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Does Social Software Increase Labour Productivity?

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Non-Technical Summary

Social software applications are increasingly applied in firms and particularly support communication, cooperation and information sharing between individuals. They comprise applications like wikis, blogs and social networks. These applications are web-based, self-organised and interconnect users and their knowledge making the communication processes more efficient. Social software can be applied for external communication as well as internal knowledge management making it possible for firms to access both external and internal knowledge. Firms benefit from the external usage of social software applications in areas including customer relationship management, marketing and market research. The internal usage of social software has the potential of leading to a more efficient project management and product development by knowledge sharing which might result in productivity gains. Firms can operate faster and have greater flexibility using social software compared to the usage of content management systems. It enables them to improve their time management and to save costs. A further benefit associated with social software is the support of e-commerce which opens up new communication channels with customers.

This study attempts to distinguish whether the usage of social software in a firm leads to an increase in labour productivity. The analysis ist based on recent German firm-level data consisting of 907 firms from the manufacturing industry and the service sector. As a theoretical framework, I employ a Cobb-Douglas production function with social software representing an input factor in the production process.

The analysis reveals that the usage of social software has a negative impact on labour productivity. The main driver of this productivity loss is the social software application blog. The result stays robust across different specifications controlling for several sources of firm heterogeneity. In addition, a robustness check containing social software intensity as an alternative measure for social software is applied. It reveals the same negative effect and thereby confirms the result.

Das Wichtigste in Kürze

Social Software-Anwendungen werden zunehmend auf Unternehmensebene verwendet, wobei insbesondere die Kommunikationen, Kooperation und Informationsweitergabe zwischen Individuen unterstützt wird. Diese Software umfasst unter anderem Anwendungen wie Wikis, Blogs und soziale Netzwerke. Die Anwendungen sind webbasiert, selbstorganisierend und verbinden Nutzer und deren Wissen, wodurch Kommunikationsprozesse effizienter gestaltet werden können. Social Software kann sowohl zu externer Kommunikation als auch zu internem Wissensmanagement verwendet werden. Dadurch kann sowohl auf unternehmensinternes- als auch auf externes Wissen zugegriffen werden. Besonders in den Bereichen Kundenbeziehungsmanagement, Marketing und Marktforschung können Unternehmen von externer Kommunikation durch Social Software profitieren. Darüber hinaus kann ein verbessertes Wissensmanagement zu effizienterem Projektmanagement und zu effizienterer Produktentwicklung führen. Unternehmen sind im Vergleich zur Nutzung von Content-Management-Systemen flexibler, was zu schnelleren Arbeitsabläufen führen kann. Darüber hinaus können Unternehmen sowohl ihr Zeitmanagement verbessern als auch Kosten sparen. Ein weiterer Vorteil, der in engem Zusammenhang mit Social Software steht, ist die Unterstützung des E-Commerce, da es neue Kommunikationskanäle mit Kunden schafft.

Das Ziel dieser Studie ist es, die Auswirkungen von Social Software auf die Arbeitsproduktivität zu untersuchen. Die Analyse basiert auf einem aktuellen Unternehmensdatensatz bestehend aus 907 Unternehmen des verarbeitenden Gewerbes und des Dienstleistungssektors in Deutschland. Als theoretischer Rahmen wird eine Cobb-Douglas Produktionsfunktion mit Social Software als Input verwendet.

Die Studie zeigt, dass Social Software einen negativen Einfluss auf die Arbeitsproduktivität hat. Der Produktivitätsverlust entsteht vor allem in den Firmen, die Unternehmensblogs einsetzen. Die Ergebnisse sind robust diversen Spezifikationen, die für Heterogenität kontrollieren. Weiterhin wird die Robustheit der Ergebnisse in einer Spezifikation überprüft, die Social Software nicht binär sondern durch ein Maß der Social Software-Intensität mißt. Diese Spezifikation bestätigt ebenfalls den negativen Zusammenhang und bekräftigt damit das Ergebnis.

Does Social Software Increase Labour Productivity?*

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Abstract

Social software applications such as wikis, blogs or social networks are being increasingly applied in firms. These applications can be used for external communication as well as knowledge management enabling firms to access internal and external knowledge. Firms can optimize customer relationship management, marketing and market research as well as project management and product development resulting in potential productivity gains for the firms. This paper analyses the relationship between social software applications and labour productivity. Using firm-level data of 907 German manufacturing and service firms, this study examines whether these applications have a positive impact on labour productivity. The analysis is based on a Cobb-Douglas production function. The results reveal that social software has a negative impact on labour productivity. They stay robust for different specifications and alternative measures for social software.

Keywords: social software, web 2.0, social software intensity, labour productivity
JEL-Classification: L10, M20, O33

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1 Introduction

A large range of web-based applications which are also known as web 2.0 applications are not only omnipresent in the private internet usage but are beyond that increasingly applied in firms. Social software in particular is part of web 2.0 applications and serves communication, cooperation and information sharing between individuals. Examples for social software applications are wikis, blogs, social networks or instant messaging. The common feature of all social software applications is that they are supposed to be self-organised, transparent and could make the communication process more efficient by interconnecting users and their knowledge. Thus, their usage might lead to various benefits for firms.

Social software can be applied by firms either for external or for internal purposes. It helps strengthen external communication with other firms and thereby improve customer relationship management, marketing and market research. In addition, the access of external knowledge plays a crucial role when using social software. The second field in which social software can be utilized is internal knowledge management. Used as a knowledge management tool, social software can facilitate internal communication. This may result in a more efficient knowledge and project management as well as product development. A possible consequence of the usage of social software is a greater flexibility as firms can operate faster leading to a more efficient time management and thus to a higher labour productivity. In addition, the application of social software is more cost-saving for the firms than the application of content management systems (Raabe 2007).

Apart from that, social software can be used to support e-commerce within a firm by opening up new communication channels with customers (Döbler (2008)). Firms have the opportunity to achieve business deals faster and more efficiently. Based on the various benefits for firms social software has the potential to increase the labour productivity of firms. However, there are only few studies analysing this relationship empirically.

The already established studies on social software and firm performance are either theoretical or descriptive and find ambiguous impacts. Kaske et al. (2012) reveal in a study that firms can profit from social media resulting in higher customer retention, better communication with customers and sales increases. Thus, a positive return of investment is at least achievable by using social media. Ferreira and du Plessis (2009) describe explicitly social networking as a technology that increases collaboration between individuals who share a common interest or goal leading to knowledge sharing with the possible effect of increased productivity. At the same time they note the risks associated with social networking which are, for instance, the loss of privacy, bandwidth and storage space consumption and exposure to malware. The consequence might be lower employee productivity.

Coker (2011) finds a positive effect of social software on labour productivity. Employees who take frequently short brakes during their work time to surf the internet for private purposes are more productive than those who do not. The reason for that might be that employees feel a greater autonomy at their workplace by having the opportunity to use the internet privately which increases employees' motivation. Moreover, private internet surfing during work time results in a better concentration of employees by taking short breaks from work. In contrast, Peacock (2008) emphasizes the so-called shirking effect which has a negative influence on labour productivity as social software rather distracts employees form their work. Van Zyl (2009) also finds that social software applications might affect employee productivity in a negative way when employees spend too much time using these applications for private purposes.

