Productivity Effects of Business Process Outsourcing (BPO) A Firm-level Investigation Based on Panel Data*

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April 2009

WORK IN PROGRESS, PLEASE DO NOT CITE!

Abstract

This paper analyses the impact of business process outsourcing (BPO) on firm productivity based on a comprehensive German firm-level panel data set covering manufacturing and service industries. The growing importance of service inputs into the production process is undisputed. Firms increasingly decide to go to the market and buy all or at least parts of selected services they need from external service providers. This is especially true for services which rely to great extend on new information and communication technologies. Doing so, outsourcing firms can concentrate on their core competencies. Additionally, they benefit from the expertise of the external service provider. Finally, external vendors are able to provide services at lower price because of scale effects. By estimating a production function using a system-generalised method of moments (system-GMM) estimation procedure, I show that BPO has a positive and highly significant impact on firm-level productivity in both manufacturing and service industries.

Keywords: Business Process Outsourcing (BPO), Productivity, Panel Data, System-GMM
JEL-Classification: C23, D24, L24, L60, L80

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* This paper was written as part of the research project "Business Process Outsourcing: Determinants and Consequences for Competitiveness" commissioned by the *Förderkreis Wissenschaft und Praxis* at the Centre for European Economic Research.

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1 Introduction

The overall importance of services as an input into the production process of firms is undisputed. Firms can choose between two different forms of acquiring those inputs: they can produce services themselves or they can contract out the services to an external service provider.[1] Figure 1 reflects the growing importance of external service inputs for the production process of the German economy. Between 1995 and 2005 (the latest point of time for which input-output data is available) the share of intermediate inputs from the "other business activities sector" (NACE 74) in the total production value in Germany increased from 5.45 percent to 6.38 percent. Although this increase in percentage terms seems rather moderate, the absolute numbers are quite substantial. For the period from 1997 to 2005 the increase in the share of intermediate input of 1.3 percentage points reflects an additional amount of business services requested by the market of around €91.5 billion. The import share only represents an additional €3.9 billion. The rest of the increase therefore comes from service providers located in Germany. Since concentrating solely on the "other business activities sector" is quite narrow when focusing on business process outsourcing activities, a wider definition which includes additional sectors providing business services is displayed in Figure 2. Here I show results for the "corporate service sector" which comprises the sectors "computer and related activities" (NACE 72), "research and development" (NACE 73) and "other business activities" (NACE 74). In this case, the increasing importance of services as inputs to the production process is even more pronounced. Between 1997 and 2005 (again the latest point in time with input-output data availability) the increase of services from the above defined sectors as inputs into other sectors increased by 1.5 percentage points to a total amount of almost €307 billions (including imports of around €24 billions). Data made available by the EU-Klems project allows to take a look at the share of intermediate service inputs in total value added in Germany of the past years until the year 1978. Since then the share of service input rose from 24.8 percent to 34.0 percent in 2005 for the service sector, an increase of more than 9 percentage points. Regarding the manufacturing industries, the increase is smaller but still amounts to almost 6 percentage points in the same time span. A study conducted by the Centre of European Economic Research (ZEW) in 2007

[1] Sometimes firms, especially larger ones and those with several subsidiaries, found their own service division which then provides services to all the other parts of the group. Sometimes those service divisions also begin to offer their service to external companies.

analyses the involvement of German firms in business process outsourcing. They find that 54 percent of German manufacturing firms and 59 percent of firms belonging to the service industries are involved in BPO (ZEW, 2007). This holds especially in the fields of accounting and human resource managements where the services of BPO providers are highly demanded by firms in both industries (see Figure 4).

The aforementioned figures illustrate the growing importance of external service provision for the German economy. The question now is to find out if this usage also has an effect on the business performance of the outsourcing firm, e.g. in terms of productivity gains. Why should firms resort to external providers and give away decision power and (maybe) flexibility if it does not help them to improve their economic performance in some way? Therefore, the purpose of this paper is to analyse the impact of business process outsourcing on firm-level productivity by using a comprehensive panel data set from the German manufacturing and service industries for the years 2000, 2002, 2004 and 2007. I apply different estimation methods to a production function framework, among others system-GMM estimation. This controls for unobserved firm effects, measurement errors in the variables and simultaneity of inputs and output, which may induce substantial biases in pooled OLS regressions. The results clearly show a positive and highly significant impact of business process outsourcing on the productivity of outsourcing firms.

The remainder of the paper is structured as follows: Section 2 gives a definition of business process outsourcing and develops the main hypothesis. Furthermore, an empirical literature review focusing on business process outsourcing and productivity research is presented. Section 3 introduces the estimation procedure. In Section 4 the data set and the applied transformation steps are presented. Section 5 discusses the estimation results. Section 6 concludes.

2 Background Information

2.1 Business Process Outsourcing

Business Process Outsourcing (BPO) is a broad term referring to outsourcing in all fields of economic activity. It can be defined as ‘an organisation entering into a contract with another organisation to operate and manage one or more of its business processes or sub-processes’ (Sharma, 2004). Focusing on the more technical side of BPO an alternative definition would be ‘BPO is the leveraging of technology or specialist process vendors to provide and manage an organisation’s critical and/or non-critical enterprise processes and applications’ (Mukherjee, 2007). A BPO service provider differentiates itself from a typical third party Application Service Provider (ASP) by either putting in new technology or applying existing technology in a new way to improve a (business) process. The application of BPO usually also means that a certain amount of risk is transferred to the vendor which runs the process on behalf of the outsourcer. Business segments which are typically outsourced include information technology (IT), human resources, facilities and real estate management, and accounting. In recent years, because of the rapid development of information technology, business process outsourcing has increasingly become the delegation of one or more IT-intensive business processes to an external provider that in turn owns, administers and manages the selected process based on defined and measurable performance criteria. With BPO, the outsourcing provider not only takes over administrative responsibility for a technical function but also assumes strategic responsibility for the execution of a complete, business-critical function. This additional step can introduce new efficiencies and cost savings while it also enables the outsourcing vendor to deliver important strategic benefits to the customer. BPO is positively related to the search for more efficient organisational designs: cost reduction, productivity growth and innovative capabilities. Hence, a source of strategic advantage.

