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Wagner, Joachim; Vogel, Alexander

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Alexander Vogel and Joachim Wagner

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Innovation and Exports of German Business Services Enterprises: First evidence from a new type of firm data*

Alexander Vogel and Joachim Wagner

Leuphana University Lueneburg; Leuphana University Lueneburg and IZA, Bonn
[alexander.vogel@leuphana.de; wagner@leuphana.de]

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Abstract:
This paper contributes to the literature by providing the first evidence on the link between innovation activities (measured by the share of engineers and scientists in the workforce) and exports of German business services firms based on a large representative longitudinal sample of enterprises. The data combine for the first time information at the firm-level that is taken from data produced by the Statistical Offices and by the Federal Labour Agency. We document that R&D activities are positively linked with exports, and that this link is present when observed firm characteristics (including firm size, productivity, and human capital intensity) and unobserved time-invariant firm characteristics are controlled for. From an economical point of view the effect is, however, rather small. Furthermore, we find some evidence for self-selection of innovative services firms on export markets. We have to admit, however, that the panel is too short, and that the number of firms that start to export and start to perform R&D during the period under investigation is too small, for any convincing attempt to investigate the direction of the causal link between exports and innovation activities.

Keywords: Innovation, export, business services, Germany
JEL classification: F14

* This paper is part of the project *KombiFiD – Kombinierte Firmendaten für Deutschland* that is financially supported by the German Ministry for Education and Research (BMBF). It is a joint project of the Institute of Economics of Leuphana University Lueneburg, the research data centres of the German Federal Statistical Office and the statistical offices of the German federal states, the Institute of Employment Research of the Federal Employment Agency and the research department of the German Central Bank. While members of the KombiFiD-team from all institutions contributed to the construction of the data set used in this paper we alone are responsible for the results presented here and the conclusions drawn.

1. Motivation

The service sector becomes more and more important in Germany[1] and services are considered as an engine of growth (Statistisches Bundesamt 2009). This holds true especially for international trade in services. In 2010 Germany was the second largest exporter of commercial services after the United States (World Trade Organization 2011, Appendix Table 2). Reliable information on the characteristics of exporting and non-exporting firms is important to guide theorists and policy makers in an evidence based way. How do these exporting firms differ from firms that sell their services on the national market only? What makes a successful exporter? Are there easily observable characteristics of a firm that are closely related to success on international markets? If this is the case, policy measures might be designed that either target firms with these characteristics to foster export activities, or that help firms that do not yet have these characteristics to build them up and to become the successful exporters of the future. If there are no such characteristics, this casts doubts on the adequacy of specially targeted export promotion programs with a focus on selected groups of firms.

While the characteristics of exporting German firms from manufacturing industries have been investigated empirically in a large number of studies using micro data for firms (establishments or enterprises)[2] micro-econometric studies on exports of services firms are still rare, not least due to the fact that suitable representative longitudinal firm level data became available only recently (see Vogel

[1]This is true for other advanced economies, too; see Jorgensen and Timmer (2011) and Eichengreen and Gupta (2011).

[2] Wagner (2011a) provides a synopsis of 51 micro-econometric studies on exports and firm characteristics in Germany published between 1991 and 2011; see also Wagner (2011b) for a recent investigation that overcomes many of the shortcomings of earlier studies.

2009).Table 1 provides a synopsis of eight micro-econometric studies on exports and firm characteristics that use firm level data from German services industries.[3] For each study a short description of the sample used is given, the methods applied in the empirical investigation are listed and the core findings are summarized.

[Table 1 near here]

The studies by Ebling and Janz (1999), Lejpras (2009), and Arndt, Buch and Matthes (2012) are based on small samples; these studies and the studies by Kelle and Kleinert (2010) and by Kelle et al. (2012) use cross section data only. Panel data for a large and representative sample of enterprises - that allow to control for unobserved time-invariant firm characteristics and to look at the direction of causality between firm characteristics and exports - are only used in Vogel and Wagner (2010), Eickelpasch and Vogel (2011), and Vogel (2011).

Based on theoretical hypotheses derived in the literature and empirical evidence reported for firms from other countries Eickelpasch and Vogel (2011) investigate empirically the determinants of export behavior of German services firms in detail. The main hypotheses tested and the results can be summarized as follows:

In line with previous studies, Eickelpasch and Vogel (2011) expect size to have a positive relation to the export behaviour of the enterprises: Large firms have more resources to enter foreign markets than small companies have. A second

[3] The studies are listed in chronological order by year of publication and in alphabetical order of the (first) author within a year. Purely descriptive studies and studies that include only dummy variables for services industries (but no separate estimations for services firms) are not included. See Kelle (2012) for an empirical investigation of German manufacturers as services exporters.

considered variable is productivity: Based on the argument of additional costs caused by exporting that can only be absorbed by more productive enterprises, a positive effect of productivity on export behaviour is expected. Furthermore, human capital is expected to have a positive impact on the export behaviour of firms, due to the fact that skills are positively related to the technological capabilities of the firm and that a high level of interaction with clients abroad requires good language skills and a high level of intercultural competence of the employees, especially in the service sector. In addition to size, productivity and human capital, Eickelpasch and Vogel (2011) control for further variables like the experience on the national market (to include the idea of the stage model of internationalisation) or the investment per employee (as a proxy for the expectations of growth), too.

Looking at the main findings, the results show a positive relationship between export intensity and size, productivity and human capital. However, when it is controlled for unobserved heterogeneity the significance for productivity and human capital disappears and only size has a positive significant effect. This indicates that the influence of productivity and human capital on export performance is linked to unobserved factors that could not be investigated with the data from the German business services statistics panel.