Using data from 907 German firms belonging to the manufacturing industry and the service sector, this paper tests the hypothesis whether the usage of social software applications increases labour productivity. As analytical framework, I employ a Cobb-Douglas production function with social software being an input in the production process. The production function is estimated by ordinary least squares (OLS) and instrumental variable (IV) regression to reduce the potential endogeneity of social software. The instrumental variables for the IV-regression are the private use of wikis, blogs and social networks by the interviewees.

The results reveal that social software has a negative impact on labour productivity. These results stay robust to different specifications controlling for several sources of firm heterogeneity like firm size, IT-intensity, qualification and age structure, export activity, e-commerce as well as training of employees and consulting. The negative effect of social software on labour productivity points towards a suboptimal usage among employees caused for instance by the shirking effect. In addition, several robustness checks such as an alternative measure for social software confirm the results.

The paper is organised as follows: Section 2 provides an overview of the literature on social software and derives the main hypothesis. Section 3 describes the database whereas section 4 presents the analytical framework 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 and gives an outlook on further possibilities of research.

2 Background Discussion and Hypothesis Derivation

This section classifies the present paper into the literature and provides a definition of social software applications as well as an overview of the theoretical and empirical studies concerning social software and labour productivity. This paper is related with the literature on the productivity impact of information and communication technologies (ICT). Kretschmer (2012) provides a survey on the relationship between ICT and productivity and concludes that ICT has a positive and robust impact on firms' productivity which is increasing over time. ICT has to be embedded in complementary organisational investments in order to lead to productivity gains. My analysis fits into this literature since social software is one type of ICT applications. Thus, the current analysis departs form the literature by focusing specifically on social software as ICT application and thus investigating whether or not the impact on labour productivity is consistent with the general literature.

The applications named social software are a rather new phenomenon and are often referred to as web 2.0 applications. Summarising the existing literature on social software reveals that social software encompasses web-based applications which connect people and support communication, interaction and cooperation as well as information sharing (e.g. Raabe 2007, Back and Heidecke 2012) and thus harness collective intelligence (O'Reillly 2005). It uses the potential, contributions and knowledge of a network of participants (Back and Heidecke 2012). Beck (2007) argues that social software has had a profound effect by changing the nature of efficiency of communication processes in both business and private life. Social software is supposed to be self-organised, transparent and should support social feedback (e.g. Hippner 2006, Raabe 2007). Social software applications are for instance wikis, blogs, web forums (discussion forum, internet forum), instant messaging services (Skype), social bookmarking, podcasts and social networks sites like Facebook or LinkedIn. Nielson (2010) mentions that social media account for nearly one quarter of all internet activity in the USA in the year 2010.

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). In line with that, firms have access to external knowledge by using social software (Döbler 2008). On the other hand, it can be utilized for internal purposes as a knowledge management tool to facilitate internal communication, including for example knowledge and project management or product development. Information sharing and communication between employees, customers and business partners can be faster and more efficient in these areas by using social software. Knowledge sourcing which is closely related to knowledge management is essential for the productivity of firms. Kremp and Mairesse (2004) find that different knowledge management practices such as information sharing and internal and external knowledge acquisition contribute to the innovative performance and productivity of firms in a positive way.

Social software applications can impact labour productivity of firms in various different ways. Koch and Richter (2009) provide an overview of various case studies among firms concerning the usage of social software. They picture different implementation fields for social software and describe the possible benefits emerging for firms in case social software is efficiently adopted. Firms have a greater flexibility and can operate faster by using social software compared to the usage of content management systems which serve similar purposes. A content management system is a special type of software that enables users to jointly create, edit and organise content such as web sites as well as text documents or multimedia files. The positive aspects of social software may make firms even more productive as being faster and more flexible results in a better time management leaving more time capacities for other work. Furthermore, firms using social software applications face lower costs as their adoption and usage in firms is usually cheaper compared to content management systems (Döbler 2008). The consequence of lower costs is also a higher labour productivity.

Döbler (2008) mentions another important aspect of social software that might influence labour productivity. Social software can be utilized as a tool supporting e-commerce in a firm. It opens up new communication channels with customers leading faster and more efficiently to business deals. Moreover, e-commerce can be integrated into social software applications allowing customers directly to purchase firms' products via social software. Combining e-commerce and social software applications might lead to more purchases in the same time span and thus to a higher labour productivity. Bertschek et al. (2006) show that B2B e-commerce has a positive impact on labour productivity.

Having all capabilities of social software in mind as well as the different ways of contributing to an improvement of labour productivity, I hypothesize that its usage might increase labour productivity in a firm. While the literature on this topic is either theoretical or descriptive, this study analyses this subject using firm level data.

A few previous studies investigated the usage of social software and its impact on firm performance. A study by McKinsey Quarterly (2009) describes the impact of social software on labour productivity as an S curve. At the beginning of the adoption process, labour productivity increases not at all or only very slightly. Not until several years, labour productivity starts to rise very fast before reaching a higher level slowing down again afterwards. A further study conducted by McKinsey (2010) indicates that Web 2.0 usage in firms increases their performance as those firms are more likely to gain market share and higher profit margins. The reason for that is that Web 2.0 ensures more flexible processes inside the firm as the information flow is optimized and thus management practices are less hierarchical.

Ferreira and du Plessis (2009) provide a descriptive analysis about online social networking with an ambiguous impact on employee productivity. On the one hand, they describe social networking as a technology that can be used to increase collaboration between individuals who share a common interest or goal. The increased collaboration between employees in a firm leads to knowledge sharing with the possible effect of increased productivity. On the other hand, they note the risks associated with social networking such as loss of privacy, bandwidth and storage consumption, exposure to malware, possibly leading to lower employee productivity.

Kaske et al. (2012) analyse the benefits of social media usage in firms for the return on investment by comparing different case studies. The results reveal that firms can indeed profit from social media resulting in higher customer retention, better communication with customers and sales increases. Thus, a positive return of investment is at least achievable by using social media.

Aguenza et al. (2012) analyse the impact of social media on labour productivity based on a conceptual overview of empirical studies concerning this topic. They find ambiguous effects investigating different studies. The first study is conducted by Coker (2011) and shows that employees who take frequently short brakes during their work time to surf the internet for private purposes are more productive than those who do not. The reason for that might be that employees feel a greater autonomy at their workplace by having the opportunity to use the internet privately which increases employees' motivation. Moreover, private internet surfing during work time results in a better concentration of employees by taking short breaks from work.

A theoretical study conducted by Wilson (2009) concludes that social software enables organisations to extend their business opportunities by finding new customers and thus increasing sales. In addition, it can help monitoring new trends by collecting information. Firms are able to extend their product or service offers which might also boost sales. Social software also acts as an application tool to recruit new employees. This might contribute to higher labour productivity. Nevertheless, several other studies included in the overview of Aguenza et al. (2012) found the opposite result. For instance, Peacock (2008) mentions the so-called shirking effect as a negative influence on labour productivity as social software could distract employees form their work. The shirking effect could thus have a negative impact on labour productivity. Van Zyl (2009) addresses the shirking effect in a theoretical study on social networking in firms as well. Social software applications as wikis, blogs and social networks might affect employee productivity in a negative way when employees spend too much time using these applications for private purposes instead of work-related.