An important fact of business process outsourcing is its ability to free corporate executives from some of their day-to-day process management responsibilities. Executives usually spend most of their time managing everyday business and only some time on formulating strategies for a successful advancement of the company. This can look quite different when business processes are outsourced. Once a process is successfully outsourced, the ratio can be easily reversed. As a result, executives have more time. This saved time helps them tremendously to explore new revenue areas, accelerate other projects and focus on their customers. This, beyond any doubt, leads to productivity improvements.

Companies that outsource their business processes are often able to generate new efficiencies and improve their productivity. They are in a better position to reallocate their resources to other important projects. This also helps their employees to increase their efficiency and productivity. In most cases highly qualified experts are brought in to design and manage these processes. Those experts bring with them increased productivity and years of experience that most companies previously did not have access to or could not afford on their own. The availability of highly qualified skill pools and the faster adoption of well-defined business processes leads to productivity improvements without compromising on quality.

2.2 Outsourcing of Services

Business Process Outsourcing is very closely related to service outsourcing since it can be seen as the outsourcing activity of a sub-group of services. The empirical literature dealing with service outsourcing and offshoring (the outsourcing to a service provider abroad) is much diversified. Some papers deal with the outsourcing drivers, e.g. with the factors that affect the outsourcing decision of the firm (Abraham and Taylor, 1996; Girma and Görg, 2004; Antonietti and Cainelli, 2007; Merino and Rodríguez Rodríguez, 2007).[2] Another topic the empirical literature on service outsourcing is dealing with, is the effect of outsourcing on firm success, e.g. in terms of productivity increases of the outsourcing and/or offshoring firms. Important contributions were made by Siegel and Griliches (1992); Fixler and Siegel (1999); Görg and Hanley (2005); Jiang and Qureshi (2006); Sako (2006); Hijzen (2007) and Görg et al. (2008). All those papers analyse the relationship between productivity and service outsourcing in general. Heshmati (2003) and Olsen (2006) provide surveys of the more general literature on outsourcing and its relationship to efficiency and productivity. The extent to which services are outsourced is treated by the paper of Amiti and Wei (2005). They find that the international outsourcing of material inputs

[2] Theoretical aspects about the determinants of outsourcing and offshoring can be found in Grossman and Helpman (2003, 2005) and Antràs et al. (2006)

is still more important than the international outsourcing of services. However, taking a look on the dynamics of both outsourcing aspects, the growth rate of service outsourcing is much higher compared to the growth rate of material outsourcing.

2.3 Outsourcing and ICT

Business process outsourcing is very closely related to information technology outsourcing. BPO even comprises IT outsourcing to some extend. The increasing importance of information and communication technologies (ICT), especially the usage of computers and intra and internet network connections, has revolutionised the provision of services. Even more important, a broad variety of new services were created because of the possibilities offered by new and fast developing information and communication technologies. Therefore, the vast majority of business processes today rely in some way on information and communication technologies. In addition, the operation of a firm's ICT infrastructure itself can be interpreted as business process.

Various authors have analysed ICT/IT outsourcing and offshoring, including Loh and Venkatraman (1992) as well as Barthêlemy and Geyer (2001; 2004; 2005), who took a close look on the determinants of IT outsourcing. Additionally, further research was devoted to the outsourcing firms' performance, basically trying to identify (labour) productivity effects of IT outsourcing. Maliranta et al. (2008) thereby find out that IT outsourcing enhances an organisation's IT use and thus boosts its labour productivity. In contrast, Bertschek and Müller (2006) cannot find any significant differences in key variables between outsourcing and non-IT outsourcing firms. They even find that firms without IT outsourcing produce more efficiently than those involved in IT outsourcing. Ohnemus (2007) in turn finds the opposite. He shows that IT outsourcing firms are more efficient in their production processes. Furthermore, he finds that employees working at a computerised workplace are more productive in IT outsourcing firms. Besides the empirical literature dealing with IT outsourcing, there is also a variety of theoretical papers analysing various aspects of IT outsourcing. For a comprehensive overview see Dibbern et al. (2004).[3]

The analysis of Abramovsky and Griffith (2006) rather attempts to identify the impact of information and communication technologies on the make or buy decision of business services. They rely on British firm-level data for the years 2001 and 2002. Information and communication technologies reduce the transaction costs and the costs of adjustment of outsourcing relationships. Therefore, long distance service outsourcing (offshoring) has become increasingly popular during the last few years. Additionally, the costs of these outsourcing activities decreased significantly. Abramovsky and Griffith (2006) find out that ICT-intensive firms tend to buy a greater amount of services on the market (compared to in-house production). Furthermore, these firms are more involved in international service outsourcing (offshoring).