The investigation of Eickelpasch and Vogel (2011) is mainly limited by the fact that the German business services statistics panel suffer from a lack of information on activities related to innovation, a firm characteristic that – along with size, productivity and human capital – is seen as an important determinant of export behaviour in the literature. Innovation is expected to be positively related to export performance for two reasons. First, innovating firms can be expected to be more productive than non-innovating firms, and more productive firms are known to have a

higher probability of exporting and a higher share of exports in total sales. Second, business services firms that invest in Research and Development (R&D) activities and employ experts working in R&D can be expected to develop innovative solutions to problems faced by customers not only at home but in foreign countries, too. This leads to a positive effect of R&D on exports by business services firms. Empirical evidence reported for German services firms by Ebling and Janz (1999), Lejpras (2009), and Arndt, Buch and Matthes (2012) is fully in line with these arguments. This evidence is, however, based on small samples of cross-section data only.

To the best of our knowledge international studies that consider the link between exports and innovation in the service sector are only available for the US (Love and Mansury 2007), the UK (Gourlay, Seaton and Suppakitjarak 2005) and for Canada (Chiru 2007). Overall, these studies show, that in the business services sector innovativeness (e.g., measured by an innovator dummy or the intensity of innovation expenditures) is predominantly positively associated with the probability of exporting (Gourlay, Seaton, & Suppakitjarak 2005, Love & Mansury 2007) and the export intensity (see Chiru 2007, Gourlay, Seaton and Suppakitjarak 2005, but, conversely, Love & Mansury 2007 show a negative effect). However, Love and Mansury (2007) and Chiru (2007) use only cross-sectional data and Gourlay, Seaton and Suppakitjarak (2005) estimate only probit and tobit regressions without controlling for unobserved heterogeneity.

This paper contributes to the literature by providing the first evidence on the role of innovation activities for exports of German services firms based on a new large representative longitudinal sample of enterprises. While we are able to control for unobserved heterogeneity to our empirical models, we have to admit that the panel is too short, and the number of firms that start to export and start to perform

R&D during the period under investigation is too small, for any convincing attempt to investigate the direction of the causal link between exports and innovation activities.

A number of recent studies, summarized and extended in Aw, Roberts and Xu (2011), argues that the technology and export decisions of a firm are interdependent, and that both channels may endogenously affect the firm's future productivity. Our data are not rich enough to estimate a dynamic, structural model of exporting and R&D investment a la Aw, Robert and Xu (2011). Our aim is much more modest. We test whether there is a positive correlation between exports and R&D in German business services firms when it is controlled for unobserved time invariant firm characteristics and we investigate whether the evidence on the role of other variables included in the empirical model for services firms' exports by Eickelpasch and Vogel (2011) differs when the model is augmented by including information on R&D activities from a newly available data set.

That said, the rest of the paper is organized as follows. Section 2 introduces the new data. Section 3 presents an overview about the export participation in the West German business services industries, a comparison of exporting and non-exporting business services firms as well as the results of the investigation concerning the determinants of export intensity. Section 4 concludes.

2. Data

The empirical investigation uses data for enterprises[4] from business services industries[5] that come from two sources. The first source is the German business

[4] Data are for legal units (enterprises, or *Unternehmen*), not for local production units (establishments, or *Betriebe*). In this paper we use the term firm as a synonym for enterprise.

services statistics panel which contains information on more than 20,000 business services enterprises per year (see Vogel (2009) for more detailed information about the dataset). These data, that were used before by Vogel (2011), Eickelpasch and Vogel (2011) and Vogel and Wagner (2010), are the source for the following variables:

First, we use the German business services statistics panel to generate our variables concerning the export behaviour of the firms. These are the export activity as well as the export intensity, where export activity is specified as a binary variable indicating the "export status" of the enterprise (1 if exporting, 0 if not). The export intensity captures the export behaviour by the percentage of exports to total turnover.

Second, we follow Eickelpasch and Vogel (2011) and generate all independent variables they used in their analyses from the German business services statistics panel. These variables cover information about the employees, productivity, human-capital, part-time work, legal status, the experience of the national market, investment and goods and services for resale of the firms.

Employees are covered by the number of persons employed and its squared value. The productivity variable is measured as labour productivity in terms of value added per employed person. The human capital of the firms is captured in form of labour costs, made up of wages, salaries and employers' social security costs per employee. More appropriate would be the relation between labour costs and the hours worked. However, the data set does not contain information on hours worked.

[5]Business services industries are defined in this paper as NACE divisions 72 (e.g., hardware and software consultancy, data processing, software publishing and database activities), 73 (i.e., research and development) and 74 (e.g., business, management and tax consultancy, advertising, legal activities, market research, and architectural and engineering activities).

In order to control whether using the number of employees is misleading, we employ available information on the proportion of employees who work part time.

To include the legal status of the firms we use three dummy variables, one if the firm is owned by a sole proprietor, one if the firm is a business partnership and one if the company is a limited liability company, such as a stock company or a limited company.

The capability of firms to operate nationwide is captured by the number of subsidiaries within Germany and investment activities are measured as the relationship of gross investment to the number of employees.

To control for a possible effect of products and services that are not produced by the company itself on the export and export intensity decision, we use the share of turnover represented by goods and services that were purchased explicitly for resale in the same condition as received in our model. Unfortunately, we cannot distinguish between purchased goods for resale and purchased services for resale. Thus we cannot directly control for the effect that high export intensity might reflect a high share of purchased goods for resale (that might be easier to export than services). However, we use this control variable at least as a proxy for this effect.

Finally, we use the data from the German business services statistics panel to generate a set of dummy variables of the economic activities (2-digit, NACE divisions 72, 73 and 74) of the firms.

As said, unfortunately, the German business services statistics panel has no information on either the share of employees engaged in research and development (R&D), or on the amount of money spent on R&D activities, or on the introduction of innovative services.

