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The Adoption of Social Enterprise Software

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Non-Technical Summary

Though in an infancy state, the so-called social enterprise software is a highly promising software application for firms. This software links firms' enterprise software systems and social software applications, thereby offering a novel and remarkably rapid real-time information transfer, e. g. by combining business collaboration, content sharing and instant messaging into one familiar, easy-to-use interface. Besides this, social enterprise software supports tracking data from customer surveys, commentaries, reviews or user profiles on social networks or blogs, thus enabling firms to identify new customers, new market segments and recent trends. With this specific customer data collected and processed, social enterprise software might even facilitate the development of new products, given that it allows the utilizing firms to observe customer tastes and build up customer profiles.

This paper analyzes the determinants of social enterprise software adoption and considers factors like firm size, ICT intensity, human capital or international competitive situation. The analysis is based on recent German firm-level data consisting of German firms from the manufacturing industry and the service sector. We apply a two-step approach by using a bivariate probit model controlling for possible sample selection including a valid exclusion restriction.

The results indicate that firms with highly qualified workers, a large share of young employees and international business activity are more likely to adopt social enterprise software. Larger and more ICT-intensive firms and recent innovators also have a higher propensity to use social enterprise software. In addition, firms belonging to the service sector are more eager to implement social enterprise software applications. Robustness checks qualitatively confirm the estimation results of the bivariate probit model.

Das Wichtigste in Kürze

Obwohl sich Social Enterprise Software noch immer in der Einführungsphase befindet, ist sie schon jetzt eine vielversprechende Softwarelösung für Unternehmen. Diese Software verbindet Unternehmenssoftware und Soziale Software, wodurch ein neuer und bemerkenswert schneller Informationstransfer in Echtzeit entsteht, beispielsweise durch die Zusammenführung von Kooperationen, Content Sharing und Instant Messaging in eine einzige, leicht verständliche Benutzeroberfläche. Des Weiteren erlaubt Social Enterprise Software den Unternehmen Kundenbefragungen, Kommentare, Kritiken oder Benutzerprofile in sozialen Netzwerken oder Blogs zu verfolgen, was die Identifikation neuer Kunden, Marktsegmente und jüngster Trends ermöglicht. Durch das Einbeziehen und die Verarbeitung dieser speziellen Kundendaten könnte Social Enterprise Software sogar die Entwicklung neuer Produkte begünstigen, da es den Firmen, die die entsprechende Software verwenden, ermöglicht, einen Überblick über Kundenwünsche zu behalten und Kundenprofile zu entwickeln.

Dieses Papier analysiert die Determinanten der Einführung von Social Enterprise Software und berücksichtigt dabei unter anderem Firmengröße, IKT-Intensität, Humankapital und die internationale Wettbewerbssituation. Die Analyse basiert auf einem aktuellen Unternehmensdatensatz bestehend aus Unternehmen des verarbeitenden Gewerbes und des Dienstleistungssektors in Deutschland. Wir verwenden einen zweistufigen Ansatz durch die Anwendung eines bivariaten Probitmodells, das eine mögliche Stichprobenselektion mit einem geeigneten Ausschlusskriterium berücksichtigt.

Die Ergebnisse zeigen, dass Unternehmen mit hochqualifiziertem Personal, einem großen Anteil an jungen Mitarbeitern und internationalen Aktivitäten eher Social Enterprise Software einsetzen als andere. Größere und IKT-intensivere Unternehmen, sowie innovative Unternehmen zeigen ebenfalls eine höhere Wahrscheinlichkeit zur Einführung von Social Enterprise Software. Darüber hinaus sind Dienstleistungsunternehmen vergleichsweise stärker an einer Einführung interessiert. Robustheitschecks bestätigen die Ergebnisse des bivariaten Probitmodells.

The Adoption of Social Enterprise Software*

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Abstract

Social enterprise software is a highly promising software application for firms, though it is still in an infancy state. It offers rapid real-time information transfer based on business collaboration tools or instant messaging. The software collects and processes customer data from surveys, consumer feedback, reviews, blogs or social networks. This enables firms to build up detailed customer profiles potentially anticipating upcoming trends. We analyze the determinants of social enterprise software adoption based on the literature on the adoption of new technologies. In our analysis, we control for factors like firm size, intensity of information and communication technology, human capital and international competitive situation. Exploiting recent German firm-level data and a model controlling for sample selection, the results reveal that firms with highly qualified workers, a large share of young employees and international business activity are more likely to adopt social enterprise software. Larger and more ICT-intensive firms and recent innovators also have a higher propensity to use social enterprise software. In addition, firms belonging to the service sector are more eager to implement social enterprise software applications than manufacturing firms.

Keywords: enterprise software, social software, social enterprise software
JEL-Classification: L10, M20, O31

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1 Introduction

In recent years, social software[1] has increasingly appeared in or been at the heart of both public conversations and press releases. The recently surging phenomenon "Facebook" is omnipresent and even more frequently hit than Google in search engines (Nuttall and Gelles 2010). Social software is already widely used in private households and firms alike. However, a new type of enterprise software emerges interrelating recent social software applications and firms' established enterprise systems[2]. These new applications which are called social enterprise software[3] link firms' enterprise software systems and social software applications. They offer thereby a novel and remarkably rapid real-time information transfer, e. g. by combining business collaboration, content sharing and instant messaging into a single, easy-to-use interface[4]. Social enterprise software supports tracking data from customer surveys, consumer feedback, reviews or user profiles on social networks or blogs, enabling firms to identify new customers, new market segments and recent trends. With this specific customer data collected and processed, social enterprise software might even facilitate the development of new products as it allows the utilizing firms to observe customer tastes and build up customer profiles.

Up to now there are no empirical studies on this emerging phenomenon given that these software packages began to come up in 2008 (Chess Media Group 2010) with Social Customer Relationship Management being the first application followed by first announcements of Social Enterprise Resource Planning at the end of 2008 (Williams 2009). Consequently, as social enterprise software is still in its infancy state empirical evidence about determinants and characteristics of the firms which decide to adopt these most recent software applications is still lacking.