Meyer (2010) investigates the relationship between social software and innovation activity among service firms. The empirical study shows that service firms experience higher innovation activity if they rely on social software applications. The result is consistent with a descriptive study conducted by Andriole (2010). The study shows that the social software application wiki improves knowledge management, customer relationship management and innovation more than all other social software applications. A large amount of literature claims that innovation activity is a prerequisite for productivity gains and thus innovative firms experience a higher labour productivity (see for example Crépon et al. (1998) or Hall et al. (2009)).

The summary of the studies on the possible effects of social software on labour productivity support the hypothesis of a positive impact of social software on labour productivity. Nevertheless, there are also hints that the use of social software might have the opposite effect on labour productivity under certain conditions.

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 characteristics like exports and e-commerce. In general, the interviewee was the chief executive officer of the firms who could decide to pass on questions to a corresponding employee like 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 various service and manufacturing sectors in Germany. [1] http://kooperationen.zew.de/en/zew-fdz/home.html The selection from the population of German firms was stratified according to seven branches of the manufacturing industry and ten service sectors, to five employment size classes and to two regions being East and West Germany.[2]

The ZEW ICT surveys are organized as a panel dataset. As the questions on the usage of social software were included for the first time in the last survey of 2010, a panel data analysis cannot be provided in this paper. Thus, I employ a specific cross-section which consists of a combination of the survey waves conducted in 2007 and 2010 for inference. Combining these two surveys is necessary as I need a well-defined temporal sequence between the dependent variable labour productivity and the explanatory variables to minimize potential endogeneity problems. The variables collected in 2010 mostly refer to the year 2009 and the variables of the wave of 2007 to the year 2006. Matching the data of both waves and considering item non-response for social software, sales, labour and investments leads to about 907 observations.

[1] The data set used for this analysis is accessible at the ZEW Research Data Centre: `http://kooperationen.zew.de/en/zew-fdz/home.html`

[2] Table 5 in the appendix contains the distribution of industries in the sample.

Total sales and the number of employees are needed to construct labour productivity. There are no data available to measure the physical capital stock of the firm. Thus, I use gross investment in the year 2009 as a proxy for the capital stock. Bertschek et al. (2006), for example, also use this method in their study.

The usage of social software refers to the year 2010. In order to capture this usage, the firms were offered a list of different applications and they were asked if they use them. The firms had the opportunity to answer the question for every application with either yes or no. With this information, I construct a dummy variable for the usage of social software which takes the value one if at least one of the following social software application is used in the year 2010: wiki, blog, social network or collaboration platform. This dummy variable represents the main explanatory variable of my empirical analysis.

The fact that social software was partly adopted later than total sales and the number of employees were measured leads to a problem for my analysis as social software should be adopted before the labour productivity is measured. To ensure at least the same time period for the adoption of social software and sales as well as the number of employees, I drop all observations in which social software was introduced in the year 2010 leaving only firms which introduced social software until the year 2009 in the sample. Overall, only about 10 observations were dropped. All other explanatory variables are related to the years 2007 and 2006.

An alternative measure for the usage of social software I use in this study is the so-called social software intensity of the firms. It measures how many different social software applications are used by the firms taking values from 0 to 4. One major drawback of this variable is that it does not measure how much time the employees spend on using them. It measures only the variety of these applications used by the firms and thus the openness of the firms towards social software. I use social software intensity as a robustness check to analyse the effects of variety and openness towards social software on labour productivity.

Table 1 shows the descriptive statistics for the variables included in the production function. The average sales amount in 2009 results in € 63.13 mio. while the average firm size is about 170 employees. Labour productivity is calculated as the ratio of total sales to the total number of employees and takes an average value of € 0.22 mio. For 2009, the mean gross investment is about € 2.03 mio. Comparing firm size and gross investments with the values of the year 2006, I observe that both values were higher in the past. The average firm size in 2006 was 190 while gross investments amounted to about € 3.07 mio on average. One possible explanation for the decrease of both values might be the financial crisis that arose in the year 2008.

Table 1: Summary Statistics

Variable	**Mean**	**Min.**	**Max.**	**N**
sales 2009 (in mio)	63.13	0.03	15000	907
number of employees 2009	170	1	25000	907
log. number of employees 2009	3.56	0	10.13	907
investments 2009 (in mio)	2.03	0	500	907
log. investments 2009	-1.92	-8.52	6.21	907
labour productivity 2009	0.22	0.01	13.33	907
log. labour productivity 2009	-2.13	-4.46	2.59	907
number of employees 2006	190	1	35000	907
log. number of employees 2006	3.56	0	10.46	907
investments 2006 (in mio)	3.07	0	600	907
log. investments 2006	-1.53	-6.90	6.40	907
share of firms using social software in 2009	0.33	0	1	907
social software intensity 2009	0.48	0	4	904
share of employees with PC 2007	0.47	0	1	903
share of export sales 2006	0.13	0	1	898
share of high qualified employees 2006	0.22	0	1	882
share of medium qualified employees 2006	0.60	0	1	880
share of low qualified employees 2006	0.12	0	1	881
share of employees <30 years 2006	0.23	0	1	887
share of employees $30-50$ years 2006	0.57	0	1	886
share of employees >50 years 2006	0.20	0	1	887
share of firms using B2B e-commerce 2007	0.56	0	1	905
share of firms using B2C e-commerce 2007	0.25	0	1	905
share of firms with training 2006	0.81	0	1	905
share of firms with consulting 2006	0.68	0	1	905
share of firms in East Germany 2010	0.37	0	1	907

Source: ZEW ICT Survey, own calculations.

The descriptive statistics of the usage behaviour of the firms concerning social software are pictured in Table 2. About 33 percent of the firms use at least one of the above mentioned social software applications in 2009. The most frequently used applications are collaboration platforms which are used by about 16 percent of the firms. 14 percent of the firms employ social networks while wikis are used by about 13 percent of the firms. 11 percent of the firms use blogs. These descriptive numbers indicate that social software is rather applied for communication and cooperation purposes, as applications which serve these aims are slightly more favoured. The average number of social software applications used by the firms, which represents social software intensity, is about 0.48.

The data set contains information on the interviewee's private usage of social software. This variable was measured by asking the interviewed person, who is the CEO of the firm in most cases, if he or she currently uses wikis, blogs or social networks in private life. Table 2 indicates that 42 percent of the interviewed persons use at least one of these social software applications privately. Thus, the private usage is slightly more diffused than the usage in the firm. Social networks are used by about one third of the interviewed persons privately while the second most frequently used application privately are wikis used by 20 percent of the interviewed persons. Private blogs are only used by 12 percent. The intensity of the private usage shows hardly any difference compared to the usage within the firm. The average number of applications that are used privately is also 0.62. Figure 1 illustrates the above mentioned descriptive statistics.

Table 7 in the appendix pictures the correlation structure between the social software applications used in the firm and privately. The strongest correlations between the various social software applications are between social networks and blogs used in the firm as well as collaboration platforms and wikis with correlation coefficients of 0.55 and 0.34 respectively. Concerning the private usage of social software, the usage of wikis and blogs exhibit the highest correlation with a correlation coefficient of 0.31.

Table 2: Descriptives: Usage of Social Software Applications

Variable	**Mean**	**N**
social software 2009	0.33	907
social software intensity 2009	0.48	907
wiki 2009	0.13	907
blog 2009	0.11	907
social network 2009	0.14	905
collaboration platform 2009	0.16	906
private use of social software 2010	0.42	902
intensity of private use of social software 2010	0.62	897
private use of wiki 2010	0.20	902
private use of blog 2010	0.12	902
private use of social network 2010	0.31	904

Source: ZEW ICT Survey, own calculations.

