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ROBUST ESTIMATES OF EXPORTER PRODUCTIVITY PREMIA IN GERMAN BUSINESS SERVICES ENTERPRISES[1]

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ABSTRACT: *A large and growing number of micro-econometric studies show that exporting firms are more productive than firms that sell their products on the home market only. This so-called exporter productivity premium qualifies as a stylized fact. Only recently researchers started to look at the role of extreme observations, or outliers, in shaping these findings. These studies use micro-econometric methods that are robust against outliers to show that very small shares of firms with extreme values drive the result. The large exporter productivity premium found for samples of firms including outliers are dramatically smaller in samples without these extreme observations. Evidence on this, however, is limited so far to firms from manufacturing industries. This note adds comparable evidence for firms from the business services industries. We find that the estimated exporter productivity premium is statistically significant and relevant from an economic point of view when a standard fixed effects estimator is used to control for unobserved firm characteristics, but that it drops to zero when a robust estimator is applied.*

Keywords: *Exporter productivity premium, services firms, robust estimation, panel data,*

JEL Classification: F14, C23, C81, C87

1. INTRODUCTION

A large and growing number of micro-econometric studies show that exporting firms are more productive than firms that sell their products on the home market only. This so-called exporter productivity premium qualifies as a stylized fact that is found for firm

[1] All computations were done in the research data centre of the Statistical Office in Hannover. The data used are confidential but not exclusive; information how to access the data is provided in Zühlke et al. (2004) and Vogel (2009). To facilitate replication and extensions the Stata code is available from the first author on request.

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level data from almost every country – regardless of the productivity measure used and even after controlling for unobserved firm characteristics in fixed-effects models.[4] These empirical findings motivate a class of theoretical models of heterogeneous firms that are at the heart of the so-called *new new trade theory* showing that only the more productive firms export while the less productive serve the national market.[5]

Only recently researchers started to look systematically at the role of extreme observations, or outliers, in shaping these findings of statistically significant and economically large exporter productivity premia. Everybody who ever worked with firm level data will strongly agree that if one investigates a sample of heterogeneous firms often values of some variables for some observations are much larger or smaller than the values for the other observations in the sample. Often it is not possible to decide whether these observations represent clear noise or do reflect the skewness of the distribution. In both cases, however, these extreme observations, or outliers, may have a large impact on the results of statistical analyses. Conclusions based on a sample with and without these units may differ drastically.

While applied researchers tend to be aware of this, the detection of outliers and their appropriate treatment is usually not considered as an important issue. Given that due to confidentiality of the firm level data used single observations as a rule cannot be inspected closely enough to detect and correct reporting errors or to understand the idiosyncratic events that lead to extreme values a widely used procedure to keep these extreme observations from affecting the results is to drop the observations from the top and bottom one percent of the distribution of the variable under investigation. A case in point is the international comparison study on the exporter productivity premium by the International Study Group on Exports and Productivity (ISGEP) (2008, p. 610).

However, although this approach is rather popular in applied micro-econometric studies it is in some sense arbitrary. Why the top and bottom one percent? Why not choose a larger or smaller cut-off point? There are alternative approaches to deal with extreme observations (outliers) that are substantiated in statistics. In a pioneering study Verardi and Wagner (2011) applied a newly developed robust estimator for fixed effects models to estimate the productivity premium for exporters for firms from manufacturing industries in Germany. Contrary to findings from the earlier literature they show that a very small number of firms with extreme values (3 percent of the sample) drive the result. The large exporter productivity premium found for samples of firms including outliers of 13.5 percent drops to only one percent and is, therefore, dramatically smaller in the sample without these extreme observations. Similar findings are reported in Verardi and Wagner (2010) in a study on the exporter productivity premium in German manufacturing firms by area of export destination that applies a highly robust MM-estimator in estimates based on cross-section data, too.[6]

[4] See Wagner (2007) for a survey and International Study Group on Exports and Productivity (ISGEP) (2008) for an application covering 14 countries.

[5] The canonical model that is motivated by empirical findings of an exporter productivity premium is Melitz (2003); for a survey of the theoretical literature see Redding (2010).

[6] See also Wagner (2011) for a comparison of estimated exporter productivity premia based on various vari-

This paper contributes to the literature in two ways: First, we offer a detailed comparison of different approaches to deal with outliers. More precisely, we compare the standard approaches (namely trimming the data and quantile regressions) with the use of outlier robust estimators. Second, the evidence on the role of outliers in shaping results for estimates of exporter productivity premia is limited so far to firms from manufacturing industries. Thus, we contribute to the literature by looking for comparable evidence for firms from the German business services industries. In doing so we follow Dan Hamermesh (2000, p. 376) who argues that "the credibility of a new finding that is based on carefully analyzing two data sets is far more than twice that of a result based only on one."