We aim at filling this gap by empirically evaluating appropriate determinants and firm characteristics expected to influence the adoption decision. As social enterprise software can be regarded as a new technology or a recent process innovation there are several characteristics which may influence the decisions leading to eventual implementation. For

[1] E. g. wikis, blogs, microblogs or social networks.

[2] E. g. Enterprise Resource Planning (ERP), Supply Chain Management (SCM), Customer Relationship Management (CRM).

[3] See for example Oracle Social CRM: http://www.ababj.com/crm/oracle-crm-release-supports-mobile-social-networking.html

[4] See for example Novell Vibe Cloud: http://www.novell.com/products/vibe-cloud/features/enterprise-social-software.html

instance, the adoption might depend on the availability of qualified personnel (Wozniak 1987; Lo and Sutthiphisal 2010) or on the size of the firm (Davies 1979; Frambach and Schillewaert 2002). The firms' decision to engage in such a process innovation may also depend on former innovation experience (Flaig and Stadler 1994) or on the competitive environment a firm is facing (Bertschek 1995, Aghion et al. 2009).

We use a unique database consisting of German manufacturing and service firms and apply a two step approach controlling for sample selection. The results reveal that firms with a highly qualified workforce and a large share of young employees are more likely to adopt social enterprise software. More IT-intensive firms which are active in e-commerce and feature a large proportion of expenditures for information and communication technologies (ICT) are also more likely to employ recent social enterprise software applications. If a firm is active in international business activities like importing it relies more frequently on sophisticated social enterprise systems compared to firms that do not engage in international commerce. Furthermore, if a firm was already successful in the past in terms of innovation activity by realizing process or product innovations it faces a higher probability of linking enterprise systems and social software. Large firms are more likely to implement social enterprise software than others. Finally, service firms are more eager to adopt social enterprise software than manufacturing firms.

The paper proceeds as follows: Section 2 provides an overview of the literature focusing on the adoption of new technologies and clarifies the terms and benefits of enterprise software, social software and social enterprise software. Additionally, Section 2 derives the main hypotheses for the factors we expect to influence the adoption decision. Section 3 presents the dataset whereas section 4 highlights the empirical model and establishes the estimation approach. The estimation results and several robustness checks to clarify the validity of the results are presented in Section 5. Finally, Section 6 concludes.

2 Background Discussion

2.1 Adoption of New Technology

In general, the adoption and diffusion of new technologies may be modeled by so-called epidemic models attempting to explain the share of firms which adopt and implement

the new applications over time. These models are usually based on the assumption of a sigmoid form of the diffusion path indicating that a few firms adopt the invention early with the adoption process then gaining momentum as other firms learn about the invention and decelerating afterwards once the majority of firms has entered the post-adoption period (Tirole, 1988). Comprehensive surveys on these models of diffusion are offered by Geroski (2000) and Karshenas and Stoneman (1995). Empirical analyses of these models are provided for example by Baptista (2000) and Gruber and Verboven (2001). Starting out with Baptista (2000) who investigates the diffusion of computer numerically controlled (CNC) machine tools and microprocessors the results, based on a hazard rate model, reveal that especially during the early stage of diffusion, regional learning effects play an important role in the sense that they reduce the time of adoption. Gruber and Verboven (2001) on the other hand analyze the diffusion of mobile telecommunications services in the 15 member states of the European Union for the period 1984 to 1997 employing a logistic model of diffusion. Their results confirm that transitioning from analogue to digital technology and deregulation of the telecommunication market have positive effects on the diffusion of mobile telecommunications. Focusing on the adoption of specific ICT practices Bertschek and Fryges (2002) analyze the determinants of business-to-business (B2B) e-commerce implementation in German firms. Their results show that firm size, export activity and the share of highly skilled workers positively impact the firms' decision to utilize B2B. In addition, Bertschek and Fryges (2002) confirm that firms are more likely to implement B2B if other companies within the same industry do so as well. Nevertheless, the empirical evidence in the literature of technology adoption and diffusion based on firm-level analysis is, particularly regarding European countries, somewhat limited. Fabiani et al. (2005) provide an analysis for Italy by analyzing a survey of 1500 Italian manufacturing firms. Focusing on investments in ICT the results of Fabiani et al. (2005) indicate that the most important determinants are firm size, the human capital of the workforce and the presence of large firms in the local environment. ICT adoption also tends to be associated with changes in a firm's organizational structure.

As discussed among specialists and vendors linking social software and enterprise systems by adopting social enterprise software (SES) is still in an infancy state merely beginning to embark upon the diffusion process. Therefore the question arises which firms are the first to adopt this new technology and what specific characteristics determine their adoption decision. This decision is of course related to the potential costs and

expected benefits SES produces for the utilizing firm. First of all, the implementation of SES involves several costs as the technical requirements have to be fulfilled, be it by buying a complete social enterprise software solution from a vendor or procure the programming of the interfaces from ICT specialists inside or outside the firm. Moreover, the working process has to be reorganized in order to allow efficient use of the new technology. This includes training or seminars for the workforce as well as testing phases of the new software directly within the firm. The potential benefits of a new technology like reduced costs or increased performance, however, cannot be identified in a straightforward way as SES has not been available long enough yet to generate any measurable payback. Nevertheless, firms linking enterprise systems and social software via implementing SES systems expect to realize several potential benefits. These benefits are naturally related to the benefits and enhancements enterprise software systems and social software applications provide to a utilizing firm.

2.2 Benefits of Enterprise Systems, Social Software and Social Enterprise Software

Enterprise systems are company-wide suites of business software devoted to particular process integration across the value chain. They encompass a wide range of software products supporting day-to-day business operations and decision-making. The widely diffused enterprise systems, Enterprise Resource Planning (ERP) and Customer Relationship Management (CRM), serve many industries in numerous areas. To be more precise, ERP systems use a source of data that integrates enterprise functions such as sales and distribution, materials management, production planning, financial accounting, cost control and human resource management. They replace complex interfaces between different systems with standardized cross-functional transaction automation (Aral et al. 2006). An ERP system is expected to reduce order cycle times, which in turn may lead to improved throughput, customer response times and delivery speeds (Cotteleer 2002; McAfee 2002). In contrast, by covering the front office of the firm CRM systems facilitate the development of medium-term relationships with customers and reduce duplications in data entries due to several unlinked sources by providing the appropriate infrastructure, e. g. enabling effective sales force automation, centralized customer data warehousing and data mining paired with decision support and reporting tools (Katz 2002; Suresh 2004). A CRM system is, moreover, expected to lead to superior customer

loyalty, reduced cost of sales and services or improved bottom-line profits (Chen 2001). Empirical evidence confirming positive impacts of enterprise software on several different measures of firm performance is given for example by Aral et al. (2006), Hitt et al. (2002) and Engelstätter (2011).