The second source of data is the Establishment History Panel (*Betriebs-Historik-Panel*).[6] Details aside, this data set is built from individual level information for employees covered by social security.[7] In a first step for each year from 1975 onwards information for all employees working in a local production unit (establishment) was aggregated, and this is the standard version of the Establishment History Panel. In this study a different version of the Establishment History Panel is used. Here for multi-establishment enterprises information from all establishments of the enterprise was aggregated in a second step. The result is a data set with detailed information about the characteristics of the employees (covered by social security) in each enterprise in a year.

From these data we do not have any direct information on the number of employees working in R&D. However, information on the composition of the workforce includes, among others, the number of engineers and natural scientists in the firm. These highly qualified employees can be expected to work on the development of innovative solutions that will eventually lead to improved or completely new ways to perform business services. Therefore, the share of

[6] For an introduction to the Establishment History Panel see Spengler (2008); a detailed description of the current version is Hethey-Maier and Seth (2010).

[7] "All employees who are subject to at least one of the following compulsory insurances are liable to social security: health insurance, long-term care insurance, pension insurance, unemployment and accident insurance. However, not liable to social security and thus not included in the data are civil servants, conscripts, those doing alternative civilian service, self-employed, judges, scholars, students, pensioners, clergy and others." (Spengler 2008, p. 502)

engineers and natural scientists in all employees can be viewed as a suitable measure for the R&D intensity and the innovativeness of an enterprise.[8]

The German business services statistics panel is prepared by the German statistical offices. The data can be accessed for scientific research via the Research Data Centres of the Federal Statistical Office and the Statistical Offices of the Federal States (see Malchin and Voshage 2009). The Establishment History Panel is build from administrative data by the Research Data Centre of the Federal Employment Agency at the Institute for Employment Research. The data can be accessed via this Research Data Centre for scientific research (see Spengler 2008).

Linking the confidential firm level data across the borders of the data producers, however, is difficult. Details aside, it is technically not easy (but not impossible either) and it is legal only if the firm agreed in written form. The basic idea of the project *KombiFiD* (an acronym that stands for *Kombi*nierte *Fi*rmendaten für *D*eutschland, or combined firm level data for Germany) that is in detail described on the web (see www.kombifid.de) is to ask a large sample of firms from all parts of the German economy to agree to match confidential micro data for these firms that are kept separately by three data producers (the Statistical Offices, the Federal Employment Agency, and the German Central Bank) in one data set. These matched data are made available for scientific research while strictly obeying the data protection law, i.e. without revealing micro level information to researchers outside

[8] To support this argument consider the following evidence from a sample of 4,588 German enterprises from manufacturing industries that has information on both the share of the employees in R&D and the share of engineers and natural scientists in all employees. The mean values for both shares are more or less identical (2.39 percent and 2.41 percent, respectively), and the same holds for the estimated marginal effects of both shares on the propensity to export in an empirical model that controls for firm size, physical capital intensity, human capital intensity and a set of detailed industry controls.

the data producing agencies. In *KombiFiD* 54,960 firms were asked to agree in written form to merge firm level data from various surveys and administrative data for the reporting years 2003 to 2006. 30,944 firms replied and 16,571 agreed. These 16,571 firms are in the *KombiFiD Agreement Sample*.

The sample of enterprises used in the empirical investigation performed here consists of all firms from business services industries in West Germany[9] in the *KombiFiD Agreement Sample* for which information from both data sources[10] – the German business services statistics panel and the Establishment History Panel - could be linked in the KombiFiD project for 2003 to 2006. Due to the fact that the German business services statistics do not provide information about the export activities of small firms, only firms with an annual sum of turnover and other operational income greater than or equal to €250,000 are considered for the analyses. Further, the analysis includes only firms with one or more wage and salary earners. This leads to a data set with 8,474 observations from 2,299 firms.

Some firms reported extremely high or low values of the considered variables. To avoid bias of the descriptive overview and the econometric estimations by outliers, firms that belong to the 1st or 99th percentile of the wage or value added distribution

[9] The sample is limited to firms from West Germany. There are large differences between enterprises from West Germany and the former communist East Germany even many years after the unification in 1990. Therefore, an empirical study should be performed separately for both parts of Germany. The *KombiFiD Agreement Sample* for East German business services firms, however, contains only a small number of firms, and this sample turned out to be not representative for the population of firms in a replication study that compares results based on the complete data and data from the *KombiFiD Agreement Sample* (see Vogel and Wagner 2012).

[10] Data on foreign direct investments and balance sheet data from the German Central Bank are not used in this study. The KombiFiD sample including data from this source is rather small and consists mostly of large exporting firms; therefore, these data are not suited for an empirical investigation of export participation and export performance.

or to the 99th percentile of the number of persons employed, investment or purchased goods and services for resale distribution are excluded from all computations.[11] This leads finally to a data set with 7,862 observations from 2,069 West German business services firms.

To sum up, the definition of all above-mentioned variables that we use in our analyses as well as their source are presented in Table 2.

[Table 2 about here]

3. Results from the empirical investigation

3.1 Export Participation

The firms' export activities are measured by the export intensity, defined as the percentage of exports in total turnover. The share of exporters in all business services enterprises in our sample was about 23 percent in 2003 and about 28 percent in 2006. Table 3 shows that in both years the distribution of the export intensity was highly skewed – most of the exporters sold a relative small share of their total production abroad, and only a few firms exported a very high share.

[Table 3 about here]

[11] Tables that present all results based on the original dataset without outlier control are available from the first author on request.

3.2 Comparison of Exporters and Non-Exporters

This section compares exporting and non-exporting enterprises. In a first step we look at the mean and the standard deviation of all variables for the groups of exporting and non-exporting firms in the unbalanced panel dataset for 2003 to 2006. In a second step we take a closer look at the difference of the share of engineers and scientists by estimating the exporter premium and by testing for self-selection effects into export markets.