To anticipate our most important result we find that the estimated exporter productivity premium is statistically significant and relevant from an economic point of view when a standard fixed effects estimator is used to control for unobserved firm characteristics, but that it drops to zero when a robust estimator is applied.

The rest of the paper is organized as follows. Section 2 briefly describes the services sectors and substantiates why we expect export premia in the business services sector, too. Section 3 introduces the data used. It shows that firms are extremely heterogeneous and that there are extreme observations at both ends of the productivity distribution in each year. Section 4 describes the alternative approaches used to deal with outliers and presents the results from non-robust and from robust estimations. Section 5 concludes.

2. BUSINESS SERVICES FIRMS AND EXPORT PREMIA

Empirical studies in the manufacturing sector show that exporting firms are more productive than non-exporting firms. To explain these findings, the literature provides two hypotheses concerning the link between export activities and productivity. First, because of additional costs related to exporting a self-selection of more productive firms into export markets is hypothesised. Second, it is hypothesised that exporters can learn through knowledge transfer from foreign customers and competitors and the more intensive competition in international markets.

To explain why we expect export premia also in the business services sector, we briefly discuss the characteristics of this sector in the following. Unless otherwise stated, business services are defined in this paper as NACE (rev. 1) 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). Even though the business services sector covers a wide range of activities, these activities have in common that they provide primarily intermediate inputs and that business services are traded more than most other services[7].

ants of robust and conventional (OLS) estimators.

[7] According to the German balance of payments, business services (defined as research and development, advertising, engineering, computer and commercial services) have by far the highest trade volume of any

The key differentiating factor for the internationalisation of services firms and manufacturing firms seems to be the inseparability between consumer and producer (Erramilli 1990). However, due to the characteristics of business services, exports in form of personnel travelling to foreign markets, the provision of services to foreign costumers in the home market but also in form of embodied (e.g. reports, letters) and wired (e.g. telephone conversations, data transfers) services play a significant role in the internationalisation process of business services enterprises (see for example, Roberts, 1999). Thus, the paper focuses on a part of the services sector where exporting has some similarity to the export of goods.

Concerning the learning-by-export hypothesis, it is obvious, that the more general arguments – knowledge transfer and more intensive competition – apply also to firms in the business services sector and not only to firms in the manufacturing sector. Concerning the self-selection hypothesis, the business service sector is comparable to the manufacturing sector in terms of three types of costs and barriers. First, the need for resources (for example, Javalgi et al., 2003; Winstead & Patterson, 1998) and the need for knowledge concerning marketing, foreign markets (i.e., market research), and so on (for example, Winstead & Patterson, 1998) are important barriers in both sectors. Second, while shared with the manufacturing sector, cultural and language differences represent barriers and costs that are more critical in the business services sector since, because of the high level of interaction between user and provider, exporters of services must have good language skills, a high level of intercultural competence, and the ability to customize and adapt services to the specific market (McLaughin & Fitzsimmons, 1996; Winstead & Patterson, 1998). Regulatory barriers, like the need for locally recognised professional qualifications or other country-specific requirements, can also affect the fixed costs of entering an export market and the variable costs of servicing that market to a greater extent for service enterprises than for manufacturing enterprises (Kox & Nordås, 2007). Finally, while shared with manufacturing enterprises, elements that represent a lower cost barrier for service enterprises include transportation costs. While service enterprises may see additional costs in the form of personal transport costs if the service is supplied by a person in a foreign country, transportation costs tend to play a secondary role in the case of cross-border delivery of services, primarily because of communication technology, while they play a primary role in the delivery of goods. Lower transportation costs could allow less productive service firms to enter export markets (Melitz, 2003). However, due to similarities in internationalisation between the business services and manufacturing sectors (Roberts, 1999) a similar self-selection effect of more productive business services enterprises is expected.

The bottom line, then, is that we expect to find export premia in the business services sector, too.

service other than transport (cf. Deutsche Bundesbank, 2011). In addition, Jensen and Kletzer (2006) classified nearly all business services as tradable, based on the geographic concentration of service activities in the United States.