Social software, on the other hand, encompasses web-based applications which connect people and support communication, interaction and cooperation (e.g. Raabe 2007, Back and Heidecke 2008). In general, such social software applications are wikis, blogs, web forums (discussion forum, internet forum), instant messaging services, social bookmarking, podcasts and social networks sites like e. g. facebook. Within a firm, social software can be applied for different purposes. On the one hand, it can be used to strengthen external communication with other firms and partners or enhance customer relationship management, marketing and market research (Döbler 2007, Raabe 2007). On the other hand, it can be utilized as a knowledge management tool to facilitate internal communication, including for example knowledge and project management or product development. With such an enhanced flow of information and faster communication firms using social software expect increased efficiency and access to a greater pool of knowledge, be it internal or external, thereby increasing firm performance. Concerning empirical evidence for the impacts of social software Meyer (2010) shows that service firms experience higher innovation activity if they rely on social software applications.

Social enterprise software such as social CRM or social ERP, which links social software applications and firms' enterprise systems is a rather young technology, only a handful of solutions are made available by vendors[5] at the moment. However, the potential impacts of this technology on performance, process or knowledge management seem quite obvious. Once both types of systems are connected and can share data in real-time, employees participate in a very fast information transfer as they utilize social software applications like instant messaging which enables them to source all available data as needed directly from the enterprise systems. As connected enterprise systems link business units, connected social and enterprise software can extend communication even more by connecting every employee and providing all data he may require, e. g., customer or sales information. This offers a more central network position to the employees, possibly fostering their innovative activity (Tsai 2001) as they access new knowledge in a faster and better organized fashion.

[5]Currently we only know from big vendors like Oracle or SAP who offer appropriate social enterprise system solutions.

Establishing a connection between social and enterprise software seems particularly useful for CRM systems as a social CRM can directly implement and exploit data and information from customer surveys, commentaries, reviews or user profiles on social networks or blogs. If this data is processed and prepared via social CRM it enables the utilizing firm to monitor recent trends and customer demands ahead of time, helping with the elaboration of sales forecasts and market development expectations. In addition, utilizing this data might also result in new product developments or open up new market segments. Based on the collected data a social CRM system may identify concrete customers for products and services based on the information these potential customers provide on their profiles in social networks. In line with that, a social CRM may also track changes in the profiles thereby easily identifying new possible customers. However, social CRM adds value back to the customer as it is a customer engagement strategy offering the customer different opportunities to get in contact and interact with the firm. The customer can choose his prefered communication channel to interact with the company, for instance email, instant messenger, messages in social networks or blogs. By giving feedback on the firms' products and services the customers may even contribute to the development of new products or the improvements of current ones. In addition, the established interaction between the customer and the firm based on the social CRM might allow engaging non-traditional industry influencers like bloggers, independent analysts and customers passionate about brands (Chess Media Group 2010) resulting in a positive attitude of the firm's products which might attract even more customers.

2.3 Factors Influencing the Adoption Decision

As the benefits of social enterprise software are currently not directly measureable due to its rather recent upcoming, we set up several hypotheses concerning the factors that are likely to influence the trade-off between potential costs and benefits of this technology. However, as implementing social enterprise software could also be interpreted as an organizational or process innovation, characteristics influencing the decision to adopt both kinds of innovation should also be of concern. Therefore, as we expect many different firm characteristics to influence the decision to adopt social enterprise software we define several groups of determinants.

Firm size

First of all, adopting social enterprise software is likely to depend on the size of the company as adopting is more probable for larger firms since these companies can stem the risks and costs of an early adoption more easily (Davies, 1979). On the other hand, Frambach and Schillewaert (2002) expect smaller firms to also adopt early as these firms might be more flexible and innovative themselves. Nevertheless, larger firms may generally feel more pressure to adopt innovations in order to support and improve their activities and stay competitive (Frambach and Schillewaert, 2002). Given these conflictive predictions we cannot present a clear hypothesis of the impact of firm size on the adoption decision for social enterprise software.

International activity and competitive environment

The adoption of a new technology might also depend on the presence of international involvement. It seems plausible that companies engaged in foreign activities such as exporters are more likely to use social enterprise software, especially since social CRM facilitates the management of and communication with international contacts due to real-time messaging and planning capabilities. International competition also forces domestic companies to produce as efficiently as possible in order to stay competitive. Bertschek (1995) shows empirically that international competition enhances the individual firm's probability of engaging in product or process innovation. As linking enterprise and social software can be interpreted as a process innovation, the same argument should also hold in this context. Aghion et al. (2009) support this argument as they stress the impact of the competitive environment, measured as new firm entry, on the incentives to adopt innovations. However, they show differences for high tech industries and laggards as industries near to the technological frontier react positive in terms of innovative activity to new firm entry, laggards on the other hand are negatively affected. Given these results we expect firms active in a highly competitive environment to be more likely to adopt social enterprise software compared to firms doing business in areas with low competition.

Characteristics of the workforce

Wozniak (1987) stresses the impact of human capital, measured by education and experience, on the adoption of a new technology in agriculture and confirms empirically that more educated and experienced farmers are more likely to be early adopters than other farmers. In a more recent study, Lo and Sutthiphisal (2010) support this finding as they show that new technology adoption, measured as electrical technology adoption

in the US in general, depends on the availability of appropriate human capital and an environment promoting inventions. As social enterprise software is considered a new and sophisticated technology, the adopting firms need a highly qualified workforce. Spitz-Oener (2006) suggets that the use of new technologies and the diffusion of ICT change the skill requirements and thus lead to an increase in demand for highly qualified labor. However, not only the quality of the workforce impacts the adoption decision as the age structure of the workforce also influences the firms' openness to new technologies. Meyer (2010) confirms this assumption by showing that firms with a higher share of younger employees are more likely to adopt new technologies. Based on these results we expect firms with a high proportion of highly qualified employees as well as younger employees to have a higher propensity to adopt social enterprise software in contrast to firms without an appropriate human capital base available.