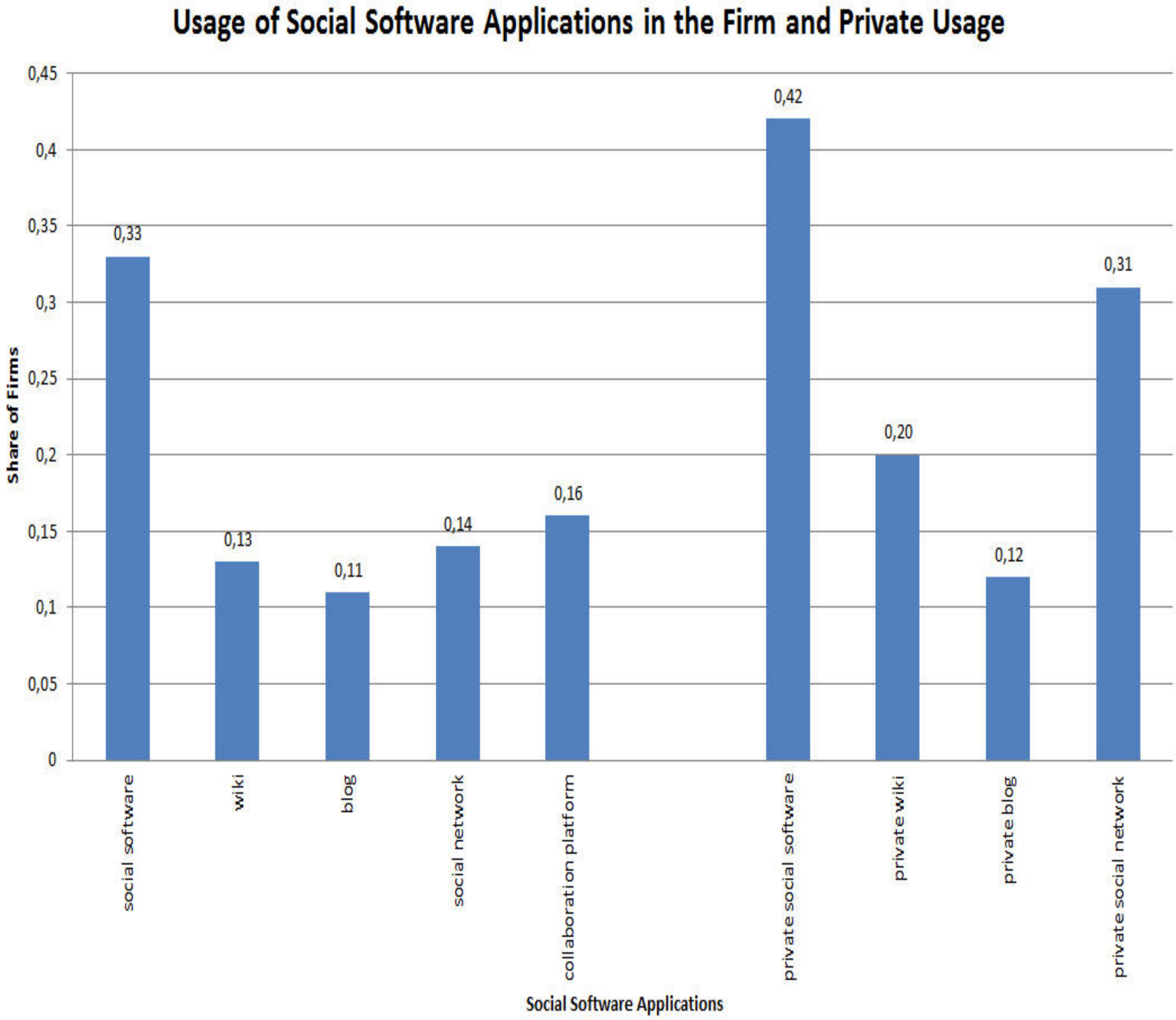

Figure 1: Usage of Social Software Applications in the Firm and Private Usage

Exploring the relationship between social software and labour productivity descriptively in detail, I first compare the difference between labour productivity for firms using social software and for firms which do not use this type of software. The comparison (see Table 6 in the appendix) shows that labour productivity for firms using social software is about 0.20 while it is about 0.24 for firms not using social software. Although the difference of both mean values is rather small, it points to a difference in productivity. Descriptively, firms using social software face a lower labour productivity than firms not using it. In a second step, I analyse how the usage of social software is related to different firm characteristics. Table 6 in the appendix shows these relationships. Firms that are engaged in training of employees, consulting, B2B e-commerce, B2C e-commerce and export activity have a slightly lower labour productivity when they use social software than firms not using these applications. A remarkable difference occurs especially for B2C e-commerce. Firms not using any type of social software have a labour productivity that is 15 percentage points higher while using B2C e-commerce at the same time than firms using social software. The descriptive analysis hints at a negative relationship between social software and labour productivity.

4 Analytical Framework and Estimation Procedure

In order to investigate the impact of social software usage on labour productivity, I assume that a firm i produces according to a production technology. The production process of the firm i is represented by a function $f(.)$ that relates the inputs of the firm to the output:

$$Y_i = f(A_i, L_i, K_i, S_i) \tag{1}$$

where Y_i denotes the output of firm i. The inputs are capital and labour (K_i, L_i) as well as social software (S_i). The parameter A_i measures total factor productivity and reflects the efficiency of production. In order to specify the production technology, I assume a Cobb-Douglas production function. Social software enters the logarithmic version of the function in a linear way. The error term denoted by ϵ_i is assumed to be independent and identically distributed

$$ln(Y_i) = ln(A_i) + \alpha ln(K_i) + \beta ln(L_i) + \gamma S_i + \epsilon_i. \tag{2}$$

In econometric estimations labour productivity measured by the logarithm of sales per employee is used as a dependent variable:

$$ln\left(\frac{Y_i}{L_i}\right) = ln(A_i) + \alpha ln(K_i) + (\beta - 1)ln(L_i) + \gamma S_i + \epsilon_i. \tag{3}$$

I estimate the model first by a common OLS estimation and afterwards by an instrumental variable regression with robust standard errors in order to instrument labour and gross investments in 2009 with their values in 2006 to reduce potential endogeneity. The fact that the usage of social software and labour productivity are both measured in the year 2009 could also lead to an endogeneity problem. It might be the case that already successful firms are more inclined to use social software pointing towards a reverse causality. To account for the potential endogeneity of this explanatory variable I also run the estimation with social software instrumented by the private use of wikis, blogs and social networks.

There are three reasons why the private usage of social software applications by interviewees are valid instruments for the usage within the firm. The first one is that both types of usage exhibit a high correlation which is necessary for instrumenting (see table 7 in the appendix). The interviewed person who is the CEO of the company in most cases has the power to introduce social software applications in the firm if he or she has made good experiences with the private usage and expects benefits from the usage in the firm. The second reason is that the private usage of social software is exogenous from the firms' point of view. The last reason is that the private usage has a similar variability like the usage of social software in the firms and thus sufficient explanatory power.

For the econometric analysis, I add some further control variables which might also have an impact on labour productivity. The controls comprise different firm characteristics such as IT intensity, export activity, qualification and age structure of employees, e-commerce, training, consulting, as well as region and industry dummies. The following section describes the measures of all variables used in the estimations.