3 Empirical Framework

In order to estimate the impact of business process outsourcing on a firm's productivity, I refer to a production function framework using a Cobb-Douglas specification:

$$\begin{aligned} Y_{it} &= F(A_{it}, L_{it}, K_{it}, BPO_i) \\ &= A_{it} \; L_{it}^{\alpha} \; K_{it}^{\beta} \; \mathrm{e}^{\gamma BPO_i}, \end{aligned} \tag{1}$$

where Y_{it} refers to output of firm i at time t, L_{it} represents labour input and K_{it} represents capital input. BPO_i is a dummy variable indicating if firm i has been involved in business process outsourcing since the year 2000 or before. After taking logs on both sides, one can rewrite Equation (1) in the following way:

$$y_{it} = \alpha \, l_{it} + \beta \, k_{it} + \gamma \, BPO_i + \eta_i + \lambda_{j(i),t} + \epsilon_{it}, \tag{2}$$

[3] In their literature overview Dibbern et al. (2004) analyse 84 papers published between 1992 and 2000. They find that most of the studies focus on Transaction Cost Theory, Agency Theory or Strategic Management Theory as a reference framework to explain IT outsourcing.

where small letters denote the corresponding logarithmic value and multifactor productivity $ln(A_{it}) = \eta_i + \lambda_{j(i),t} + \epsilon_{it}$ is decomposed into a firm-specific and time-invariant fixed part η_i, a time-variant industry-specific part $\lambda_{j(i),t}$,[4] and a time-variant firm- specific residual ϵ_{it}. Firm-effect η_i captures fixed or quasi-fixed factors affecting productivity, e.g. management ability, organisational capital, branding or location. The residual ϵ_{it} comprises measurement errors, m_{it}, and firm-specific productivity shocks, μ_{it}, such that $\epsilon_{it} = m_{it} + \mu_{it}$. In this analysis, both m_{it} and μ_{it} are assumed to be serially uncorrelated and only their sum ϵ_{it} is considered.

The industry time–variant part $\lambda_{j(i),t}$ captures variations in productivity that are specific to a particular industry and that are left unexplained by the input variables. In this sense, $\lambda_{j(i),t}$ helps to ensure that outputs of firms are more readily comparable across industries. In particular, demand fluctuations induced by industry–specific business cycles may lead to variations in factor utilisation that are similar across firms of one industry. The resulting industry–specific changes of productivity are then captured by $\lambda_{j(i),t}$. While the industry–specific component $\lambda_{j(i),t}$ will be controlled for by including time–variant industry dummies, distorting effects from unobserved η_i and ϵ_{it} will be addressed by econometric techniques. I account for the fact that both η_i and ϵ_{it} may be correlated with the inputs if, for example, firms with a good management (i.e. a high η_i) are both more productive and more inclined to make use of capital input, or if a demand shock (high ϵ_{it}) raises both productivity as well as investment.

The endogeneity of the explanatory variables can be removed by an instrumental variable regression. In this respect, it is convenient to use GMM estimations with internal instruments, i.e. other moments of the same variable (Hempell, 2006). More precisely, the first differences of the explanatory variables are instrumented here by the levels of the lagged variables. The prediction power of the internal instruments could be small, however, given the only minor changes in some of the variables (e.g. number of employees) from one year to another. That could evoke biases in the GMM estimator in first differences (Blundell and Bond, 1998). Therefore I prefer the so-called system-GMM estimator of Arellano and Bover (1995). Here, the differences are instrumented again with lagged levels as internal instruments. The levels

[4] With $j(i)$ denoting the industry j that firm i is operating in.

of the covariates are simultaneously instrumented by adequate lagged differences. The main advantage of this approach is that besides the temporary differences, differences among firms in levels are also taken account of in the estimation. That improves the information used for identifying the effect and usually enhances the precision of the estimator. A necessary condition for the system-GMM estimator is that the correlations between the unobserved fixed effects and the covariates remain constant over time (Arellano and Bover, 1995). The productivity estimations are carried using the command xtabond2 in STATA 10.1 (Roodman, 2006). I applied the available two-step estimation variant which is asymptotically more efficient than the one-step alternative. Unfortunately, the reported two-step standard errors tend to be severely downwardly biased (Arellano and Bond, 1991; Blundell and Bond, 1998). To resolve this problem, Windmeijer's adjustment process for variances is applied (Windmeijer, 2005). This method helps to make the two-step system-GMM estimation more efficient than the one-step estimation.

4 Data

The firm-level data used for the empirical analysis are taken from a survey conducted by the Centre for European Economic Research (ZEW) between 2000 and 2007. It is a representative survey of information and communication technologies in the German manufacturing and selected service sectors.[5] In each wave a total of approximately 4,400 firms were surveyed. The data is stratified according to industries (seven manufacturing industries and seven service sectors), size (three distinct classes) and region (East or West Germany). Merging all four existing waves of the collected data results in an (unbalanced) panel structure in important key variables. Besides a huge amount of variables dealing with information and communication technologies, the ZEW ICT-survey contains annual data on sales, number of employees (and their skill structure) and expenditures on gross investment. In the last wave, which was conducted in 2007, information about ICT and business process outsourcing was collected. The survey

[5] The first wave of the so called ZEW ICT-survey was conducted in the year 2000, the second wave followed two years later, the third wave in 2004 and the hitherto last survey wave took place in 2007.

did not only focus on the present state of the outsourcing activities of each firm but also asked for the starting year of various BPO activities (for a further discussion of this point, see page 11).

In order to conduct meaningful production function estimations, same of the available variables have to be transformed using external data sources. In the following I will illustrate how this external data is used to transform the available survey data which enables me to run production function regressions. For output Y_{it} I use a measure of firms' value added. Alternatively, the originally available data on total sales from the survey could be used with including firm–level intermediate goods as an additional input. However, the available data lacks reliable information on intermediate inputs. Using sales for output instead of value added without the inclusion of the amount of intermediate inputs might lead to an omitted variable bias in the regressions since industries that operate rather at the end of the value chain (such as wholesale and trade) resort more to intermediate goods in terms of quantity than other industries do. In order to control for these differences and to deflate the corresponding outputs, I calculate the shares of real value added in nominal gross output at the NACE two–digit industry level.[6] The firm–level data on sales are then multiplied by these industry–specific shares.[7] For labour input, the number of employees in full-time equivalences is used.