Product innovations and process innovations

As process and product innovations are often interrelated (Hall et al., 2009) one could expect that product innovation activity impacts the firms' openness towards new technology. This might be especially true in the case of social CRM as product innovations are far easier to handle, categorize or organize if a firm can directly access all results of customer surveys or has a structured list of all customer commentaries at hand. Interpreting the implementation of social enterprise software as process innovation also leads to the success breeds success phenomenon (Flaig and Stadler, 1994; Peters et al. 2009) indicating that former innovation activity positively affects current innovations. Overall, we hypothesize that former innovation activities positively impact the firms' decision to implement social enterprise software.

ICT intensity

The decision to implement SES is likely to depend on the firm's ICT intensity which is empirically confirmed by Bertschek and Fryges (2002) for the decision to adopt the formerly new technology B2B e-commerce. For ICT intensity, many different measures, like e. g. the share of workers equipped with a personal computer or the number of networked computer systems, could be used. In our following empirical analysis we measure ICT intensity with three different variables, i. e. the expenditures for ICT components and staff, established e-commerce practices and ICT outsourcing. In line with Bertschek and Fryges (2002) we hypothesize that ICT intensive firms are more likely to adopt sophisticated social enterprise software applications.

3 Description of Data

The dataset used in this study stems from two computer-aided telephone surveys conducted in 2007 and 2010 by the Centre for European Economic Research (ZEW). These ZEW ICT-surveys lay a specific focus on the diffusion and use of ICT in German companies. In addition, the surveys contain detailed information about the firms' economic characteristics and performance such as the qualification or age structure of the workforce and other variables, e. g. competitive situation, research and development activities (R & D), innovation performance, exports and e-commerce. In general, the interviewee was the chief executive officer of the firms who could also decide to pass on questions to a corresponding employee like, e. g., the head of the ICT department. Each wave of this dataset originally contains information of about 4.400 firms with five or more employees, representatively chosen from important service and manufacturing sectors in Germany. The data basis for the sample stems from the credit rating agency Creditreform. This agency provides the largest data base on firms available in Germany. The selection from the population of German firms was stratified according to industries, i. e. seven branches of the manufacturing industry and ten selected service sectors, to five size classes and to two regions, i. e. East and West Germany.

The ZEW ICT surveys are organized as a panel dataset. However, as the questions on the usage of social enterprise software and social software applications were included for the first time in the survey of 2010, a panel data analysis cannot be provided in this paper. Thus, we employ a specific cross-section which consists of a combination of the survey waves conducted in 2010 and 2007 for inference. Combining these two surveys is necessary as we need a well defined temporal sequence between the usage of social enterprise software and the exclusion restriction ICT training we use for our empirical analysis. Social enterprise software was measured in the year 2010 while ICT training was measured as the share of employees who received specific ICT-related training in the year 2006. We explain the selection decision firms face in order to adopt social enterprise software and our necessary identifying exclusion restriction in detail in the next section.

For this study, we construct a dummy variable for the usage of social enterprise software which takes the value one if a firm establishes a link between its enterprise systems in use and its employed social software applications in the year 2010 and zero otherwise. Establishing such a link needs to be interpreted as adopting social enterprise software as this

Table 1: Summary Statistics

Variable	Mean	Min.	Max.	N
social enterprise software	0.216	0	1	1523
enterprise software	0.794	0	1	1516
social software	0.409	0	1	1458
social software and enterprise software	0.369	0	1	1521
number of employees	245.711	1	45000	1523
log (number of employees)	3.701	0	10.714	1523
share of highly qualified employees	0.247	0	1	1408
share of medium qualified employees	0.596	0	1	1406
share of low qualified employees	0.157	0	1	1413
share of employees younger than 30 years	0.216	0	1	1415
share of employees between 30 and 50 years	0.555	0	1	1420
share of employees older than 50 years	0.229	0	1	1425
0-5 competitors	0.431	0	1	1523
6-50 competitors	0.311	0	1	1523
more than 50 competitors	0.257	0	1	1523
exports	0.495	0	1	1519
imports	0.443	0	1	1514
former product and process innovation	0.785	0	1	1511
ICT outsourcing	0.357	0	1	1183
ICT expenditures per employee	670.674	1	300000	1195
log. (ICT expenditures per employee)	0.919	-5.480	12.611	1195
service sector	0.522	0	1	1523
East Germany	0.328	0	1	1523
ICT training 2006	0.139	0	1	1458

Source: ZEW ICT Survey, own calculations.

software is the only tool that enables firms to link both types of software. Accordingly, this dummy variable, i. e. using social enterprise software, represents the dependent variable in our analysis. The descriptive statistics in table 1 show that more than 20 percent of the firms use social enterprise software. However, to employ social enterprise software firms need to adopt enterprise systems and social software first. In order to analyze the usage of social enterprise software, we accordingly built three dummy variables for the usage of social software applications, the usage of enterprise software systems and the usage of both social software and enterprise software in the year 2010. The dummy variable representing the use of social software applications takes the value one if at least one social software application such as a blog, wiki, social network, collaboration platform, podcast or RSS-feed is used in the year 2010. Table 1 shows that at least one