Table 4 indicates that exporting enterprises are on average more productive, pay higher wages and have a lower share of part-time employees than non-exporting enterprises. Furthermore, the share of sole proprietors and enterprises with no subsidiary is higher among non-exporting enterprises than among those that do export. The share of turnover from purchased goods and services for resale is on average higher at exporting firms and the gross investment per person employed is on average slightly higher in exporting firms, too. Contrary to our expectations, non-exporters are on average lager (in terms of persons employed) than exporters.[12]

[Table 4 about here]

Table 4 shows that on average the share of engineers and scientists is 3.8 percent in non-exporting firms and 6.5 percent in exporting firms. To test whether this very large difference holds even if we control for other firm characteristics in a next step the so-called exporter premium is estimated. This exporter premium shows the ceteris paribus difference of the share of engineers and scientists between

[12]A possible explanation may be the fact that large business services firms are oversampled in the KombiFiD Agreement Sample (see Vogel and Wagner 2012).

exporting and non-exporting enterprises, controlling for enterprise size (number of persons employed and its squared value) plus the sector of economic activity at the 2digit-level and the year of observation by including a full set of interactions terms of year and sector. The results are presented in Table 5.

[Table 5 about here]

In the pooled regression we find a positive exporter premium of 2.7 percentage points that is economically large and statistically highly significant. However, after controlling for unobserved heterogeneity by including fixed enterprise effects, no significant difference concerning the share of engineers and scientists between exporters and non-exporters is found. This insignificant exporter premium in the fixed effects model (compared to the pooled regression) suggests that the exporter status variable is positively correlated with the unobserved effect.

The exporter premium reported above does not provide any information about the direction of causality between exporting and the share of engineers and scientists. In the following we test whether the exporter premium reflects self-selection effects by analysing the differences between exporter starters and firms that continue to serve the national market only, several years before the export-starters begin to export.[13] Table 6 presents the pre-entry premia of enterprises that began to

[13] In addition to the self-selection hypothesis, it could be hypothesised that exporting improves the share of engineers and scientists. However, because the dataset covers only a short time period and only less than 50 firms show the export pattern (no export in 2003 and 2004 but export activities in 2005 and 2006) that is required for the test (see Table A1 in the appendix), it is not meaningful to test this learning-by-exporting hypothesis.

export in 2006 for two years before starting to export, one year before starting to export and at the starting year.

[Table 6 near here]

The regression coefficients indicate that even in the periods before they begin to export, prospective exporters have on average a share of engineers and scientists that is nearly 2 percentage points higher than in firms that do not start to export. However, these pre-export premia are not statistically significant at any conventional level. One reason may be the small number (less than 100) of West German business services enterprises included in our sample that began to export in the considered period.

3.3 Determinants of export intensity

To investigate the determinants of the export intensity we apply an approach that uses all available information about export behaviour – whether a firm exports or not, and how large the share of exports in total sales is - by applying the fractional probit estimator developed by Papke and Wooldridge (1996). This approach was introduced into the micro-econometrics of exporting by Wagner (2001) where details on the advantage of this method compared to a tobit approach or a two-step approach (that estimates an equation for export participation in a first step and the share of exports in total sales for exporting firms in a second step) are discussed. Suffices it here to say that a fractional model is tailor made for a sample where the dependent variable is a proportion that is by definition limited between zero and one (or zero and one

hundred percent) and where a probability mass is located at zero (because a large share of firms does not export at all).

Papke and Wooldridge (2008) showed that in a balanced panel dataset (with large cross-sectional dimension and only few time periods) time-invariant unobserved heterogeneity can be controlled for by adding the time averages of all explanatory variables to the fractional probit approach described above. Wagner (2010) applied this fractional probit panel approach to investigate the links between exports and firm characteristics for German manufacturing firms.

In line with this approach, we use a balanced panel dataset for the years 2003 to 2006 and estimate both a variant of the empirical model that does not control for unobserved time-invariant heterogeneity and a second variant where the time averages of all explanatory variables are added to control for unobserved heterogeneity. Using a balanced panel subset with complete information on all variables in each year and each firm leads to a reduced data set with 6,908 observations from 1,727 firms.[14]

First we replicate the results of Eickelpasch and Vogel (2011) by using only the variables from the German business services statistics panel. In a second step we add the share of engineers and scientists from the Establishment History Panel to consider also the R&D intensity and the innovativeness of the firms in our model.

Table 7 presents the marginal effects for an average firm as well as the p-values (based on cluster robust standard errors) of pooled fractional probit

[14] To check the robustness of the results of the balanced panel dataset we run the fractional probit without time averages of all exogenous variables also on the unbalanced panel dataset. The results are almost identical concerning the size, signs and significance of the marginal effects (see Table A2 in the appendix). Descriptive panel statistics of the balanced dataset can be found in Table A3 in the Appendix. These statistics indicate that the export intensity variable shows a considerable high within variation.

regressions of the export intensity (share of exports on total turnover) on several regressors.[15]

[Table 7 near here]

Based on the pooled fractional probit without control for unobserved time invariant firm characteristics (see second column of Table 7) we find in line with Eickelpasch and Vogel (2011) a positive significant correlation between the export intensity and human capital (measured by average wages) and the share of turnover from purchased goods and services for resale of the firms. Furthermore, private companies and public limited companies have a significant higher probability to choose a higher volume of exports than sole proprietors. The marginal effect of the share of part-time workers is negative and statistically significant, while the investment per employee has no statistically significant effect on the export intensity decision.

In contrast to Eickelpasch and Vogel (2011) we do not find a significant positive correlation between the export intensity and size (in terms of persons employed) and labour productivity. Concerning size a possible explanation could be that large business services firms are oversampled in the KombiFiD Agreement Sample (see Vogel and Wagner 2012). Regarding the productivity variable it has to be mentioned, that the p-value of 0,130 indicates that the effect is close to be weakly significant at the 10% level. Furthermore, the effect of the productivity variable seems to be influenced by our trimming method to control for outliers. Based on the results

[15] The fractional probit regressions are estimated with the Stata command for generalized linear models (Stata 10).

from the original data (without trimming) productivity shows a positive marginal effect that is highly statistical significant at the 1% level, while the signs and significance level of the other variables are almost identical.