Starting out with the explanatory variables, I measure labour and at the same time firm size by the logarithm of the number of employees in the year 2006. There is no information about the capital stock of the firms in the data. Thus, I consider gross investments in euro of the year 2006 as proxy for capital.

I proxy the IT intensity of the firms by the share of employees working with a computer in the year 2007. At the same time this variable measures workers' technological skills (Bertschek et al. 2010). In general, a higher IT intensity leads to higher labour productivity. Draca et al. (2007) indicate that ICT has a positive and robust impact on firms' productivity.

I 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 2006. The share of low qualified employees is taken as the reference category. I expect a higher labour productivity in firms with a higher share of highly qualified employees as a certain high level of education is necessary to perform more productively. Hempell (2003) shows that the educational level contributes directly to productivity.

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 2006. It is important to include the age structure of employees in the model as there might be differences in productivity for different age categories. The ability to process information and adapt to new situations decreases with age while verbal competence and experience increase (see Börsch-Supan, Düzgün and Weiss (2005)). Bertschek et al. (2009) found that employees younger than 30 years are less productive than prime age workers between 30 and 55 years.

I measure the export activity of the firms by a variable that comprises the share of export sales of the firms during the year 2006. Several studies show that exporting firms are more productive than otherwise identical firms (see Bernard et al. (2007) for the U.S., Mayer et al. (2007) for European countries and Fryges et al. (2008) for an analysis of exports and profitability in German firms). Wagner (2011) provides a survey of empirical studies that were done on the topic of international trade and firm performance since 2006.

The usage of e-commerce is measured by two dummy variables, each of them taking the value one if a firm applies business-to-business or business-to-consumer e-commerce respectively and zero otherwise. Both e-commerce applications were measured in the year 2007. Bertschek et al. (2006) found a positive impact of B2B e-commerce on labour productivity in German firms when B2B e-commerce is accompanied by ICT-investment. Firms' labour productivity is thus enhanced by using B2B e-commerce.

I include training of employees measured by the share of employees who received training in the year 2006 in my analysis. ICT training is included in this variable. Training is important for firms as ICT investments are often complemented by changes in the contents and the organisation of workplace. These changes require a continuous update of employees' skills. Hempell (2003) shows that firms boosting training of employees after investing in new ICT perform significantly better concerning labour productivity.

Another relevant aspect contributing to labour productivity is consulting. Therefore, I include in the empirical analysis a variable controlling for consulting in general which also includes IT consulting. Cerquera (2008) highlights a positive impact of IT consulting on firms' observed productivity.

In addition, dummy variables control for industry-specific fixed effects and sector-specific variation in labour productivity. A dummy variable for East Germany accounts for potential regional differences. East German firms are generally less productive than West German firms.

5 Results

5.1 Main Results

Table 3 shows the results of the OLS estimation of equation 3. In the first specification I include only labour and capital measured in the year 2007 in the estimation equation. While capital is positive and highly significant, the coefficient of labour is not exactly plausible. It is rather small and insignificant showing the incorrect sign as well. This points towards increasing returns to scale, but could also point to potential endogeneity of this variable. In the second specification I add the dummy variable for social software to the estimation equation. The relationship of social software and labour productivity is not significant indicating that social software has no effect on labour productivity. The coefficients of labour and capital remain qualitatively unchanged.

In the third specification, labour productivity is regressed on production input factors, social software, IT intensity, export activity as well as age and qualification structure. In addition, industry dummies are included to control for potential sectoral differences and a dummy for East Germany controls for regional differences. Again, social software has no significant impact on labour productivity. The coefficients of labour and investments remain qualitatively unchanged as well. The coefficient of IT intensity is positive and significant at the one percent level. This indicates a positive relation between labour productivity and the share of employees working with a computer. Firms selling their products or services abroad are more productive than firms which do not. The higher the share of export sales is, the more productive the firms are. The result is significant at the one percent level. The results also reveal that employees over 50 years have a labour productivity that is about 34.1 percentage points lower than for prime age workers between 30 and 50 years. The result is significant at the five percent level.

In the fourth specification of table 3, I augment the specification with the variables B2B e-commerce, B2C e-commerce as well as training and consulting. The effects of the input factors and older employees as well as exports and IT intensity do not change qualitatively by controlling for additional unobserved heterogeneity via including the mentioned variables. The effect of social software on labour productivity remains insignificant in the last specification as well as the variables B2B e-commerce, B2C e-commerce, training and consulting.

Table 4 reports the second stage estimation results of equation (3) using 2SLS with robust standard errors.[3] Labour and investments of the year 2009 are instrumented with their lagged values of the year 2007 to reduce potential endogeneity. I estimate the specifications 2 till 4 of the econometric model which are the same as the ones estimated by OLS in table 3. The results show that social software reduces labour productivity by about 18.7 percent. The result is significant at the one percent level. The input factors show the expected positive signs and coefficients with this estimation method.[4]

The results of the second specification indicate that the relationship between social software and labour productivity is once again negative. Firms using social software have a 16.6 percent lower labour productivity than firms not using this type of software. This result stays significant at the one percent level. The effect of IT intensity is also positively significant reflecting a positive relationship between labour productivity and ICT that

[3]The results of the first stage regression, with investments and labour instrumented by their lagged values, are available from the author upon request.

[4]The coefficient of labour is negative since it reflects the production elasticity of labour minus one. The estimated coefficients of the various categories of labour plus one reflect the productivity of the respective labour category relative to its reference group.

Table 3: OLS Regression

Dependent Variable: Labour Productivity	(1)	(2)	(3)	(4)
social software		−0.082	−0.076	−0.077
		(0.058)	(0.057)	(0.059)
log. labour	0.042	0.042	0.026	0.020
	(0.028)	(0.028)	(0.024)	(0.026)
log. investments	0.114***	0.114***	0.082***	0.083***
	(0.021)	(0.021)	(0.020)	(0.020)
employees with PC			0.398***	0.390***
			(0.127)	(0.128)
export activity			0.471***	0.471***
			(0.155)	(0.156)
highly qualified employees			0.246	0.232
			(0.176)	(0.174)
medium qualified employees			0.010	−0.002
			(0.121)	(0.120)
employees < 30			−0.138	−0.135
			(0.150)	(0.151)
employees > 50			−0.341**	−0.325*
			(0.167)	(0.168)
B2B e-commerce				0.030
				(0.056)
B2C e-commerce				0.035
				(0.066)
training				0.071
				(0.065)
consulting				−0.035
				(0.056)
East Germany			−0.326***	−0.328***
			(0.056)	(0.057)
constant term		−2.080	−2.630***	−2.781***
		(0.128)	(0.215)	(0.221)
industry dummies	no	no	yes	yes
number of observations	907	907	858	854

Significance levels: *: 10%, **: 5%, ***: 1%. Standard errors in parentheses. Reference categories: unqualified employees, employees 30–50 years.

is found in several other studies. If the share of employees working on a computer rises by one percentage point, labour productivity is 33.4 percent higher. Exporting firms are more productive than non-exporting firms. Furthermore, the results reveal that highly qualified employees are more productive than low qualified employees. The productivity is 36.2 percent higher for employees with university or university of applied science degree. The coefficient is significant at the ten percent level. The estimation results also show that employees above 50 years are less productive than prime age workers. Their labour productivity is 31.7 percent lower.