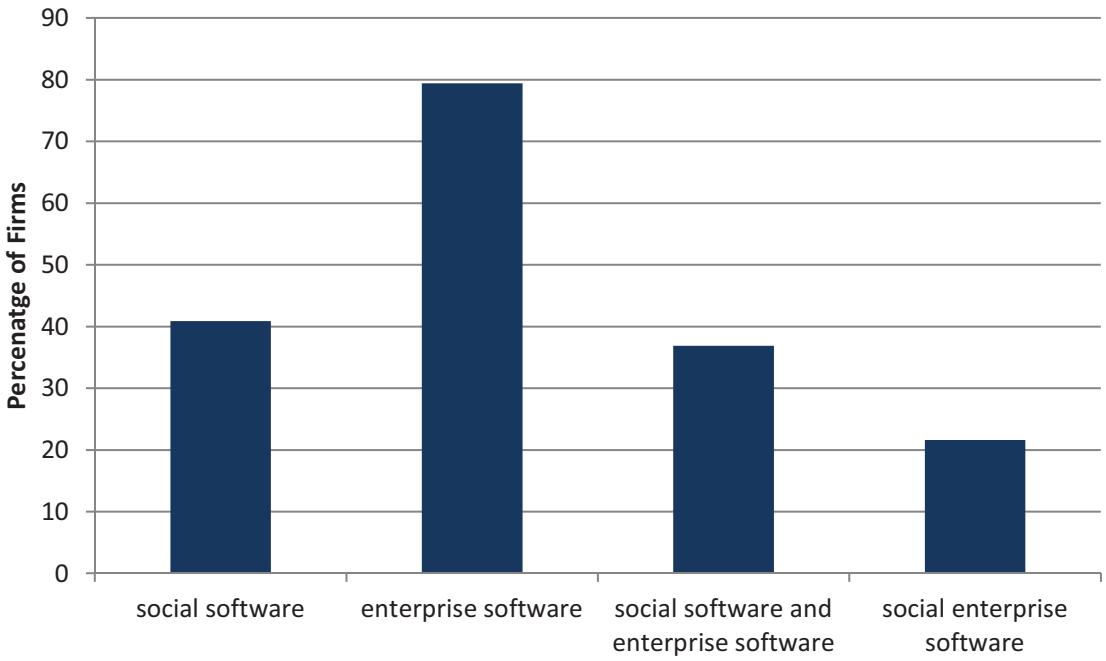

Figure 1: Usage of Software Applications

Source: ZEW ICT Survey 2010, own calculations, 1523 observations, descriptive statistics.

social software application is employed by about 40 percent of the firms. The dummy variable for the usage of enterprise software systems, on the other hand, takes the value one if a firm uses at least one of the enterprise software systems ERP, SCM or CRM and zero otherwise. About three quarters of the firms use at least one of the mentioned enterprise software applications. Furthermore, table 1 indicates that about one third of the firms employ at least one type of social software and one enterprise software application. About 60 percent of the firms using enterprise software and social software link both software applications with each other. For a better overview we picture the usage of the different software applications in figure 1.

4 Analytical Framework and Estimation Procedure

The usage of social enterprise software can be interpreted as the adoption of a new technology and is, in general, based on a strategic decision made by the firms. Due to the fact that only firms who use at least one social software application and at least one enterprise software application are able to link both software types we face a selection problem in our analysis. The decision to adopt social enterprise software has to be split up into two parts. First, firms have to decide about using both social software and enterprise software applications. The second part of the decision process then refers to whether firms link their social software applications with their enterprise software systems. Both decisions depend on several heterogeneous firm characteristics that we include in our model. Due to this sample selection problem resulting in a two stage decision process we use the Heckman selection model (Heckman 1979) for inference in our empirical analysis. The first part of the decision process is modeled by the selection equation

$$ES_i^* = X_i\beta_1 + ID_i\beta_2 + Z_i\beta_3 + \epsilon_i \qquad ES_i = 1 \text{ if } ES_i^* \geq 0; ES_i = 0 \text{ otherwise} \quad (1)$$

with ES_i^* being a latent variable reflecting both the use of social software applications and enterprise software for firm i. Both types of software applications are used by firm i but not linked with each other at this point of time. X_i contains firm characteristics expected to influence the decision of firm i to use social software and enterprise software, i. e. firm size, qualification structure of the workforce, age structure of the workforce, e-commerce, competitive situation, exports, imports, innovation activity, ICT outsourcing and ICT expenditures for ICT components and staff as argued in section 2. ID_i includes control dummies for the service sector and East Germany. Z_i reflects the exclusion restriction we use in our analysis being ICT training measured in the year 2006. We assume a standard identically distributed error term.

As the selection equation (1) shows which firm characteristics foster the unlinked use of social software applications and enterprise software, the next consecutive step will be to reveal the firm characteristics that lead to the linkage of social software and enterprise

software, i.e. adopting SES. We model the second part of the decision process being the outcome equation as

$$SES_i^* = X_i\gamma_1 + ID_i\gamma_2 + u_i \qquad SES_i = 1 \text{ if } SES_i^* \geq 0; SES_i = 0 \text{ otherwise} \quad (2)$$

where SES_i^* is the unobserved latent variable accounting for the usage of social enterprise software for firm i. In the outcome equation, we use the same explanatory variables X_i as in the selection equation without the mentioned exclusion restriction. u_i is again a standard identically distributed error term. Equations (1) and (2) are estimated via maximum likelihood. As ES_i and SES_i are both dummy variables we use a bivariate probit with sample selection (Berinsky 2004) as estimation procedure for the Heckman selection model. The employed explanatory variables as well as the exclusion restriction and their temporal sequence are explained in detail in the following.

Starting out with the explanatory variables, we control for firm size by the logarithm of the number of employees measured in the year 2009. We also consider the qualification structure of the workforce by creating three control variables: the share of highly qualified (university or university of applied science), medium qualified (technical college or vocational qualification) and low qualified (other) employees measured in the year 2009. The share of low qualified employees is taken as the reference category.

Three variables control for the age structure of the employees. The first one represents the share of employees younger than 30 years, the second one the share of employees between 30 and 50 years (reference category) and the third one the share of employees over 50 years. The age structure of employees was measured in the year 2009.

The usage of e-commerce is measured by a dummy variable taking the value one if a firm applies either business-to-business or business-to-consumer e-commerce. Both e-commerce applications were measured in the year 2010.

The competitive situation is another relevant issue for the usage of social enterprise software. We created three dummy variables representing the number of main competitors in the year 2009 according to the firms' self assessment. The first one includes zero to

five competitors, the second one six to 50 competitors which is our reference category and the last one more than 50 competitors.

We measure the export activity of the firms by creating a dummy variable that takes the value one if the firms exported goods or services during the year 2009. The firms' import activity is measured analogously as a dummy variable taking the value one if the firms imported goods or services during the year 2009 and zero otherwise.

A dummy variable for former innovation activity was created by taking the value one if a firm realized at least one product or process innovation during 2007 and 2009 and zero if no type of innovation was realized.