Some firms did not report investment figures for one or more of the survey periods. Since the total number of firms (and observations) in the sample is already at the lower limit, I tried to keep as many observations in the sample as possible. Therefore I imputed investments for firms with missing values by multiplying the total number of employees with industry and year specific average investment intensities (investment per employee) obtained from the full survey sample (full cross section) in each specific survey year. In order to construct a capital stock from investment data, I use official producer price deflators for investment goods to deflate the investments of firm i. Given the deflated investments for capital, I apply the perpetual inventory

[6] For these calculations I used Table 81000-0103 and Table 81000-0101 from the German Statistical Office.

[7] If Z_{it} and Y_{it} are sales and value added of firm i in period t, and if $Z_{j(i),t}$ and $Y_{j(i),t}$ are sales and value added aggregated over all firms of the same industry $j(i)$ that firm i is operating in. Then the unknown value added of firm i is approximated by $Y_{it} \simeq Z_{it} \cdot Y_{j(i),t}/Z_{j(i),t}$.

method with constant, geometric depreciation to construct the capital stock. Accordingly, the capital stock K_{it} of firm i in period t results from investment $I_{i,t-1}$ in the following way:

$$K_{it} \;=\; (1-\delta_{j(i)})K_{i,t-1} \;+\; I_{i,t-1} \qquad (3)$$

with $\delta_{j(i)}$ denoting the industry-specific depreciation rates of capital stocks for firm i.[8] Since no information is available on the level of capital stocks, I construct initial capital stocks employing the method proposed by Hall and Mairesse (1995). Under the assumption that investment expenditures on capital goods have grown at a similar, constant average rate g in the past in all firms, Equation (3) can be rewritten for period $t = 1$ (2000) by backward substitution in the following way:[9]

$$\begin{aligned}
K_1 &= I_1 \;+\; (1-\delta)I_{-1} \;+\; (1-\delta)^2 I_{-2} \;+\; \dots \\
&= \sum_{s=0}^{\infty} I_{-s}(1-\delta)^s \\
&= I_0 \sum_{s=0}^{\infty} \left[\frac{1-\delta}{1+g}\right]^s \\
&= \frac{I_1}{g+\delta} \qquad (4)
\end{aligned}$$

In order to derive the initial capital stocks, assumptions about the pre-period growth rate g of investments have to be made. Hereby, I assume an annual growth rate of approximately 5 percent ($g = 0.05$). Since there are time lags between the installation and the productive contribution of capital goods, I employ the capital stock at the beginning of each period (or at the end of the corresponding previous period) as a measure of capital input. In order to

[8] I calculated the depreciation rates $\delta_{j(i)}$ by industries as the shares of capital consumption in net fixed assets evaluated at replacement prices (time series 81000-0107 and 81000-0117 of the German Statistical Office). The unweighted mean over all industries amounts to 4.8 percent with a maximum in NACE 72 (data processing) of 26.0 percent and a minimum in NACE 70 (real estate) with 2.3 percent.

[9] In fact, the initial value of investment for firm i $I_{i,1}$ is replaced by the average of the observed values of investment such that $I_{i,1} \simeq \frac{1}{T}\sum_{t=1}^{T} I_{it}$.

apply suited econometric techniques (system-GMM estimation), I consider only firms for which consistent information is available for at least three consecutive periods.[10]

The resulting unbalanced sample consists of 700 firms with a total of 2371 observations. The statistics of the total sample, the outsourcing firms and the non-outsourcing firms are summarised in Table 1. The figures report the means and medians of the unweighted firms' means over time. The majority of firms in the reference sample are small and medium–sized firms with a median of 49 employees. The median value of the number of employees is higher for firms involved in outsourcing (61 employees) than for non-outsourcing firms (38 employees). The bottom rows of Table 1 report the means and medians of the firms' (longitudinal) averages of output and capital intensity (value added and capital per employee). At the median firm, a workplace is equipped with capital worth €60,950. The median value added per employee is €62,900. Again value added per employee and capital per employee is higher for the outsourcing sub-sample compared with the non outsourcing sample. [11]

The business process outsourcing variable , the main variable of interest in this analysis, is a dummy variable indicating if firm i partly or completely outsources business processes to an external service provider. The variable is time-invariant, taking the value one if the firm began to outsource business processes in the year 2000 or before, with 2000 being the first year for which data from the survey is available. The questionnaire of the ICT survey asked firms about their outsourcing engagement in certain business activities, the starting year of this engagement and the extend of their outsourcing (fully or partly). A firm belongs to the outsourcing group if at least one of the following business processes is provided by an external service provider: (i) IT services, (ii) Marketing, (iii) Procurement, (iv) Customer Services and (v) Sales and Distribution.

[10] Since information about BPO is essential for the analysis conducted in this paper and BPO information was only collected in the 2007 survey, all firms included in the final sample were observed in the year 2007. The panel observations then reach back at least to the year 2002 and sometimes even further to the first wave of the ZEW ICT-survey in 2000.

[11] The corresponding mean values are substantially higher than the median since some firms display very high values for both inputs and outputs per employee.