3. DATA

The data used in this study come from the business services statistics (*Strukturerhebung im Dienstleistungsbereich*) established by the German Federal Statistical Office and the statistical offices of the Federal States. The statistics were first compiled for the year 2000 on the initiative of the European Union. The data covers enterprises and professions of the NACE (revision 1) divisions I (transport, storage and communication) and K (real estate, renting and business activities) with an annual turnover of 17,500 € or more. A stratified random sample is used to select the enterprises. The stratification is based on the federal states, 4-digit industries, and 12 size ranges (in terms of turnover or employees). Because the sample of enterprises required to give information in 2003 was also used in 2004 to 2007, it is possible to merge the cross-sectional datasets to a panel dataset that covers the years 2003 to 2007.

The business services statistics include information about the economic sector, the number of persons employed (not including temporary workers), total turnover, salaries and wages, and export – defined as turnover for business with companies located abroad, including exports to foreign affiliates.[8] Small enterprises with an annual sum of turnover and other operating income lower than 250,000 € are given a shorter questionnaire, so important information, such as information about export activities, is missing for these enterprises.[9] For more details about the dataset see Vogel (2009).

For the purpose of analysing the relationship between exporting firms and productivity, we use data for firms with an annual sum of turnover and other operating income equal or higher than 250,000 € operating in the business service sector based on the 4-digit NACE sector classification 72-74 (NACE classification rev. 1), covering the period 2003-2007.[10] Productivity is measured as labour productivity, defined as turnover per employee (in Euro). More appropriate measures of productivity like total factor productivity, cannot be computed because of a lack of information on the capital stock in the surveys. Controlling for the industry affiliation, however, can be expected to absorb much of the differences in the degree of vertical integration and capital intensity.[11] Table 1 gives in-

[8] Unfortunately, information on the target countries of exports is not included in the statistics and we cannot distinguish between service and goods exports as well as the different types of services exported by the firm. Also, no information is obtained about other forms of companies' activities abroad, such as cooperation, direct investments, exports via commercial presence, or imports.

[9] However, even if small enterprises (with an annual sum of turnover and other operating income lower than 250,000 €) account for 35 percent of all enterprises in the pooled dataset, these firms cover only two percent of the employees and one percent of the turnover of the considered sectors. Do to the stratified random sample this shares increase when we use cross-sectional weights. However, the big picture remains: Small enterprises account for 57 percent of all firms, but cover only 12 percent of the employees and 6 percent of the turnover of the considered sectors.

[10] The data used in this study are confidential but not exclusive; information on how to access the data via the research data centres of the Federal Statistical Office and the statistical offices of the federal states is provided in Zühlke et al. (2004) and Vogel (2009).

[11] Note that Bartelsman and Doms (2000, p. 575) point to the fact that heterogeneity in labor productivity has been found to be accompanied by similar heterogeneity in total factor productivity in the reviewed research where both concepts are measured. In a recent comprehensive survey Chad Syverson (2011) argues that high-productivity producers will tend to look efficient regardless of the specific way that their productivity is meas-

formation about the distribution of two variables used in the empirical model to estimate the exporter productivity premium, turnover per employee (labor productivity) and the number of employed persons (the measure of firm size). Note that the smallest and the largest values are confidential (because they are figures for a single firm); therefore, only the average of the three smallest and largest firms can be reported. Due to confidentiality it is not possible to explore the extremely large and small labor productivity values at the firm level. Extremely small values could for example exist in firms with high other operating income but small turnover. Extremely large values could occur in firms where for example the actual activity is spun off to a separate entity. However, the aim of this paper is to analyze the effect of alternative approaches to deal with outliers. Therefore, we decide to use the original data without trimming these extreme observations in advance.

Table 1: *Distribution of the variables used – Original data*

	Number of observation	Mean	Standard Deviation	Minimum*	Maximum*	p1	p25	p50	p75	p99
										Reporting year: 2003
Turnover per employee	23,064	165,665	1,068,793	0.0020	69,100,000	6,291	44,763	74,965	132,004	1,472,567
Number of employed persons	23,064	71.69	348.80	1	15370	1	7	14	40	1,008
										Reporting year: 2004
Turnover per employee	24,082	162,442	764,374	0.0018	47,100,000	6,498	45,352	75,854	134,473	1,510,551
Number of employed persons	24,082	72.44	355.94	1	15608	1	7	14	39	1,037
										Reporting year: 2005
Turnover per employee	24,782	161,527	620,638	0.0018	30,800,000	6,396	46,504	77,457	138,047	1,521,151
Number of employed persons	24,782	72.10	404.50	1	21815	1	7	14	38	999
										Reporting year: 2006
Turnover per employee	26,478	166,731	656,182	0.0018	36,500,000	6,808	47,397	79,175	139,680	1,566,667
Number of employed persons	26,478	74.87	468.52	1	26696	1	7	14	39	1,050
										Reporting year: 2007
Turnover per employee	27,751	172,288	739,045	0.0026	39,800,000	7,010	47,536	79,946	141,871	1,574,772
Number of employed persons	27,751	78.02	545.95	1	34,034	1	7	14	39	1,097