When we control for unobserved time-invariant effects by adding the time averages of the explanatory variables, the statistical significant effects of most variables disappear (see fourth column of Table 7). Only the negative effect of the share of part-time workers is still statistically significant. Overall, this is again consistent with the results of Eickelpasch and Vogel (2011). After controlling for unobserved heterogeneity they find only significant positive effects of size and the share of turnover from purchased goods and services for resale. Thus, there seems to be further time-constant factors that are correlated with the considered variables and could not be observed in the estimation.

In the next step we extend the study of Eickelpasch and Vogel (2011) by adding the share of engineers and scientists as a proxy for the R&D activities of the firms to the analysis. When we include information on innovation in the estimation of the export intensity this has almost no effect on the size, signs and significance levels of the marginal effects of the other variables. This is true for both the pooled fractional probit with and without controlling for unobserved heterogeneity (see third and fifth column of Table 7). For the share of engineers and scientists we find a statistically significant positive correlation with the export intensity. This is true even if unobserved time invariant firm characteristics are controlled for by including the time averages of all exogenous variables.

To facilitate the interpretation of the economic relevance of the reported results, we predict the export intensity (based on the pooled fractional probit regressions presented above) for an average firm and show how the predicted export

intensity differs for different levels of the share of engineers and scientists. Based on the model without control for unobserved heterogeneity the predicted export intensity for a share of engineers and scientists of ten percent is only 0.5 percentage points higher than the predicted export intensity in the case of no engineers and scientists. Based on the model with control for unobserved heterogeneity the difference of the predicted export intensity between a share of engineers and scientists of zero and ten percent is only slightly higher (0.8 percentage points). Thus, we can summarise that the size of the effect is rather small (see Figure 1).

[Figure 1 near here]

4. Concluding remarks

This paper is the first empirical study that uses panel data for a large and representative sample of enterprises from business services industries in Germany to investigate the links between exports and innovation activities (measured by the share of engineers and scientists in the workforce). We document that R&D activities are positively linked with exports, and that this link is present when observed firm characteristics (including firm size, productivity, and human capital intensity) and unobserved time-invariant firm characteristics are controlled for. From an economical point of view the effect is, however, rather small.

Furthermore, we find evidence that in the years preceding the export start R&D activities are higher in firms that will start to export in future years than in firms that will continue to sell their services on the home market only. Although our findings here are based on a comparably small number of export starters only (and, therefore, on regression coefficients that are not statistically significantly different from zero at

any conventional level) we interpret this as evidence for self-selection of innovative services firms on export markets.

Whether experience on export markets stimulates R&D activities (via contacts with customers and competitors on foreign markets, or higher competitive pressure), too, cannot be tested with the data at hand due to the short time period covered and the small number of export starters in business services industries in our sample that can be monitored over a sufficiently long period after the start.[16]

Unfortunately, time cannot heal this. The unique new data set used here (that is described in section 2) cannot grow over time by adding new waves from years after 2006, because there will be no second attempt to ask firms for their written consent to match information kept inside the German Statistical Office with data from the Establishment History Panel that is build from administrative data by the Research Data Centre of the Federal Employment Agency in the Institute for Employment Research and that are kept in that institute. However, by demonstrating that R&D activities and export activities are positively linked in enterprises from German business services industries, and by pointing out that both the direction of causality and the strength of the links are not yet well understood not least because of limitations of the data at hand, this paper might stimulate future efforts to built a panel data set that is tailor made for the investigation of these important topics.

[16] The small number of years covered by the sample furthermore hinders the use of micro-econometric methods that test for a causal link between R&D activities and exports by an IV approach that applies GMM (General Methods of Moments) first difference regressions.

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Tables

Table 1: Synopsis of empirical studies on firm characteristics and export activities in German services fims[1]

Study	Data	Method	Core findings
Ebling and Janz (1999)	Mannheim Innovation Panel in the Service Sector, wave 1997 (N = 1,010)	Probit; simultaneous probit	Innovation activities and human capital positively related to exports; export activities do not enforce innovation activities
Lejpras (2009)	Survey of 876 services SMEs In East Germany in 2004	Probit	Firm size and introducing a completely novel product relate significantly positively to exports of SMEs
Kelle and Kleinert (2010)	Transaction level data set of trade in services merged with MIDI data from Deutsche Bundesbank for 2005. Comprehensive data for Germany. (N = 209,060 observations for 33,756 firms	Descriptive statistics	Rather few firms from all sectors trade services. Bulk of exports and imports concentrated in few global and diversified firms
Vogel and Wagner (2010)	Sample of business services firms with annual turnover over 250,000 €, 2003 – 2005 (N – ca. 20,000 / year)	OLS; fixed enterprise effects; Fractional logit; generalized propensity score; dose response function	Negative profitability differential of services exporters compared to non-exporters that is statistically significant but small. Self-selection of less profitable firms into exporting. No positive causal effect of exporting on profitability in services firms
Eickelpasch and Vogel (2011)	German business services statistics panel 2003 – 2005 (N = ca. 20,000 / year)	Descriptive statistics; t-test for difference in mean; Probit; fractional probit with and without fixed firm effects	Positive relationship between export performance and size, productivity and human capital intensity in models without fixed firm effects; with fixed effects only firm size significant
Vogel (2011)	German business services statistics panel 2003 – 2005 (N = ca. 20,000 / year)	Descriptive statistics; OLS; fixed effects regression	Exporting firms are larger, more productive and pay higher wages, but have lower turnover profitability, in models without fixed firms effects. Evidence for self-selection of larger, more productive firms paying higher wages into exporting

Arndt, Buch and Mattes (2012)	IAB Establishment Panel waves 2004 – 2006; sample of establishments from services used: N = 1,733	Two-step Heckman selection model for export decision and share of exports in total sales; Probit, OLS	Exports positively related to firm size, productivity and R&D
Kelle, Kleinert, Raff and Toubal (2012)	Transaction level data set of trade in services merged with MIDI data from Deutsche Bundesbank for 2005. 9,848 observations (each one a combination of a firm, service product group, destination country, and export channel)	Probit, generalized ordered logit, multinomial probit	Productivity is both a statistically significant and economically important determinant of export participation

[1] The studies are listed chronologically by the date of publication and in alphabetical order of the (first) author within a year. Purely descriptive studies and studies that include only dummy variables for services industries (but no separate estimations for services and manufacturing firms) are not included.