Taking a look at Table 2 reveals the decomposition of the sample by industry affiliation. One can easily see that the greatest share of firms in the sample belongs to the *metal and machine construction industry*. The smallest share of firms on the other hand belongs to the *wholesale trade industry*.[12] As the last two columns of Table 2 indicate, business process outsourcing is extremely popular in the *chemical industry*. More than 61 percent of the firms belonging to this industry are involved in BPO. The industry with the least involvement in business process outsourcing is the *electronic processing and telecommunication industry*. Here, only 26 percent of the firms outsource business processes to an external service provider. Overall, 43 percent of all firms are outsourcing companies.

Table 3 shows descriptive statistics of labour productivity (value added per employee), separated into firms with BPO and firms without BPO. The mean of labour productivity is substantially higher for firms that are involved in outsourcing compared to those firms without any involvement in BPO. Outsourcing firms reach a mean value for labour productivity of about €114,063 and non-outsourcing firms show a value of €74,208. According to a t-test the difference is also highly significant at any conventional level. When calculating the logarithm of labour productivity (the logarithm of productivity is later on used in the estimation procedures) and comparing the means in the two sub-samples a t-test again shows that the mean of the logarithm of labour productivity is significantly higher in the sample of firms with outsourcing activities.

5 Results

Tables 4 and 5 show the results for pooled OLS, random effects and system-GMM estimation. The first two columns of Table 4 contain the results of the pooled OLS regression for a pure productivity estimation with labour and capital inputs and productivity estimation. The additional dummy variable indicates if firm i is involved in business process outsourcing. In both estimations the labour and capital input coefficients are highly significant, reaching values

[12] For a detailed description and composition of the sectors included in the survey, see Table 6. In the ZEW ICT-survey banks and insurances are also surveyed, but since there is no output data available for those firms (only the balance sheet total and insurance premiums, respectively), these industries are excluded from the analysis in this paper.

of about 0.96 for labour input and 0.08 (0.07) for capital input. The coefficient for BPO is also positive and highly significant, reaching a value of 0.25. The pooled OLS estimates are possibly biased because observations of the same firm in different years are considered as independent and unobserved heterogeneity cannot be taken into account.

To account for this possible bias, I estimated a random effects model.[13] The estimation results are shown in the third column of Table 4. In contrast to the pooled OLS regression of column two, the capital coefficient is significantly smaller and not significant at the usual significance level any more. Additionally, the labour coefficient increased to 0.99. Moreover, the BPO coefficient slightly increased to a value of 0.27 and is still highly significant.

The endogeneity problem of labour and capital is further addressed in the system-GMM regressions. Here, the lagged endogenous variables are used as instruments. Labour and capital are regarded as endogenous variables, the dummies for industry, time, and the location of the firm (East or West Germany) are assumed to be exogenous. Besides, the BPO dummy variable, which indicates if firm i has done business process outsourcing since at least the year 2000 is assumed to be exogenous. System-GMM estimation results are presented in 5. I estimated a basic production function without the 'BPO-input' variable as a starting point. The results for the labour and capital inputs are again highly significant, as well as the coefficient for the dummy variable indicating if a firm is located in East or West Germany. In contrast to the OLS and random effects regressions, the coefficient for labour is smaller reaching a value of 0.81. However, the capital input coefficient increased to around 0.26, which is considerably higher than 0.08 in the pooled OLS regression. Adding BPO as an input factor to the production function estimation and focusing on all firms in the sample, I can find a significant positive impact of business process outsourcing on productivity at the firm level. The coefficient reaches a value of 0.21 and is highly significant. In this setup, the labour and capital input coefficients do not differ much compared to the basic setup of the productivity equation.

[13] A fixed effect model would also be an appropriate alternative in this case. However, since the variable of main interest is a time-invariant dummy, this variable would not be identified in a fixed effect model.

In a further step, I want to see if there are differences concerning the productivity effects of business process outsourcing in the different sectors of the manufacturing or service industries. The results of these two estimations are reported in columns three and four of 5. In both settings the labour input coefficient is highly significant but the difference in absolute terms is quite substantial. While the coefficient for labour is around 0.72 in the manufacturing industry, it is almost 0.96 in the service sector. This result is not surprising, since manufacturing is generally less labour intensive than the service sector. Consequently, the capital coefficient is higher for manufacturing than for services, albeit in neither estimation the coefficient achieves significance. The most interesting finding is that in both estimations the impact of business process outsourcing is positive and highly significant (at the five percent level in manufacturing and at the one percent level in services). In absolute terms, the impact seems to be more pronounced in the service sector (0.33 compared to 0.27).

In all system-GMM estimations, there is significant first order correlation (of the first differenced residuals) and no second order correlation at the usual levels. This result indicates the validity of the applied instruments. This is further undermined by the Hansen J-Test of overidentification. In all settings the null hypothesis could not be rejected.

6 Concluding Remarks

The aim of this paper is to analyse the impact of business process outsourcing on firm-level productivity. An augmented production function approach is used which takes account of firms' BPO activities. For the empirical analysis system-GMM estimation is applied for a panel data set of German firms. The results show that business process outsourcing has a considerably positive and significant effect on firm-level productivity. This result holds for firms of the manufacturing as well as for firms from the services sector. The coefficient indicating if a firm is involved in BPO is again highly positive and significant in separate estimations for manufacturing firms and service firms.

The outsourcing of business processes to external providers seems to be a good choice for firms. The allows managers to focus on the core business of the firm. Moreover, the qualified and experienced work of the service provider and the cost savings finally result in an improved business performance. This research, however, is still at the beginning. Further research efforts are necessary and should focus for example on a decomposition of labour input by qualification and age. Moreover, interactions between BPO and specific input factors could be taken into account.

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Appendix

A – Data

Output (Y): Firms' value added is used as output measure. Because of data restrictions only data of sales is available. I constructed firm-specific and deflated value added figures by multiplying sales with the shares of real value added in nominal gross output terms at the NACE two–digit industry level.