Source: Research Data Centres of the Federal Statistical Office and the statistical offices of the Länder, The German Business Services Statistics Panel 2003-2007, Author's own calculations.
Note: (*) For confidentiality reasons the minimum is proxied by the mean of the three smallest firms and the maximum is proxied by the mean of the three largest firms

The data show a considerable degree of heterogeneity among firms. While most firms are small (the 75th percentile is around 40 employees in all years) some are very large and the value at the 99th percentile is about 1,000 times the value at the 1st percentile. Turnover per employee varies even more between the firms. The value of labor productivity is reported to be less than one Euro cent on average for the three firms at the bottom end of the productivity distribution and more than 30 million Euros for the three firms at the

ured. See International Study Group on Exportrs and Productivity (ISGEP) (2008) for a comparison of results for productivity differentials between exporting and non-exporting firms based on sales per employee, value added per employee and total factor productivity. Results proved remarkably robust. Furthermore, Foster, Haltiwanger and Syverson (2008) show that productivity measures that use sales (i.e. quantities multiplied by prices) and measures that use quantities only are highly positively correlated.

top. Turnover per employee at the 99th percentile is 234 times the value at the 1st percentile in 2003, and the respective values for the other years are similar.

This illustrates the point made in section 1 above. In a sample of heterogeneous firms often the values of some variables for some observations are much larger or smaller than the values for the other observations in the sample. Due to confidentiality of the firm level data used here single observations cannot be inspected closely enough to detect and correct any reporting errors or to understand the idiosyncratic events that lead to extreme values. Given that these extreme observations, or outliers, may have a large impact on the results of empirical studies and that conclusions based on a sample with and without these units may differ drastically the presence of such outliers in the sample should be taken care of in micro-econometric analyses.

Before turning to that exercise we will look at one other dimension of the data used in this study. We have data for five years from 2003 to 2007 from an (unbalanced) panel of firms.[12] In the econometric investigation we will use these panel data to estimate the exporter productivity premium in two types of empirical models – a model using pooled data without fixed firm effects and a model that includes fixed firm effects to control for unobserved time invariant firm characteristics. The exporter productivity premium is estimated as the coefficient of a dummy variable indicating whether a firm is an exporter or not in an empirical model that regresses the labor productivity of a firm in a year on the exporter status in this year and a set of control variables (detailed below). While in the estimation of the model with pooled data all information on all firms and all variables over the years is used the regression coefficient of the exporter dummy variable in the model with fixed firm effects is identified only from information on firms that change their exporter status (at least once) between two consecutive years[13] and only the variation in the variables over time within each of these firms is used in the estimation of the regression coefficients of the control variables, too.

To apply a fixed effects model, therefore, it is necessary to have variation of labor productivity, exporter status and control variables inside the firms over the years in the sample that is large enough to identify the coefficients of both the exporter dummy and the control variables. Table 2 shows that in the panel data set used here the variation within the firms over time is smaller than the variation between the firms (as usual) but that the within variation is quite large compared to the between variation so that an application of a fixed effects model seems to be appropriate.[14]

[12] In addition to the sample of firms that were required to give information in 2003, samples of new enterprises were annually drawn as a stratified sample from new entries to the business register in the years 2004 to 2007. Thus, we find an increase from 23,064 business services firms in 2003 up to 27,751 business services firms in 2007 in our panel dataset. This is in line with the still observable growth of the business services sector in Germany.

[13] In our sample the share of firms that start or stop to export at least once is rather large. Thus, 6,516 of the 38,266 firms in the dataset (17 percent) change their export status at least once during the time they occur in the dataset; 28,091 firms did not export and 3,659 firms export in all periods they occur in the dataset.

[14] Given that firms that are in the sample for one year only – so-called singletons – do by construction not add to the identification of the coefficients in a fixed-effects model these observations were used in the pooled model but not in the fixed-effect model. 8,517 of the 38,266 firms in the dataset are singletons.