Table 2: Definition of the variables

Variables	Definition (dimension)	Source
Export activity	Exporter (1), non-exporter (0)	1)
Export intensity	Exports (% of turnover)	1)
Share of engineers and scientists	Share of engineers and scientists in total number of employees (in %)	2)
Employees	Persons employed (number)	1)
Employees squared	Persons employed squared (number)	1)
Productivity	Value added per person employed (in €)	1)
Human capital	Labour cost per employee (in €)	1)
Part-time work	Part-time employees (% of persons employed)	1)
Legal status	Private company (2), public limited company (3), other (4) (Dummies); reference group: Sole proprietor (1)	1)
Experience on the national market	Subsidiaries in Germany (1 to 2, 3 or more) (Dummies); reference group: no subsidiary	1)
Investment	Gross investment per person employed (in €)	1)
Goods and services for resale	Purchased goods and services for resale (% of turnover)	1)

1) German business services statistics panel, Federal Statistical Office and the statistical offices of the Länder
2) Establishment History Panel, Federal Employment Agency

Table 3: Export Participation of business services firms 2003 and 2006

	2003		2006	
	Number of enterprises	Share of enterprises in all enterprises	Number of enterprises	Share of enterprises in all enterprises
West Germany				
Export intensity				
0%	1.520	76,85	1.354	71,83
> 0% and < 5%	241	12,18	257	13,63
≥ 5% and < 10%	63	3,19	77	4,08
≥ 10% and < 25%	75	3,79	93	4,93
≥ 25% and < 50%	49	2,48	56	2,97
≥ 50%	30	1,52	48	2,55
Total number of observations	1.978	100,00	1.885	100,00

Note: Only enterprises with a sum of turnover and other operating income greater than or equal to €250,000 and with one or more employees are considered. All values are unweighted.
Source: Research Data Centres of the Federal Statistical Office and the statistical offices of the Länder and Research Data Centre of the German Federal Employment Agency at the Institute for Employment Research, KombiFiD dataset 2003-2006, Author's own calculations.

Table 4: Descriptive statistics for non-exporters and exporters (unbalanced Panel 2003 - 2006)

Variables	Non-Exporters		Exporters		p-value
	Mean	Standard Deviation	Mean	Standard Deviation	
Export intensity [in % of turnover]	0,0	0,0	13,9	21,3	0,000
Share of engineers and scientists [in %]	3,769	11,204	6,466	14,383	0,000
Employees [number]	102	209	84	147	0,001
Employees squared [number]	54.220	256.994	28.606	137.622	0,000
Productivity [value added per person employed in €]	52.892	56.053	67.679	44.482	0,000
Human capital [labour cost per employee in €]	31.408	18.806	40.556	18.263	0,000
Part-time work [in % of persons employed]	27,6	25,1	19,7	17,3	0,000
Legal status [Dummies]					
Sole proprietor	0,108	0,311	0,042	0,200	0,000
Private company	0,263	0,440	0,222	0,416	0,000
Public limited company	0,606	0,489	0,697	0,460	0,000
Other	0,023	0,151	0,039	0,194	0,000
Experience on the national market [Dummies]					
No subsidiary	0,778	0,416	0,709	0,454	0,000
1 or 2 subsidiaries	0,142	0,349	0,188	0,390	0,000
3 and more subsidiaries	0,080	0,271	0,104	0,305	0,001
Investment [gross investment per person employed in €]	2.431	8.606	3.407	7.450	0,000
Goods and services for resale [in % of turnover]	7,0	15,4	11,4	18,3	0,000
Number of observations	5.725		1.957		

Note: In the last column the p-values of mean comparisons (t-tests) between the two groups are presented. Only enterprises with a sum of turnover and other operating income greater than or equal to €250,000 and with one or more employees are considered. All values are unweighted.

Source: Research Data Centres of the Federal Statistical Office and the statistical offices of the Länder and Research Data Centre of the German Federal Employment Agency at the Institute for Employment Research, KombiFiD dataset 2003-2006, Author's own calculations..

Table 5: Exporter Premia of Business Services firms in West Germany 2003 - 2006

	Estimation of the share of engineers and scientists [in %] on export status and controls		
	pooled regression 1	fixed effects model 2	Number of observations
Export Status (Dummy, 1=yes)	2.732*** (0.000)	0.193 (0.262)	7.682
Employees [10^{-1}]	-0.059** (0.012)	-0.007 (0.405)	
Employees squared [10^{-4}]	0.023 (0.150)	0.009 (0.217)	
Interaction terms of year and economic activity	yes	yes	

Note: Presented are the estimated regression coefficients, the p-values in parenthesis and the level of significance (* indicates significance at the 10% level, ** at the 5% level, and *** at the 1% level, based on cluster robust standard errors). Model 1 controls for a full set of interaction terms of year and economic activity (2-digit) dummies, the number of employed persons and its squared value. Model 2 also controls for fixed enterprise effects.

Source: Research Data Centres of the Federal Statistical Office and the statistical offices of the Länder and Research Data Centre of the German Federal Employment Agency at the Institute for Employment Research, KombiFiD dataset 2003-2006, Author's own calculations.

