workers should not be included.

	Number of regular employees					
As of June 1, 2018						

Question 28. At your establishment, roughly what percentage of employees had a university degree? Please choose the most appropriate answer for (a) managers and (b) non-managers.

(a) Managers

※ Mark one box for each year

	2013	2018
Less than 20%	☐	☐
20% or more, but less than 40%	☐	☐
40% or more, but less than 60%	☐	☐
60% or more, but less than 80%	☐	☐
80% or more	☐	☐

(b) Non-managers

※ Mark one box for each year

	2013	2018
0%	☐	☐
Less than 10%	☐	☐
10% or more, but less than 20%	☐	☐
20% or more	☐	☐

Question 29. At present in 2018, does the firm to which your establishment belongs have a CIO*? Please choose the most appropriate answer (one answer only).

* The term "chief information officer" (CIO) refers to a person that has ultimate responsibility for all aspects related to information technology (IT) within the firm, ranging from the introduction to the use and application of IT. Further, the CIO is responsible for devising and implementing an information strategy that is in line with the management philosophy of the firm.

	2018
Has a full-time CIO	☐
Has a CIO who concurrently holds other positions	☐
Does not have a CIO	☐
Do not know	☐

Question 30. Has the firm to which your establishment belongs used or applied for national or local government subsidies for the introduction of IT between January 2018 and today? Please choose all answers that apply.

	Between January 2018 and today
Already received	☐
Applying/Planning to apply	☐
Not planning to apply	☐
Do not know	☐

Question 31. At present, in 2018, about how many establishments are directly competing with your establishment to win customers, etc. Please choose the most appropriate answer (one answer only).

	2018
0	☐
1–2 establishments	☐
3–5 establishments	☐
6–10 establishments	☐
More than 10 establishments	☐

Question 32. At your establishment, how does it train and use specialized personnel in order to resolve issues straddling various specialized tasks*? Please choose the most appropriate answer.

* "Specialized tasks" refer to individual tasks that have been set up in the different fields within the establishment such as corporate planning, distribution, advertising, customer services, etc.

※ Mark one box for each year

	2013	2018
Train specialized personnel in each field and use them in teams	☐	☐
Train and use personnel capable of dealing with various fields	☐	☐
Train specialized personnel in each field and, in addition, train and use specialized personnel responsible for communication between fields	☐	☐

Question 33. Has your establishment in the past five years (2013 to 2018) made any of the innovations listed below? Please choose one answer for each row.

● Explanation of the "innovation" terminology below

1. "New products/services" refer to products or services with characteristics and uses that differ substantially from those offered/sold so far.
2. "Improvement of existing products/services" refer to substantially strengthening or improving functions of existing products/services (within or outside your firm).
3. "New combination of existing products/services" refer to producing new products/services by combining existing products/services without altering the performance or quality of those existing products/services.
4. "Introduction of new processes" refer to the adoption of new methods in processes ranging from the development to the provision of products/services.
5. "Process improvements" refer to substantial functional strengthening or improvement of processes.

	No innovations	Once every few years	Once a year	More than once a year
Development and introduction of new products/services	☐	☐	☐	☐
Improvement of existing products/services	☐	☐	☐	☐
New combination of existing products/services	☐	☐	☐	☐
Introduction of new processes	☐	☐	☐	☐
Process improvements	☐	☐	☐	☐

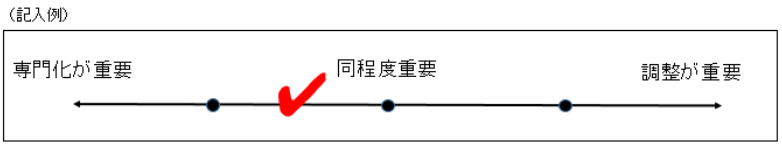
Question 34. In your own personal view, how can your establishment be described compared to other establishments in terms of the following aspects?

■ Specialization or coordination

Which of the following do you feel is more important for the performance of your establishment? Referring to the example below, indicate the degree to which aspects are important by placing a mark on the line as indicated.

・"Specialization in individual tasks" refers to a high degree of division of labor in tasks involving specialized knowledge, etc.
・"Coordination across individual tasks" refers to smooth communication across departments for the consistent implementation of tasks, etc.

Example



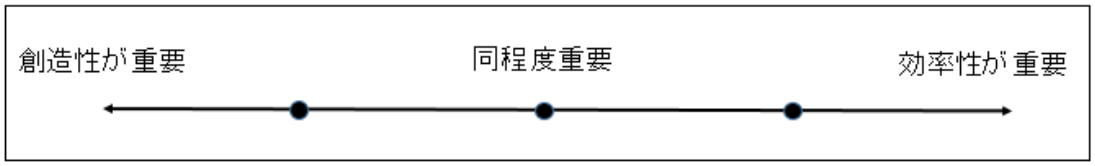
Specialization is more important　　Coordination is more important

Equally important

■ Creativity or efficiency

Which do you feel is more important in your establishment, employees' creativity or the efficiency of performing tasks?

・"Creativity" refers to employees' voluntary initiatives and ingenuity, etc.
・"Efficiency" refers to raising the efficiency of performing tasks through the standardization of tasks, etc.



Creativity is more important　　Efficiency is more important

Equally important

Thank you very much for your cooperation.

Please return the completed survey form no later than November 30, 2018.