In the third specification of table 4 the effects of the input factors, the share of highly qualified and older employees as well as exports and IT intensity do not change qualitatively by controlling for additional unobserved heterogeneity via including further variables. The effect of social software remains also qualitatively unchanged with a decrease of productivity of 15.7 percent. The significance level drops from one to five percent. The variables B2B e-commerce, B2C e-commerce as well as training and consulting are insignificant and do not point towards an impact on labour productivity.

Due to potential endogeneity of social software usage, I estimate the model as a 2SLS regression with private usage of wikis, blogs and social networks as instruments for social software. The results of the first stage regression can be found in table 9 in the appendix. The private usage of blogs and social networks is highly significant in the third specification while the private usage of wikis is significant at the five percent level. The F-statistic takes a value over 10 in every specification suggesting that all instruments are relevant for instrumenting social software. In order to investigate the validity of the instruments I run the Hansen-Sargan test of overidentifying restrictions (see table 9 in the appendix) as the number of instruments exceeds the number of endogenous variables concerning social software. The null hypothesis that all instruments concerning social software and thus the overidentifying restriction are valid cannot be rejected.

The columns 4 till 6 of table 4 show the results of the 2SLS regression with social software instrumented by its private usage besides labour and investments instrumented by their lagged values. The impact of social software on labour productivity in this IV-regression is negative but much bigger than in the estimation result when social software is not instrumented. Firms using social software experience a decrease in productivity of 46.9 percent in the third specification. The significance level is five percent. The comparison of the coefficient of social software with the one without instrumentation of social software shows a rather big difference pointing towards an endogeneity of social software. While a negative effect of social software is plausible, the size of the coefficient suggests that the validity of the instruments may be problematic. The Hausman test

Table 4: 2SLS Regression

Dependent Variable: Labour Productivity						
	(1)	(2)	(3)	(4)	(5)	(6)
social software	−0.187***	−0.166***	−0.157**	−0.323*	−0.475**	−0.469**
	(0.064)	(0.064)	(0.064)	(0.172)	(0.205)	(0.220)
log. labour	−0.224***	−0.181**	−0.179**	−0.197**	−0.154**	−0.158**
	(0.084)	(0.077)	(0.074)	(0.080)	(0.074)	(0.072)
log. investments	0.373***	0.285***	0.285***	0.356***	0.280***	0.281***
	(0.079)	(0.077)	(0.076)	(0.075)	(0.075)	(0.074)
employees with PC		0.334**	0.343***		0.357***	0.356***
		(0.132)	(0.132)		(0.137)	(0.137)
export activity		0.470***	0.479***		0.464***	0.468***
		(0.151)	(0.152)		(0.151)	(0.152)
highly qualified emp.		0.362*	0.354*		0.424**	0.411**
		(0.185)	(0.185)		(0.197)	(0.197)
medium qualified emp.		0.124	0.121		0.148	0.139
		(0.144)	(0.144)		(0.148)	(0.147)
employees $<$ 30		−0.082	−0.092		−0.043	−0.045
		(0.159)	(0.159)		(0.165)	(0.166)
employees $>$ 50		−0.317*	−0.308*		−0.353**	−0.340*
		(0.169)	(0.171)		(0.174)	(0.176)
B2B e-commerce			−0.002			0.021
			(0.059)			(0.063)
B2C e-commerce			0.017			0.024
			(0.070)			(0.072)
training			0.016			0.044
			(0.072)			(0.074)
consulting			−0.049			−0.040
			(0.059)			(0.061)
East Germany		−0.290***	−0.286***		−0.292***	−0.291***
		(0.060)	(0.062)		(0.063)	(0.064)
constant term	−0.552	−1.510***	−1.505***	−0.637	−1.555***	−1.562***
	(0.461)	(0.441)	(0.445)	(0.438)	(0.428)	(0.433)
industry dummies	no	yes	yes	no	yes	yes
number of observations	907	858	854	897	848	844

Significance levels: *: 10%, **: 5%, ***: 1%. Standard errors in parentheses. Reference categories: unqualified employees, employees 30–50 years. Labour and investments instrumented in all specifications, social software instrumented in specification 4 till 6.

rejects the null hypothesis that social software is exogenous (see table 9 in the appendix). All other variables remain qualitatively unchanged.

The negative impact of social software on labour productivity points towards a suboptimal usage of social software within the firms. I addressed this issue in section 2 and found evidence in other studies that firms can only benefit from social software if they use these applications efficiently. There are various possible reasons why firms obviously have difficulties using social software in a way that generates productivity gains. The most important reason might be the shirking effect. Social software could have a distracting impact upon employees. They might decide to spend a part of their working time for instance in social networks using them privately. This leads to less working time available and thus to a productivity loss (Peacock (2008) and van Zyl (2009)).

Some employees might feel the need to interact and communicate more due to the simple availability of social software applications. The emerging flood of information and interaction associated with this fact might lead to an over-challenge of employees. They might not be able to handle their normal workload as they are busy all the time with social software activities resulting in a decrease of labour productivity.

Another important reason is that the adoption of social software is recent for most of the firms that adopted social software in the year 2007 while labour productivity was measured in 2009. As the time lag is relatively short, social software can be regarded as a new technology used by the firms. A large amount of literature covers the topic of the adoption of new technologies in general and the short-term productivity loss that is often associated with it, see Aghion et al. (2009) for instance. According to this literature, labour productivity increases in the longer term when the new technologies are integrated in the IT-infrastructure and employees got used to it.

One explanation for this short-term productivity loss is that the adoption of social software applications in a firm comprises organizational changes. Those changes could imply coordination costs leading to a decrease in labour productivity especially if the firms fail to consider these costs before the adoption. Such coordination costs might be for instance bandwidth and storage space consumption as well as exposure to malware as argued by Ferreira and du Plessis (2009). In order to use social software applications efficiently after their adoption firms might have to invest in special training for their employees as well. Usually it takes a certain amount of time until employees are able to use social software in a productive way after the corresponding training. Thus it might be the case that my analysis measures only the short-term impact on productivity. Due to the lack of availability of long-term data, I have to pass an analysis of long-term effects of social software on labour productivity on to further research.

A further aspect which I consider quite relevant is the lack of acceptance of social software among employees, customers and the management board of firms. Employees could use social software applications only reluctantly as they see no benefit in including these applications in fields like marketing, internal or external communication or project management. The rare usage of social software could lead to an insufficient know-how among employees about its handling and thus to a suboptimal usage in case it is needed.

The customers of the firms might not accept the usage of social software when they interact with a firm due to security reasons. It is possible that customers might not want the firms to have access to all customer information available in social software applications, especially private information. If firms decide to manage external communication with customers or cooperation partners via social software but face a lack of acceptance among customers and partners, this might lead to a decreasing labour productivity within the firms. The cooperation or interaction can only be managed in a suboptimal way as it might take longer using alternative communications tools.

The lack of acceptance among the management board of a firm might be an additional problem. This is often the case when the management board has second thoughts about security risks or shows little interest in the usage of social software. By using social software, the management board might loose control over the contents provided to customers or cooperation partners in these applications. The consequence might be that sensible data about the firm are accessible to other parties which might be harmful for the firm and thus to its productivity. On the other hand, if the management board uses social software only rarely, employees might not feel encouraged to use it either. The lack of acceptance of all three parties can be traced back partially to the fear of loosing privacy which is also an important aspect of the usage of social software mentioned in section 2 and motivated by Ferreira and du Plessis (2009).