Table 6: Self-selection into export markets of business services firms in West Germany 2006

	OLS estimation of the share of engineers and scientists [in %] on export start in t=2006 and controls in t, t-1 and t-2			number of	
	Two years before starting (t-2)	One year before starting (t-1)	In the starting year (t)	non-exporters	export starters
Export Starter 2006 (Dummy, 1=yes)	1.612 (0.296)	1.814 (0.238)	2.017 (0.194)	1.129	84
Employees	-0,011*** (0.000)	-0,011*** (0.000)	-0,011*** (0.000)		
Employees squared [10^{-5}]	0,548*** (0.000)	0,592** (0.000)	0,587*** (0.000)		
Economic activity dummies	yes	yes	yes		

Note: Presented are the estimated regression coefficients, the p-values in parenthesis and the levels of significance (* indicates significance at the 10% level, ** at the 5% level, and *** at the 1% level, based on robust standard errors).

Source: Research Data Centres of the Federal Statistical Office and the statistical offices of the Länder and Research Data Centre of the German Federal Employment Agency at the Institute for Employment Research, KombiFiD dataset 2003-2006, Author's own calculations.

Table 7: Determinants of export intensity of West German business services firms with and without considering unobserved time-constant charateristics 2003 - 2006 (balanced panel)

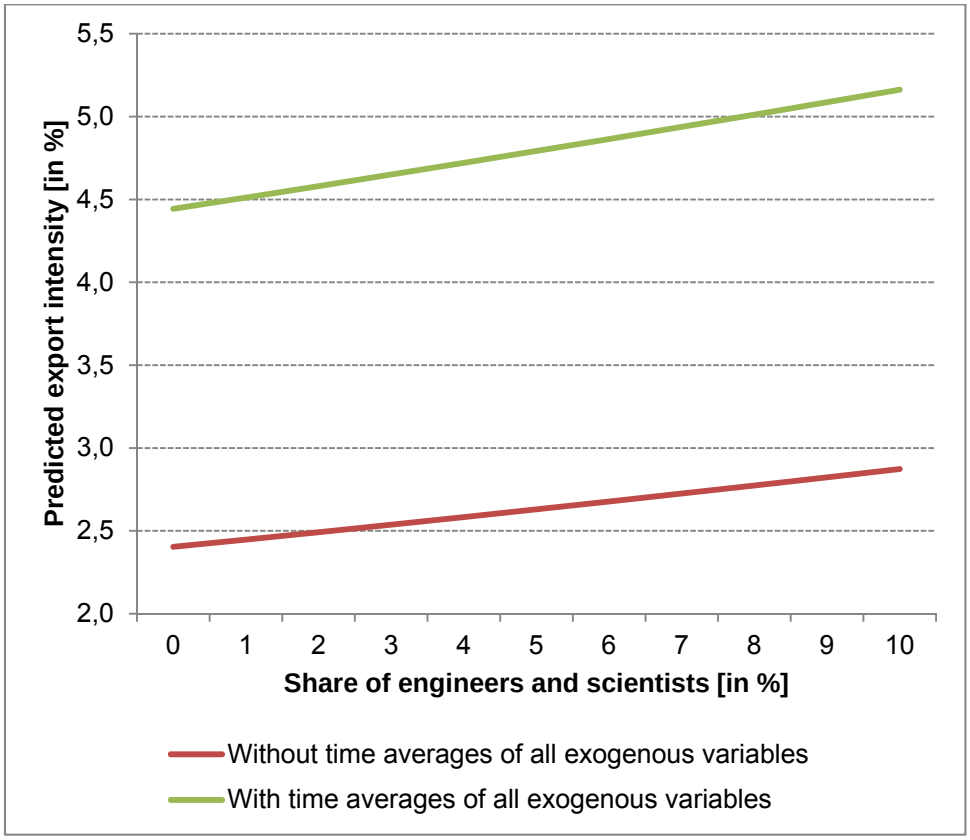
	Pooled fractional probit regression of the export intensity (exports as percent of turnover) Balanced Panel 2003 to 2006		Pooled fractional probit regression of the export intensity (exports as percent of turnover) Balanced Panel 2003 to 2006	
	Without time averages of all exogenous variables		With time averages of all exogenous variables	
Share of engineers and scientists [10^{-1}]		0.005 *** (0.000)		0.010 * (0.054)
Employees [10^{-2}]	0.000 (0.901)	0.000 (0.937)	0.006 (0.446)	0.006 (0.438)
Employees squared [10^{-5}]	-0.002 (0.529)	-0.002 (0.553)	-0.004 (0.376)	-0.004 (0.357)
Productivity [10^{-5}]	0.005 (0.130)	0.004 (0.156)	-0.002 (0.565)	-0.002 (0.521)
Human capital [10^{-4}]	0.005 *** (0.000)	0.004 *** (0.001)	0.000 (0.974)	0.000 (0.959)
Part-time work [10^{-1}]	-0.002 *** (0.007)	-0.002 ** (0.017)	-0.003 ** (0.024)	-0.002 ** (0.030)
Goods and services for resale [10^{-2}]	0.033 *** (0.003)	0.033 *** (0.002)	0.008 (0.330)	0.007 (0.343)
Investment [10^{-5}]	-0.001 (0.955)	-0.001 (0.938)	0.006 (0.305)	0.007 (0.251)
Experience on the national market				
1 or 2 subsidiaries	0.001 (0.868)	0.000 (0.995)	yes	yes
3 and more subsidiaries	-0.005 (0.353)	-0.005 (0.299)	yes	yes
Legal status				
Private company	0.030 ** (0.015)	0.031 ** (0.014)	yes	yes
Public limited company	0.026 *** (0.000)	0.026 *** (0.000)	yes	yes
Other	0.049 (0.196)	0.048 (0.190)	yes	yes
Year dummies	yes	yes	yes	yes
Time averages of all exogenous variables	no	no	yes	yes
Business lines [Dummies]	yes	yes	yes	yes
Number of observations	6,908	6,908	6,908	6,908
Number of enterprises	1,727	1,727	1,727	1,727

Note: Presented are the Marginal effects, the p-values in parenthesis and the level of significance (*** significant at the 1% level, ** significant at the 5% level, * significant at the 10% level, based on cluster robust standard errors) of pooled fractional probit regressions (Papke & Wooldridge 2008) of the export intensity (share of exports on total turnover) on several regressors.