ICT outsourcing is measured by the share of ICT expenditures allotted to external service providers during the year 2009. We further proxy firms' ICT intensity by including ICT expenditures for both ICT components and staff per employee in the year 2009 in our analysis. For practical reasons we employ the logarithm of these expenditures in our empirical analysis.

In addition, we use a dummy variable to control for industry specific fixed effects. This dummy variable takes the value one if a firm belongs to the service sector and zero for manufacturing firms. A dummy variable for East Germany accounts for potential regional differences.

We use ICT training measured as the share of employees who received specific ICT-related training in the year 2006 as exclusion restriction in equation (1). We expect this exclusion restriction to be correlated with the common use of social software and enterprise software but showing no correlation with the linkage of both software types. Firms engaging in ICT training in the year 2006 might do so to get first insights into the use of social software applications and possibly prepare the use of these software applications at a later point in time. Social software applications were a new technology in the year 2006 especially for private users and not yet broadly applied by firms. Thus, ICT training is necessary for the adoption of social software applications by firms. The adoption of new enterprise software systems in firms usually also requires ICT training as these systems are sophisticated and it is hardly possible to adopt and use them properly without the required preparation. First solutions of SES systems, however, arose in the year 2008 for the first time. Accordingly we can exclude the possibility that social enterprise software may be part of the ICT training measures conducted by the firms

in 2006, thus allowing us to employ the ICT training as a suitable exclusion restriction in our empirical setup. For an overview, we descriptively analyze the average share of ICT training in the year 2006 for firms adopting social enterprise software and for non-adopters. On average, about 20 percent of the employees of firms which adopted social enterprise software in the year 2010 were engaged in ICT training in the year 2006. Likewise, about 12 percent of the employees of firms which did not adopt social enterprse software in the year 2010 were enganged in ICT training in the year 2006. These similar size of means among adopters and non-adopters suggest that the adoption of SES in 2010 is indeed not related to ICT training in 2006.

5 Results

5.1 Main Results

Table 2 shows the average marginal effects of the bivariate probit estimation with sample selection based on equations (1) and (2). In the first model specification we estimate the model with a parsimonious set of baseline variables representing some firm characteristics like firm size, qualification and age structure of the workforce, the competitive situation and the application of e-commerce. The results show that larger firms are more likely to adopt social enterprise software, a result significant at the five percent level. Furthermore, we observe that firms with a higher share of younger employees face a higher probability to link their enterprise systems with social software applications. This result stays in line with our hypothesis derived in section 2 and is significant at five percent. The usage of e-commerce practices is related to a higher probability of adopting social enterprise software by about 18.4 percentage points compared to firms which do not employ e-commerce applications. This marginal effect is significant at the one percent level also confirming our expectations pictured in section 2. Moreover, the coefficient estimate of the exclusion restriction ICT training in the year 2006 is positive and highly significant as shown in table 5 in the appendix which pictures the first stage regressions.

In the second specification of table 2 we augment the baseline specification with the variables exports, imports, former innovation performance, ICT outsourcing, ICT expenditures per employee as well as industry and regional dummys. The effects of firm

size, the share of younger employees as well as e-commerce do not change qualitatively by controlling for additional unobserved heterogeneity via including the mentioned variables. However, firms with a high share of highly qualified employees are more likely to adopt social enterprise software in the second specification. This result is highly significant at the one percent level suggesting some sort of multicollinearity in the model specification. Nevertheless, as the other significant coefficients in specification (1) do not change qualitatively in specification (2) we can expect this potential multicollinearity issue to be of minor importance. As hypothesized in section 2 firms that import goods or services are more likely to adopt social enterprise software than firms without any importing activity. The impact of imports upon the firms' decision to adopt social enterprise software is about 5.8 percentage points, significant at five percent. In addition, we include former innovations into our analysis to control for the "success breeds success" phenomenon as the adoption of social enterprise software could potentially be interpreted as a process innovation. Our results confirm that firms who have already realized product or process innovations in the past have a higher probability to use social enterprise software. The probability of linking social software with enterprise software is about 6.0 percentage points higher for past innovators than for non-innovative firms. This marginal effect is significant at ten percent. As suspected in section 2 ICT expenditures per employee have a positive impact on linking enterprise software with social software applications. Interpreting the significant marginal effect as elasticity a raise of one percent in the ICT expenditures corresponds to a raise of 1.3 percentage points of the firms' propensity to adopt social enterprise software. Moreover, the results reveal that firms being part of the service sector face a 7.1 percentage points higher probability to use social enterprise software compared to firms belonging to the manufacturing sector. This result is significant at five percent. For specification 2, table 5 in the appendix also shows that ICT training in the year 2006 contributes positively and significantly at five percent to explain firms' decision to employ social software applications and enterprise software systems.

5.2 Robustness Checks

In order to test the validity of our results we employ two further estimation approaches as robustness checks. As for the first check we estimated the model as a simple probit model without sample selection only with firms using both social software and enterprise

Table 2: Bivariate Probit with Sample Selection: Average Marginal Effects

dependent variable: dummy for social enterprise software		
	(1)	(2)
log. firm size	0.034**	0.040***
	(0.015)	(0.008)
highly qualified employees	0.161	0.202***
	(0.131)	(0.075)
medium qualified employees	−0.034	0.024
	(0.124)	(0.076)
employees < 30	0.241**	0.161**
	(0.121)	(0.071)
employees > 50	0.072	0.026
	(0.120)	(0.071)
e-commerce	0.184***	0.119***
	(0.038)	(0.025)
competitors 0 − 5	0.022	0.002
	(0.043)	(0.027)
competitors > 50	−0.009	−0.002
	(0.050)	(0.033)
exports		0.011
		(0.029)
imports		0.058**
		(0.028)
former product and process innovation		0.060*
		(0.034)
ICT outsourcing		−0.027
		(0.041)
ICT expenditures per employee		0.013**
		(0.005)
service sector dummy		0.071**
		(0.030)
region dummy		−0.012
		(0.026)
observations	1311	1049

Significance levels: *: 10%, **: 5%, ***: 1%. Reference categories: competitors 6-50, unqualified employees, employees 30–50 years. Tables of coefficient estimates located in the appendix, corresponding table 6 (main estimates) and table 5 (selection equation).

software. Table 3 shows the average marginal effects of the probit estimation of equation (2). We use the same exogenous variables as in the bivariate probit with sample selection

except for the exclusion restriction. In the first specification, the impacts of younger employees and e-commerce remain qualitatively unchanged compared to the average marginal effects of the bivariate probit with sample selection. The positive and significant effect of firm size in the bivariate probit with sample selection disappears in the simple probit model. This might be the case due to the low number of observations in the probit model as we skip the selection equation and consider only firms that actually reported using both social software and enterprise software applications and not potential users. Such a low number of observations can be expected to prohibit the precise estimation of all coefficients leading to biased results.