Employment (L): For labour input, the number of employees in full-time equivalences is used. Besides the total number of employees, the firms were asked about their share of part-time employees. I accounted for that share, assuming that part-time employees work on average half the time of full-time employees.

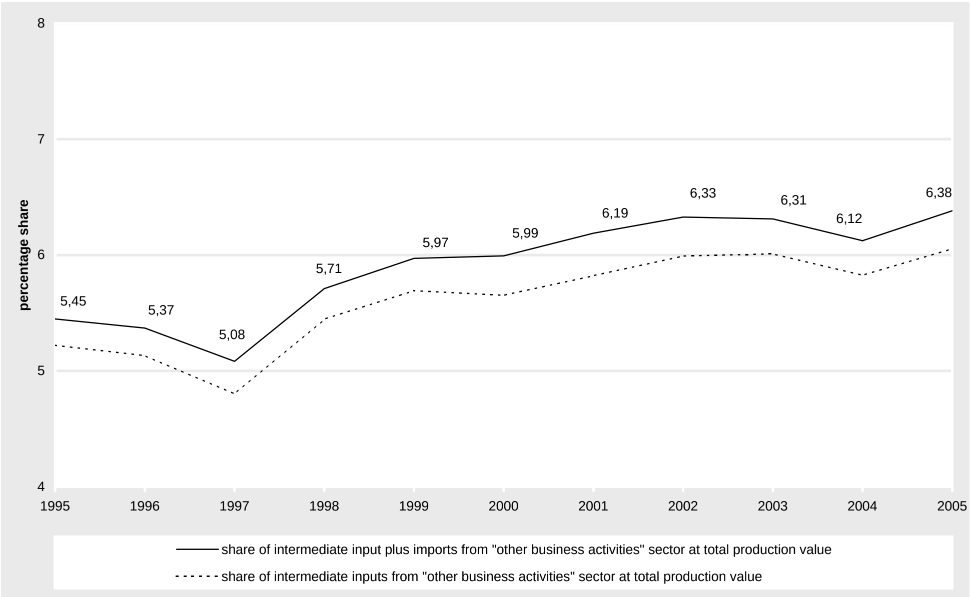
Capital Stock (K): The capital stock variable is constructed out of deflated investment information available for each firm and year. I apply the perpetual inventory method to achieve capital stock data for each firm (and year).

Business Process Outsourcing (BPO): The business process outsourcing variable is a dummy which takes on the value one if firm i started to partly or completely outsource (al least) one of the following business processes before or in the year 2000: (i) IT services, (ii) Marketing, (iii) Procurement, (iv) Customer Services and (v) Sales and Distribution.

East or West Germany: Dummy variable indicating if the location of firm i is in East or West Germany.

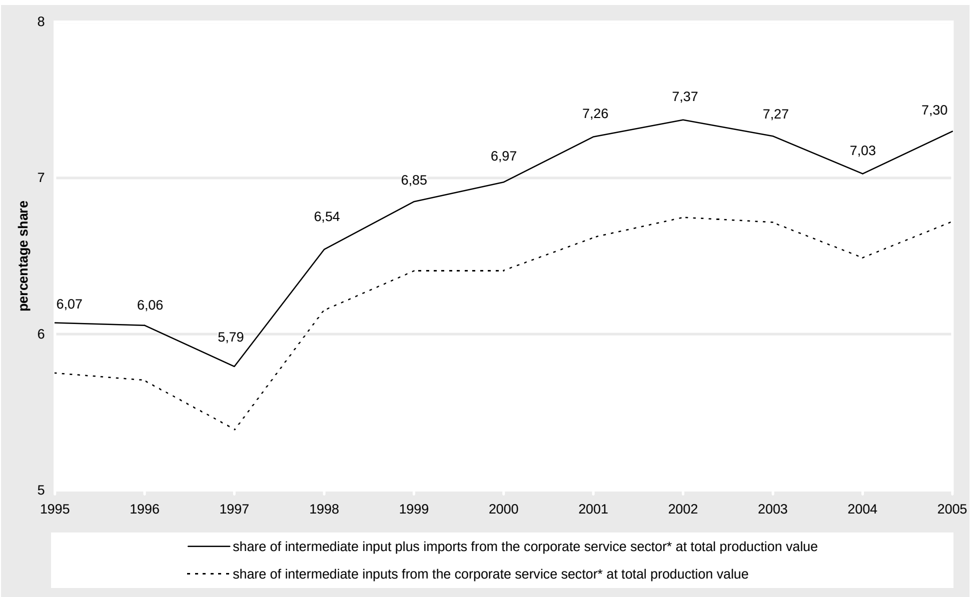
B – Figures and Tables

Figure 1: Share of intermediate inputs from "other business activities" sector in the total production value in Germany (1995-2005)