Source: Research Data Centres of the Federal Statistical Office and the statistical offices of the Länder and Research Data Centre of the German Federal Employment Agency at the Institute for Employment Research, KombiFiD dataset 2003-2006, Author's own calculations.

Figures

Figure 1: Share of engineers and scientists and predicted export intensity



Note: Presented are the predicted export intensity levels for different levels of the share of engineers and scientists of an average firm, based on pooled fractional probit regressions (Papke & Wooldridge 2008) of the export intensity on several regressors without and with time averages of all exogenous variables.
Source: Research Data Centres of the Federal Statistical Office and the statistical offices of the Länder and Research Data Centre of the German Federal Employment Agency at the Institute for Employment Research, KombiFiD dataset 2003-2006, Author's own calculations.

Appendix

Table A1: Export participation patterns (balanced panel) in West Germany 2003 - 2006

No.	Pattern	Number of enterprises	Share of enterprises [in %]
1	0000	1,040	60.2
2	1111	203	11.8
3	0111	72	4.2
4	0001	66	3.8
5	1000	52	3.0
6	0011	49	2.8
7	0100	35	2.0
8	1011	34	2.0
9	1101	30	1.7
10	1100	30	1.7
11	1110	29	1.7
12	0010	24	1.4
13	0101	21	1.2
14	1001	x	x
15	0110	x	x
16	1010	x	x
	Total	1,727	100.0

Note: A pattern 0000 (1111) indicates that the firms exports in no year (all years) between 2003 – 2006; a pattern 0101 indicates that the enterprise exports in the second and fourth year (2004 and 2006), etc.; x: deleted because of confidentiality reasons.
Source: Research Data Centres of the Federal Statistical Office and the statistical offices of the Länder and Research Data Centre of the German Federal Employment Agency at the Institute for Employment Research, KombiFiD dataset 2003-2006, Author's own calculations.

Table A2: Determinants of export intensity of West German business services firms 2003 - 2006 (unbalanced panel)

	Fractional probit regression of the export intensity (exports as percent of turnover)	Fractional probit regression of the export intensity (exports as percent of turnover)
Share of engineers and scientists [10^{-1}]		0.004 *** (0.000)
Employees [10^{-2}]	0.003 (0.395)	0.002 (0.419)
Employees squared [10^{-5}]	-0.004 (0.278)	-0.004 (0.294)
Productivity [10^{-5}]	0.001 (0.520)	0.001 (0.503)
Human capital [10^{-3}]	0.001 *** (0.000)	0.001 *** (0.000)
Part-time work [10^{-2}]	-0.026 *** (0.001)	-0.023 *** (0.003)
Goods and services for resale [10^{-1}]	0.003 *** (0.004)	0.003 *** (0.003)
Investment [10^{-5}]	0.004 (0.735)	0.004 (0.729)
Experience on the national market		
1 or 2 subsidiaries	0.001 (0.864)	0.000 (0.981)
3 and more subsidiaries	-0.007 (0.150)	-0.007 (0.132)
Legal status		
Private company	0.026 ** (0.016)	0.027 ** (0.016)
Public limited company	0.022 *** (0.001)	0.022 *** (0.001)
Other	0.043 (0.179)	0.042 (0.178)
Year dummies	yes	yes
Business lines [Dummies]	yes	yes
Number of observations	7,682	7,682
Number of enterprises	2,069	2,069

Note: Presented are the Marginal effects, the p-values in parenthesis and the level of significance (*** significant at the 1% level, ** significant at the 5% level, * significant at the 10% level, based on cluster robust standard errors) of pooled fractional probit regressions (Papke & Wooldridge 2008) of the export intensity (share of exports on total turnover) on several regressors.
Source: Research Data Centres of the Federal Statistical Office and the statistical offices of the Länder and Research Data Centre of the German Federal Employment Agency at the Institute for Employment Research, KombiFiD dataset 2003-2006, Author's own calculations.

Table A3: Descriptive panel statistics (balanced panel) West Germany 2003 - 2006

Variables	Balanced Panel 2003-2006			
	Mean	Standard Deviation		
		Overall	Between	Within
Export intensity [in % of turnover]	3.5	12.1	9.8	7.1
Export intensity [in % of turnover] - exporters only*	8.7	17.9	13.9	11.3
Share of engineers and scientists [in %]	4.4	12.1	11.9	1.9
Employees	100	197	192	46
Productivity	55984	43541	36374	23943
Human capital	33641	18960	18004	5955
Part-time work [in %]	25.6	23.6	22.2	7.9
Investment	2622	8388	5960	5904
Goods and services for resale [in %]	8.2	16.4	14.5	7.7
Number of observations	6,908			
Number of enterprises	1,727			

Note: (*) The export intensity of exporters is only based on enterprises that have in at least one of the four periods an export intenstiy greater than zero.

Source: Research Data Centres of the Federal Statistical Office and the statistical offices of the Länder and Research Data Centre of the German Federal Employment Agency at the Institute for Employment Research, KombiFiD dataset 2003-2006, Author's own calculations.

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Leuphana Universität Lüneburg
Institut für Volkswirtschaftslehre
Postfach 2440
D-21314 Lüneburg
Tel.: ++49 4131 677 2321
email: brodt@leuphana.de

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