In order to explore the negative impact of social software on labour productivity in detail, I estimate equation (3) with dummy variables for every single social software application to see which applications drive this negative impact in particular. Table 8 in the appendix presents the estimation results with each social software application dummy for the formerly mentioned specifications. Labour and capital are once again instrumented by their lagged values of 2007. The impacts of all social software applications except blogs are insignificant (see last column of table 8). In contrast, blogs have a rather big negative impact on labour productivity. Firms using blogs experience a decrease of labour productivity of about 27.2 percent, a result significant at the one percent level. The results indicate that the productivity loss of the firms concerning social software is mainly driven by the application blog. The reason for that might be the fact that it takes a certain amount of time to read all relevant blog postings and write own postings. This is rather detracting from productivity instead of increasing it (see Back and Heidecke (2008)). The coefficients of all other variables in the third specification remain qualitatively unchanged compared to the results in table 4.

5.2 Robustness Checks

For the purpose of testing the validity of the results I employ some further estimation approaches as robustness checks. In all following robustness checks, labour and investments are the only variables instrumented with their lagged values. As already mentioned in section 3, especially firms using social software and being active in B2C e-commerce face a lower labour productivity than firms not using social software. There is a certain possibility that the negative impact of social software runs mainly through B2C e-commerce and therefore, B2C e-commerce in combination with social software drives the negative impact on labour productivity. Thus, this descriptive result demands further investigation considering the negative result of the general usage of social software. I construct an interaction term between social software and B2C e-commerce and add it to the former model specifications of the main results. Table 10 in the appendix contains estimation results including the interaction term. The second stage results of the third model specification show that the negative overall impact of social software on labour productivity remains unchanged by including the interaction term.[5] The impact of B2C e-commerce remains insignificant in this model specification as well. The interaction term between social software and B2C e-commerce shows no significant impact on labour productivity. This result implies that the decrease in labour productivity caused by social software does not run mainly through B2C e-commerce. All other variables remain qualitatively unchanged in this robustness check.

An alternative measure for the usage of social software in the firms is the so-called social software intensity. The estimation of the former main specifications with social software intensity as explanatory variable leads to similar results. Social software intensity has an negative effect on labour productivity. The second stage results are pictured in table 11 in the appendix. If a firm uses one further social software application, labour productivity decreases by 8.9 percent in the third specification. Firms that are active in

[5] All results of the first stage regressions are available from the author upon request.

many different channels concerning social software and use it in this way more intensively suffer from productivity losses. The result is consistent with the main result.

The consideration of all control variables in the estimation equation reduces the sample size to 854 observations. All specifications of the main results have also been estimated using this reduced sample. Table 12 in the appendix contains the second stage results of these estimations. The coefficients in the third specification do not change qualitatively compared to the main results. The usage of social software reduces labour productivity by 15.7 percent. The significance level remains at the five percent level.

In summary, firms using social software experience a decrease in labour productivity. This result is robust across all model specifications and suggests that firms do not benefit from social software concerning labour productivity in an early stage of adoption when the usage is not efficient or they face shirking among employees or a lack of acceptance from different sides. The decrease in labour productivity is mainly driven by the social software application blog. In contrast to social software, IT intensity and export activity have a positive impact on labour productivity. Furthermore, highly qualified employees face a higher labour productivity than low qualified employees while employees who are older than 50 years are less productive compared to prime age employees between 30 and 50 years. As a further robustness check I estimate the model with the alternative variable social software intensity. The results remain qualitatively unchanged across all specifications and support the main results.

6 Conclusion

Although the current analysis sheds light on the relationship between social software and labour productivity, the question whether the usage of social software leads to a higher labour productivity needs further research. In particular, the long-term effects of social software need to be investigated since the current data cover a time period that is too short to solve this question econometrically.

The results of this study have several practical implications for firms. In general, social software has the potential of helping firms to be more productive. But in order to achieve that, social software should be channelled in an effective way to get optimal gains for employees and firms. Firms of all sizes should define strategies regarding social software and rules for employee engagement in order to possibly achieve benefits from the usage. They should monitor and control the social software usage as it might result in a security risk otherwise which could lead to sales decreases and thus to productivity losses.

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7 Appendix

Table 5: Distribution of Industries in the Sample

Industry	observations	percentage
consumer goods	81	8.93
chemical industry	48	5.29
other raw materials	57	6.28
metal and machine construction	72	7.94
electrical engineering	97	10.69
precision instruments	62	6.84
automobile	31	3.42
retail trade	55	6.06
wholesale trade	50	5.51
transportation and postal serv.	65	7.17
media services	28	3.09
computer and telecommunication services	80	8.82
financial services	45	4.96
real estate and leasing services	23	2.54
management consultancy and advertising	24	2.65
technical services	67	7.39
services for enterprises	22	2.43
sum	907	100

Source: ZEW ICT-Survey, own calculations.

Table 6: Social Software and Different Firm Characteristics

Industry	social software: yes	social software: no
labour productivity	0.24	0.20
training	0.21	0.27
consulting	0.21	0.26
B2B E-Commerce	0.19	0.26
B2C E-Commerce	0.16	0.31
export	0.25	0.36

Source: ZEW ICT-Survey, own calculations.

Table 7: Correlations between Social Software Applications

	wiki	**blog**	**social network**	**collaboration platform**	**private wiki**	**private blog**	**private social network**
wiki	1.00						
blog	0.19	1.00					
social network	0.19	0.55	1.00				
collaboration platform	0.34	0.13	0.13	1.00			
private wiki	0.19	0.14	0.18	0.18	1.00		
private blog	0.17	0.27	0.18	0.18	0.31	1.00	
private social network	0.18	0.21	0.25	0.21	0.28	0.29	1.00

Source: ZEW ICT-Survey, own calculations.

Table 8: 2SLS Regression with all Social Software Dummies

Dependent Variable: Labour Productivity			
	(1)	(2)	(3)
wiki	−0.008	0.010	0.008
	(0.080)	(0.079)	(0.080)
blog	−0.330***	−0.266***	−0.272***
	(0.093)	(0.087)	(0.087)
social network	0.041	−0.029	−0.021
	(0.089)	(0.079)	(0.079)
collaboration platform	−0.157**	−0.108	−0.092
	(0.077)	(0.076)	(0.077)
log. labour	−0.214**	−0.169**	−0.168**
	(0.083)	(0.075)	(0.073)
log. investments	0.365***	0.275***	0.276***
	(0.078)	(0.076)	(0.075)
employees with PC		0.330**	0.337**
		(0.132)	(0.133)
export activity		0.435***	0.447***
		(0.154)	(0.154)
highly qualified employees		0.364**	0.355*
		(0.184)	(0.184)
medium qualified employees		0.115	0.111
		(0.143)	(0.143)
employees $<$ 30		−0.097	−0.106
		(0.156)	(0.156)
employees $>$ 50		−0.308*	−0.300*
		(0.171)	(0.174)
B2B e-commerce			−0.001
			(0.059)
B2C e-commerce			0.027
			(0.069)
training			0.011
			(0.072)
consulting			−0.045
			(0.058)
East Germany		−0.293***	−0.290***
		(0.060)	(0.061)
constant term	−0.608	−1.569***	−1.562***
	(0.455)	(0.432)	(0.437)
industry dummies	no	yes	yes
number of observations	904	855	851

Significance levels: *: 10%, **: 5%, ***: 1%. Standard errors in parentheses. Reference categories: unqualified employees, employees 30–50 years. Labour and investments instrumented.