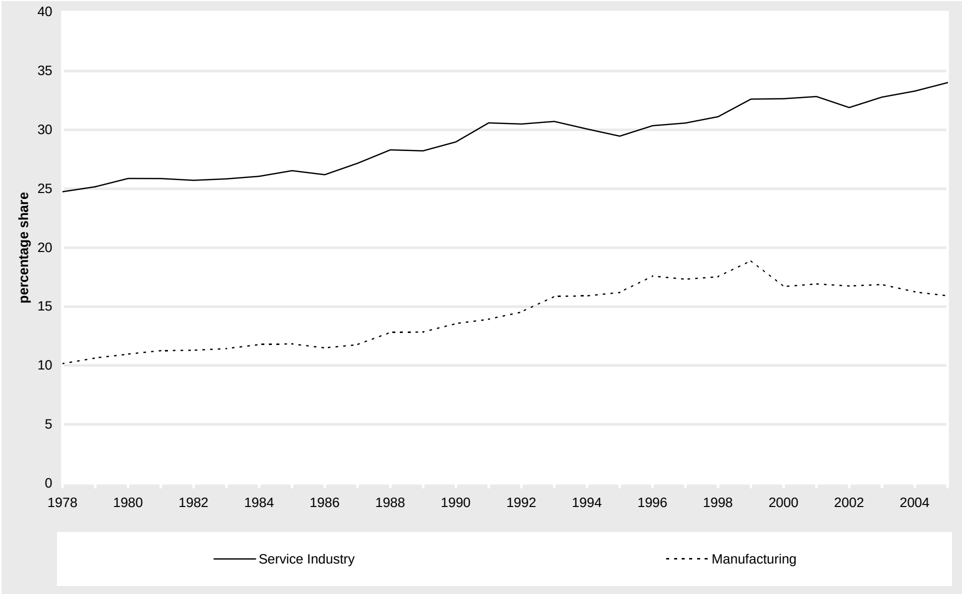
Source: Based on input-output tables provided by the Germany Statistical Office and authors' calculations.

Figure 2: Share of intermediate inputs from "corporate service sector"* in the total production value in Germany (1995-2005)



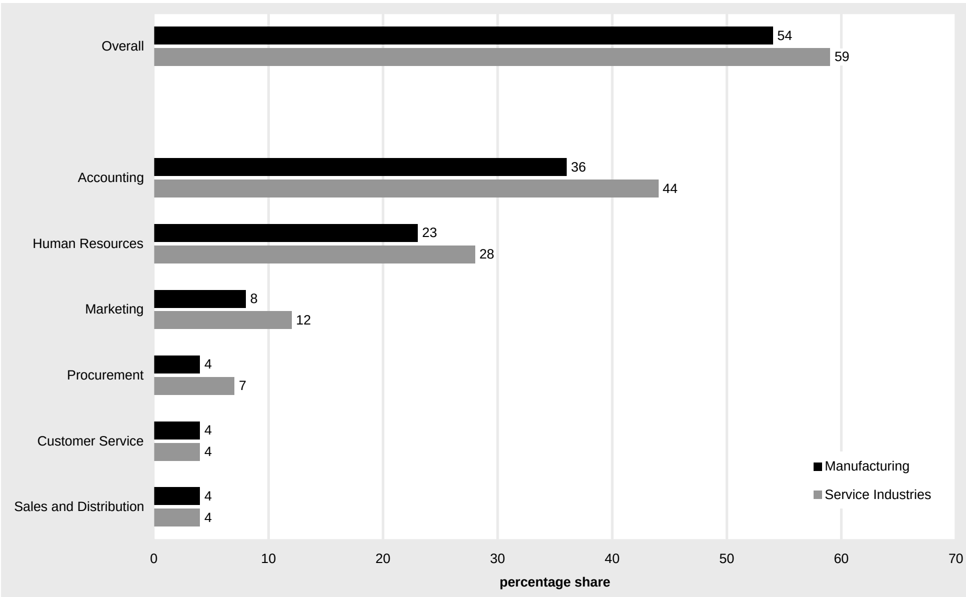
Note: *The "corporate service sector" comprises the sectors "computer and related activities" (NACE 72), "research and development" (NACE 73) and "other business activities" (NACE 74).
Source: Based on input-output tables provided by the Germany Statistical Office and authors' calculations.

Figure 3: Share of intermediate service inputs at total value added in Germany (1978-2005)



Source: EU-Klems 2008 and authors' calculations.

Figure 4: Share of firms outsourcing business processes in Germany 2007



Source: ZEW ICT-survey, first quarter 2007.

Table 1: Descriptive Statistics

Industry	All Firms		Outsourcing Firms		Non-Outsourcing Firms	
	Mean	Median	Mean	Median	Mean	Median
sales	54071.27	7008.61	82827.79	10866.67	32807.15	4833.33
value added	23379.33	3270.91	34541.41	4932.43	15125.47	2496.82
employees	223.72	48.75	305.41	60.83	163.31	38.33
capital	153961.96	2933.57	265760.78	4334.97	71291.86	2003.06
log value added	8.08	8.03	8.53	8.44	7.75	7.65
log employees	3.92	3.83	4.18	4.08	3.73	3.53
log capital	8.13	7.97	8.55	8.36	7.82	7.60
value added p. employee	91.15	62.90	114.06	67.20	74.21	60.89
capital p. employee	2261.49	60.95	3215.86	68.89	1555.77	57.61
Number of firms	701		298		403	

Note: The figures are calculated at the means and medians of the unweighted firms' means over time. Monetary values are in 1,000 Euros in prices of 2000. **Source:** ZEW ICT-survey.

Table 2: Share of Observations by Industry

Industry	All Firms	thereof ... Outsourcing	thereof ... Non-Outsourcing
consumer goods	7.9	45.5	54.6
chemical industry	6.3	61.4	38.6
other raw materials	7.6	39.6	60.4
metal and machine construction	13.4	41.5	58.5
electrical engineering	8.7	32.8	67.2
precision instruments	9.3	33.9	66.2
automobile	5.3	56.8	43.2
wholesale trade	4.0	57.1	42.9
retail trade	7.4	55.8	44.2
transport and postal serv.	7.0	53.1	46.9
electronic process. and telecom.	10.6	25.7	74.3
technical services	7.4	34.6	65.4
other business-related serv.	5.1	41.7	58.3
Total	100.0	42.6	57.4

Source: ZEW ICT-survey.