The variables in the second specification are again the same exogenous variables we used in the second specification of the bivariate probit with sample selection. Again, the effect of younger employees, e-commerce and the service sector dummy does not change qualitatively compared to the effects in the bivariate probit with sample selection. The other significant variables in the bivariate probit with sample selection being firm size, highly qualified employees, imports, former innovation performance as well as ICT expenditures per employee turn out to be insignificant by estimating a simple probit model. The reason for this might again be the loss of many observations by estimating a simple probit model. We end up with such a low number of observations which simply may not show enough variation across the employed covariates to offer sufficient statistical significances. In addition, the probit estimates are likely biased as the endogenous sample selection is not modeled appopriately.

For the second robustness check we estimated the Heckman selection model by the twostep estimator (Wooldridge 2002). The results of this so called Heckit model are pictured in table 7 in the appendix. The positive impacts of firm size, younger employees, e-commerce, imports and service sector remain qualitatively unchanged for the two step estimation procedure. In contrast, the positive impacts of highly qualified employees, former innovation activity and ICT expenditures per employee turn out to be insignificant. The reason might be the efficiency loss due to the twostep estimation procedure compared to the bivariate probit with sample selection as the outcome equation is estimated by OLS although the dependent variable is a dummy variable.

In sum, both robustness checks fail to validate three coefficient estimates, namely high qualified employees, former innovative performance and ICT expenditures per employee. Nevertheless, the robustness checks do not represent the appropriate estimation proce-

Table 3: Probit Estimation Results: Average Marginal Effects

dependent variable: dummy for social enterprise software		
	(1)	(2)
log. firm size	0.005	0.003
	(0.014)	(0.016)
highly qualified employees	−0.045	−0.035
	(0.138)	(0.164)
medium qualified employees	−0.071	−0.069
	(0.152)	(0.171)
employees < 30	0.263**	0.376**
	(0.134)	(0.151)
employees > 50	0.092	0.108
	(0.138)	(0.151)
e-commerce	0.149***	0.102**
	(0.046)	(0.051)
competitors $0 - 5$	0.032	0.077
	(0.050)	(0.056)
competitors > 50	−0.006	−0.031
	(0.063)	(0.070)
exports		−0.028
		(0.061)
imports		0.079
		(0.054)
former product and process innovation		−0.040
		(0.086)
ICT outsourcing		0.077
		(0.090)
ICT expenditures per employee		0.000
		(0.011)
service sector dummy		0.124**
		(0.063)
region dummy		−0.017
		(0.056)
observations	479	388
pseudo R^2	0.029	0.048

Significance levels: *: 10%, **: 5%, ***: 1%. Reference categories: competitors 6-50, unqualified employees, employees 30–50 years. Only firms using both social software and enterprise software.

dure for an endogenous dummy variable with sample selection and, accordingly, are likely to offer biased estimates. However, one should still treat these three coefficient

estimates with appropriate care given that all other estimates were confirmed at least in one of our robustness checks. Still, even for these three estimates at least one robustness check provided estimated coefficients which point in the same direction as the original estimates in our main approach validating the estimates to some extent.

6 Conclusion

Besides the widely established enterprise software systems and social software applications a new recent phenomenon starts to catch the attention of firms and institutions alike, namely social enterprise software. This specific software is expected to offer several benefits in information storing and handling, knowledge acquisition, management and, especially with social CRM, customer relations (Chess Media Group 2010). As social enterprise software is a very recent and new technology at the beginning of its diffusion process, potential benefits and problems are not econometrically analysed yet in the recent literature. Determinants which benefit the decision to adopt social enterprise software still remain to be investigated.

In our current study we aim at filling this gap by empirically exploring the impact of several heterogeneous firm characteristics on the firms' decision to adopt social enterprise software. Based on a German ICT firm dataset the results confirm that firms with a highly qualified workforce and a large share of young employees are more likely to adopt social enterprise software. More ICT intensive firms like e-commerce users or firms with high ICT expenditures per employee are also more open towards social enterprise software implementation. Firms active in international business activities, like importing, rely more frequently on linking enterprise and social software than firms not engaged in international business. Having already successfully established innovations in the past also results in a higher probability to employ social enterprise software. Concerning firm size the obtained results show that larger firms are more likely to implement social enterprise software than smaller ones. Furthermore, firms in the service sector are more eager to adopt social enterprise software as firms active in the manufacturing sector.

Besides offering insights for potential influences on the firms' decision to implement social enterprise software the results of our study also have several practical implications for customers and vendors of social enterprise software alike. Starting out with customers

who are interested in the requirements of these recent software applications it seems that the usage of social enterprise software is indeed dependent on a sufficiently qualified and open-minded workforce. Regarding potential benefits, larger firms may principally benefit from the enhanced knowledge handling, storing, management and processing offered by social enterprise software. These firms may be geographically spread out, possibly with several subsidiaries around the globe. Thus, they might miss a fast way to transfer knowledge. As knowledge processing and handling is a key feature for service innovations (Meyer 2010; Engelstätter and Sarbu 2010) it is reasonable that service firms are more likely to adopt social enterprise software.

For vendors, it seems obvious to focus on enhancing and improving the key features customers value the most, to boost customer satisfaction and thereby maybe realize rising sales. Based on the results obtained, these key features are the improved usage of e-commerce and the international business activities. Vendors might also consider concentrating on the service sector, maybe building up sector specific social software applications, as service firms are more likely to adopt social enterprise software. Investing in adequate solutions for large firms also seems a reasonable choice. As firms only consider linking enterprise systems and social software if they can rely on sufficient human capital, it may be the case that the skill and knowledge barriers firms have to cross in order to utilize social enterprise software might be too high. Accordingly, vendors should mitigate this burden, maybe with enhanced step-by-step tutorials or very intuitive interfaces.