Table 9: First-Stage Regression with Instrumented Labour, Investments and Social Software

	dependent variable: dummy for use of social software		
	(1)	(2)	(3)
employees with PC		0.125**	0.104
		(0.063)	(0.063)
export activity		−0.053	−0.065
		(0.078)	(0.080)
highly qualified employees		0.195**	0.181*
		(0.094)	(0.094)
medium qualified employees		0.078	0.065
		(0.066)	(0.066)
employees < 30		0.054	0.071
		(0.085)	(0.084)
employees > 50		−0.056	−0.041
		(0.090)	(0.089)
B2B e-commerce			0.072**
			(0.031)
B2C e-commerce			−0.001
			(0.037)
training			0.034
			(0.035)
IT-consulting			0.036
			(0.031)
East Germany		0.023	0.018
		(0.031)	(0.031)
industry dummies		yes	yes
log. labour 2006	0.061***	0.068***	0.056***
	(0.013)	(0.013)	(0.014)
log. investments 2006	−0.001	0.004	0.005
	(0.009)	(0.009)	(0.009)
private use of wiki	0.113***	0.092**	0.086**
	(0.041)	(0.042)	(0.042)
private use of blog	0.243***	0.220***	0.208***
	(0.054)	(0.055)	(0.055)
private use of social network	0.223***	0.172***	0.167***
	(0.037)	(0.037)	(0.037)
constant term	−0.009	−0.140	−0.169*
	(0.055)	(0.101)	(0.100)
observations	897	848	844
F-statistic	40.21($p = 0.000$)	14.47($p = 0.000$)	13.79($p = 0.000$)
Hansen-Sargan test: Hansen's J $Chi^2(2)$: 2.93304 ($p = 0.2307$)			
Hausman test: robust score $Chi^2(3)$: 15.2048 ($p = 0.0016$)			
Hausman test: robust regression $F(3, 810)$: 4.99168 ($p = 0.0020$)			

Significance levels: *: 10%, **: 5%, ***: 1%. Standard errors in parentheses. Reference categories: unqualified employees, employees 30–50 years.

Table 10: 2SLS Regression with Interaction Term for Social Software and B2C E-commerce

	Dependent Variable: Labour Productivity		
	(1)	(2)	(3)
social software	-0.187^{***}	-0.166^{***}	-0.171^{**}
	(0.064)	(0.064)	(0.070)
log. labour	-0.224^{***}	-0.181^{**}	-0.179^{**}
	(0.084)	(0.077)	(0.074)
log. investments	0.373^{***}	0.285^{***}	0.285^{***}
	(0.079)	(0.077)	(0.076)
employees with PC		0.334^{**}	0.346^{***}
		(0.132)	(0.133)
export activity		0.470^{***}	0.477^{***}
		(0.151)	(0.152)
highly qualified employees		0.362^{*}	0.354^{*}
		(0.185)	(0.185)
medium qualified employees		0.124	0.123
		(0.144)	(0.145)
employees < 30		-0.082	-0.089
		(0.159)	(0.158)
employees > 50		-0.317^{*}	-0.311^{*}
		(0.169)	(0.172)
B2B e-commerce			-0.002
			(0.059)
B2C e-commerce			-0.001
			(0.092)
training			0.017
			(0.072)
consulting			-0.047
			(0.059)
social software*B2C e-commerce			0.053
			(0.139)
East Germany		-0.290^{***}	-0.287^{***}
		(0.060)	(0.062)
constant term	-0.552	-1.510^{***}	-1.503^{***}
	(0.461)	(0.441)	(0.456)
industry dummies	no	yes	yes
number of observations	907	858	854

Significance levels: *: 10%, **: 5%, ***: 1%. Standard errors in parentheses. Reference categories: unqualified employees, employees 30–50 years. Labour and investments instrumented.

Table 11: 2SLS Regression with Social Software Intensity

	Dependent Variable: Labour Productivity		
	(1)	(2)	(3)
social software intensity	-0.111^{***}	-0.094^{***}	-0.089^{**}
	(0.034)	(0.036)	(0.036)
log. labour	-0.224^{***}	-0.179^{**}	-0.177^{**}
	(0.084)	(0.077)	(0.074)
log. investments	0.372^{***}	0.283^{***}	0.284^{***}
	(0.079)	(0.077)	(0.075)
employees with PC		0.330^{**}	0.340^{**}
		(0.133)	(0.134)
export activity		0.464^{***}	0.474^{***}
		(0.152)	(0.153)
highly qualified employees		0.387^{**}	0.378^{**}
		(0.187)	(0.186)
medium qualified employees		0.122	0.119
		(0.144)	(0.144)
employees < 30		-0.085	-0.095
		(0.158)	(0.158)
employees > 50		-0.315^{*}	-0.306^{*}
		(0.172)	(0.174)
B2B e-commerce			-0.001
			(0.059)
B2C e-commerce			0.015
			(0.069)
training			0.013
			(0.072)
consulting			-0.049
			(0.059)
East Germany		-0.294^{***}	-0.289^{***}
		(0.060)	(0.062)
constant term	-0.564	-1.526^{***}	-1.520^{***}
	(0.460)	(0.441)	(0.445)
industry dummies	no	yes	yes
number of observations	904	855	851

Significance levels: *: 10%, **: 5%, ***: 1%. Standard errors in parentheses. Reference categories: unqualified employees, employees 30–50 years. Labour and investments instrumented.

Table 12: 2SLS Regression: Reduced Sample

Dependent Variable: Labour Productivity	(1)	(2)	(3)
social software	-0.181^{***}	-0.159^{**}	-0.157^{**}
	(0.065)	(0.064)	(0.064)
log. labour	-0.236^{***}	-0.184^{**}	-0.179^{**}
	(0.084)	(0.077)	(0.074)
log. investments	0.367^{***}	0.287^{***}	0.285^{***}
	(0.080)	(0.078)	(0.076)
employees with PC		0.347^{***}	0.343^{***}
		(0.132)	(0.132)
export activity		0.473^{***}	0.479^{***}
		(0.151)	(0.152)
highly qualified employees		0.358^{*}	0.354^{*}
		(0.185)	(0.185)
medium qualified employees		0.121	0.121
		(0.144)	(0.144)
employees < 30		-0.082	-0.092
		(0.159)	(0.159)
employees > 50		-0.303^{*}	-0.308^{*}
		(0.170)	(0.171)
B2B e-commerce			-0.002
			(0.059)
B2C e-commerce			0.017
			(0.070)
training			0.016
			(0.072)
consulting			-0.049
			(0.059)
East Germany		-0.283^{***}	-0.286^{***}
		(0.061)	(0.062)
constant term	-0.536	-1.505^{***}	-1.505^{***}
	(0.462)	(0.444)	(0.445)
industry dummies	no	yes	yes
number of observations	854	854	854

Significance levels: *: 10%, **: 5%, ***: 1%. Standard errors in parentheses. Reference categories: unqualified employees, employees 30–50 years. Labour and investments instrumented.