Table 3: Comparison of Mean Labour Productivity

		Quantile				
	N	**10%**	**50%**	**90%**	**Mean**	**Std.Dev.**
Outsourcing Firms						
Labour Productivity	298	40	67	227	114.063	130.931
Non-Outsourcing Firms						
Labour Productivity	403	27	61	146	74.208	54.417

t-test on the equality of the means of **Labour Productivity**

H_0: mean(w/ BPO) - mean(w/o BPO) = diff = 0 $\rightarrow t = 5.5028$

H_1: diff $\neq 0 \rightarrow [\ p > |t|\ ] = 0.0000$

t-test on the equality of the means of **log Labour Productivity**

H_0: mean(w/ BPO) - mean(w/o BPO) = diff = 0 $\rightarrow t = 6.5412$

H_1: diff $\neq 0 \rightarrow [\ p > |t|\ ] = 0.0000$

Note: Labour productivity is value added per employee in 1,000 Euro in prices of 2000. It is calculated at the means and medians of the unweighted firms' means over time. **Source:** ZEW ICT-survey.

Table 4: Estimation Results – OLS and Random Effects

	(1)	**(2)**	**(3)**
	OLS	**OLS**	**Random Effects**
Labour	0.9641***	0.9577***	0.9946***
	(0.0233)	(0.0224)	(0.0642)
Capital	0.0778***	0.0723***	0.0471
	(0.0180)	(0.0170)	(0.0539)
BPO	—	0.2571***	0.2690***
		(0.0466)	(0.0491)
East Germany	-0.2346***	-0.2131***	-0.1928***
	(0.0624)	(0.0612)	(0.0597)
Constant	3.4538***	3.4404***	4.6081***
	(0.2179)	(0.2300)	(0.3410)
R^2	0.8418	0.8466	0.8469
Number of observations	2371	2371	1671
Number of firms			700

Note: *,** and *** indicate significance at the 10%, 5% and 1% level respectively. Robust standard errors are reported. **Source:** ZEW ICT-survey and own calculations.

Table 5: Estimation Results – SYS-GMM

	(1) Basic	(2) All	(3) Manufact.	(4) Services
Labour	0.8060***	0.8423***	0.7238***	0.9580***
	(0.1543)	(0.1426)	(0.1932)	(0.1462)
Capital	0.2569**	0.2240*	0.1010	0.0599
	(0.1254)	(0.1340)	(0.2062)	(0.0841)
BPO	—	0.2053**	0.2721**	0.3281***
		(0.0858)	(0.1075)	(0.1039)
East Germany	-0.1786**	-0.1634**	-0.2506**	-0.1808
	(0.0880)	(0.0810)	(0.0982)	(0.1117)
Constant	2.9602***	3.0126***	4.4526***	3.9048***
	(1.0392)	(1.0277)	(1.4946)	(0.7575)
AR(1) (p-values)	0.0000	0.0000	0.0000	0.0010
AR(2) (p-values)	0.5680	0.5401	0.2748	0.5633
Hansen J-Test (p-values)	0.5600	0.5647	0.3432	0.6139
R^2	0.8229	0.8334	0.8663	0.7995
Number of instruments	63	64	40	36
Number of observations	2371	2371	1383	988
Number of firms	700	700	409	291

Note: *,** and *** indicate significance at the 10%, 5% and 1% level respectively. Robust standard errors are reported.
Source: ZEW ICT-survey and own calculations.

Table 6: Industry Classification

Industry	Explanation	NACE
consumer goods		
	manufacture of food products, beverages and tobacco	15-16
	manufacture of textiles and textile products	17-18
	manufacturing of leather and leather products	19
	manufacture of wood and wood products	20
	manufacturing of pulp, paper and paper products; publishing and printing	21-22
	manufacturing n.e.c.	36-37
chemical industry		
	manufacture of coke, refined petroleum products and nuclear fuel	23
	manufacture of chemicals, chemical products and man-made fibres	24
other raw materials		
	manufacture of rubber and plastic products	25
	manufacture of non-metallic mineral products	26
	manufacture of basic metal	27
metal and machine construction		
	manufacture of fabricated metal products (except machinery and equipment)	28
	manufacture of machinery and equipment n.e.c.	29
electrical engineering		
	manufacture of office machinery and computers	30
	manufacture of electrical machinery and apparatus n.e.c.	31
	manufacture of radio, television and communication equipment and apparatus	32
precision instruments		
	manufacture of medical, precision and optical instruments, watches and clocks	33
automobile		
	manufacturing of transport equipment	34-35
wholesale trade		
	wholesale trade and commission trade (except of motor vehicles and motorcycles)	51
retail trade		
	sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel	50
	retail trade (except of motor vehicles and motorcycles), repair of personal and household goods	52
transportation and postal services		
	land transport, transport via pipeline	60
	water transport	61
	air transport	62
	supporting and auxiliary transport activities; activities of travel agencies	63
	post and courier activities	64.1
electronic processing and telecommunication		
	computer and related activities	72
	telecommunications	64.2
technical services		
	research and development	73
	architectural and engineering activities and related technical consultancy	74.2
	technical testing and analysis	74.3
other business-related services		
	real estate activities	70
	renting of machinery without operator and of personal and household goods	71
	legal, accounting, book keeping and auditing activities; tax consultancy; market research and public opinion pools; business and management consultancy; holdings	74.1
	advertising	74.4
	labour recruitment and provision of personnel	74.5
	investigation and security services	74.6
	industrial cleaning	74.7
	miscellaneous business activities n.e.c.	74.8
	sewage and refuse disposal, sanitation and similar activities	90