Our analysis faces a few potential short-comings which are primarily related to data constraints and unobserved heterogeneity in general. We do not observe management decisions of the surveyed firms. It may be the case that some firms simply adopt new technologies because they want to be on the fast lane in terms of technology, sending out a positive signal. However, a part of this phenomenon is captured in the ICT expenditures we control for as those firms can be expected to spend more money on ICT compared to firms which are not as oriented towards the technology frontier. Due to item-non-response and panel mortality our sample is particularly restricted and small if we only focus on real social enterprise software adopters in our robustness check and not on potential adopters as we did in our main analysis by controlling for sample selection. Availability of new data might take care of these potential drawbacks, accordingly we pass this issues on to further research. And last but not least our exclusion restriction is not without concern about its exogeneity. It may be the case that ICT intensive firms

invest more in ICT training and expect their trained employees to adopt and utilize social enterprise software more eagerly. As SES solutions are sophisticated software tools, even more eager employees might not be able to utilize the software to its full potential without specific training or reading. As such training and further education is definitely not captured in our exclusion restriction general ICT training, we expect the mentioned eagerness to produce an endogeneity bias of negligible size.

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7 Appendix

Table 4: Distribution of Industries in the Sample

Industry	Observations	Percentage
consumer goods	129	8.47
chemical industry	73	4.79
other raw materials	89	5.84
metal and machine construction	103	6.76
electrical engineering	172	11.29
precision instruments	93	6.11
automobile	68	4.46
wholesale trade	93	6.11
retail trade	79	5.19
transportation and postal serv.	117	7.68
banks and insurances	39	2.56
computer and telecommunication services	140	9.19
technical services	95	6.24
real estate und leasing services	37	2.43
management consultancy and advertising	42	2.76
media services	118	7.75
services for enterprises	36	2.36
sum	1523	100

Source: ZEW ICT-Survey, own calculations.

Table 5: Bivariate Probit with Sample Selection: Coefficient Estimates of Selection Equation

dependent variable: dummy for usage of social and enterprise software		
	(1)	(2)
log. firm size	0.283^{***}	0.251^{***}
	(0.028)	(0.033)
highly qualified employees	1.134^{***}	1.308^{***}
	(0.223)	(0.262)
medium qualified employees	0.159	0.299
	(0.218)	(0.251)
employees < 30	0.231	0.273
	(0.231)	(0.261)
employees > 50	-0.150	-0.024
	(0.221)	(0.250)
e-commerce	0.565^{***}	0.450^{***}
	(0.078)	(0.089)
competitors $0-5$	-0.128	-0.231^{**}
	(0.091)	(0.101)
competitors > 50	-0.054	0.039
	(0.105)	(0.118)
exports		0.142
		(0.108)
imports		0.148
		(0.103)
former product and process innovation		0.501^{***}
		(0.128)
ICT outsourcing		-0.260^{*}
		(0.147)
ICT expenditures per employee		0.077^{***}
		(0.021)
service sector dummy		0.183^{*}
		(0.160)
region dummy		-0.080
		(0.095)
ICT training 2006	0.851^{***}	0.404^{**}
	(0.173)	(0.171)
constant	-2.168^{***}	-2.609^{***}
	(0.243)	(0.309)
observations	1311	1049

Significance levels: *: 10%, **: 5%, ***: 1%. Reference categories: competitors 6-20, unqualified employees, employees 30–50 years.

Table 6: Bivariate Probit with Sample Selection: Coefficient Estimates of Outcome Equation

dependent variable: dummy for social enterprise software		
	(1)	(2)
log. firm size	0.104*	0.161***
	(0.062)	(0.034)
highly qualified employees	0.489	0.818***
	(0.448)	(0.309)
medium qualified employees	−0.104	0.097
	(0.372)	(0.310)
employees < 30	0.730**	0.652**
	(0.338)	(0.288)
employees > 50	0.218	0.108
	(0.353)	(0.289)
e-commerce	0.533***	0.467***
	(0.127)	(0.098)
competitors 0 − 5	0.068	0.010
	(0.129)	(0.111)
competitors > 50	−0.027	−0.011
	(0.154)	(0.133)
exports		0.047
		(0.120)
imports		0.232**
		(0.111)
former product and process innovation		0.255
		(0.158)
ICT outsourcing		−0.110
		(0.168)
ICT expenditures per employee		0.054**
		(0.023)
service sector dummy		0.287**
		(0.122)
region dummy		−0.050
		(0.106)
constant	−1.370**	−2.581***
	(0.694)	(0.361)
observations	1311	1049

Significance levels: *: 10%, **: 5%, ***: 1%. Reference categories: competitors 6-20, unqualified employees, employees 30–50 years.

Table 7: Twostep Heckman Model with Sample Selection: Marginal Effects on Average

dependent variable: dummy for social enterprise software		
	(1)	(2)
log. firm size	0.121*	0.109*
	(0.067)	(0.063)
highly qualified employees	0.570	0.541
	(0.381)	(0.380)
medium qualified employees	−0.012	0.038
	(0.177)	(0.211)
employees < 30	0.378**	0.476**
	(0.175)	(0.199)
employees > 50	0.011	0.067
	(0.171)	(0.188)
e-commerce	0.387***	0.317**
	(0.144)	(0.137)
competitors 0 − 5	−0.004	−0.004
	(0.066)	(0.086)
competitors > 50	−0.026	−0.004
	(0.076)	(0.088)
exports		0.034
		(0.085)
imports		0.145∗
		(0.082)
former product and process innovation		0.228
		(0.183)
ICT outsourcing		−0.068
		(0.137)
ICT expenditures per employee		0.026
		(0.021)
service sector dummy		0.206**
		(0.091)
region dummy		−0.049
		(0.072)
observations	1351	1079

Significance levels: *: 10%, **: 5%, ***: 1%. Reference categories: competitors 6-20, unqualified employees, employees 30–50 years.