Table 2: *Within and Between standard deviation of the used variables (2003-2007) – Original Data*

	Standard Deviation		
	Overall	Between	Within
Export status (dummy)	0.3893	0.3299	0.2106
Turnover per employee (log)	1.2899	1.2473	0.5458
Number of employed persons	436.13	369.01	133.90

Source: Research Data Centres of the Federal Statistical Office and the statistical offices of the Länder, The German Business Services Statistics Panel 2003-2007, Author's own calculations.
Note: Computations are based on 126,157 observations for 38,266 firms, 8,517 of which are singletons. The overall, between and within standard deviation are computed by the xtsum command of STATA 10.

4. THE EXPORTER PRODUCTIVITY PREMIUM IN GERMAN BUSINESS SERVICES FIRMS – RESULTS FROM NON-ROBUST AND FROM ROBUST ESTIMATIONS

The exporter productivity premium is defined as the percentage differential in productivity between exporting and non-exporting firms from the same industry and of the same size. It is estimated from an empirical model with the log of productivity as the endogenous variable and a dummy variable that takes on the value of one when a firm is an exporter and zero otherwise as an exogenous variable; the number of employees (and its squared value) and dummy variables for the industries and years are included to control for firm size, industry affiliation and time trend. The estimated coefficient ß of the exporter dummy variable (transformed by computing 100*exp(ß-1)) shows the average percentage difference of productivity between exporters and non-exporters after controlling for firm size and industry affiliation – the exporter productivity premium.[15]

In a first step, the exporter productivity premium in German business services firms is estimated using pooled data for the years 2003 – 2007 from the business services statistics (described in section 2) for the complete sample of 126,157 observations for 38,266 firms.[16] Results reported in the first column of row one table 3[17] show that the estimated premium is positive, statistically highly significant and very large from an economic point of view – exporters are ceteris paribus 54.7 percent more productive than non-exporting firms. These results are in line with previous findings concerning the exporter productivity premia of business services firms. Vogel (2011) and Temouri et al. (2010) find statistically and economically significant large export productivity premia for the business service sectors in France, the United Kingdom as well as in East and West Germany.

[15] See Wagner (2007) for a discussion of the standard approach used in the literature on the micro-econometrics of international firm activities to estimate the exporter productivity premium.

[16] All models for pooled data without fixed effects include a full set of interaction terms of year and industry (2-digit level) dummy variables plus the number of employees and its squared value; standard errors are computed using the firm as a cluster.

[17] The full results of the regressions are presented in Table A1 to A4 in the appendix.

Table 3: *Exporter productivity premia of business services enterprises (2003-2007)*

	Estimation of the turnover per employee on export status and controls in t			
	pooled regression		fixed effects model	
	coefficient (p-value)	number of observations	coefficient (p-value)	number of observations
Non robust standard approach – Original Data (no control for outliers)				
Turnover per employee (log)	54.7** (0.000)	126,157	3.4** (0.000)	117,640
Non-robust standard approach – Original Data – Quantile Regression (control for outliers by running a quantile regression)				
25. Quantil: Turnover per employee (log)	49.2** (0.000)	126,157	-	-
50. Quantil: Turnover per employee (log)	45.4** (0.000)		-	
75. Quantil: Turnover per employee (log)	36.4** (0.000)		-	
Non-robust standard approach – Trimmed Data (excluding outliers by excluding the 1st and 99th percentile of the distribution)				
Turnover per employee (log)	45.7** (0.000)	121,683	1.4** (0.004)	113,449
Non-robust standard approach – Trimmed Data (excluding outliers by excluding the 10th and 90th percentile of the distribution)				
Turnover per employee (log)	23.3** (0.000)	91,246	0.7+ (0.060)	84,621
Robust estimation – Original Data (using mmregress and xtregrob to control for outliers)				
Turnover per employee (log)	51.2** (0.000)	126,157	0.1 (0.410)	91,694

Source: Research Data Centres of the Federal Statistical Office and the statistical offices of the Länder, The German Business Services Statistics Panel 2003-2007, Author's own calculations.

Note: The estimated regression coefficients and the levels of significance (** indicates significance at the 1% level, + indicates significance at the 10% level, based on cluster robust standard errors; p-values for quantile regression estimates are based on standard errors bootstrapped with 100 replications) are presented for estimations of the logarithmic turnover per employed persons on the export status at t. In the pooled regression model it is controlled for a full set of interaction terms of year and economic activity (2-digit) dummies, the number of employed persons and its squared value. In the fixed effects model it is controlled for fixed enterprise effects, year dummies, the number of employed persons and its squared value. To facilitate the interpretation, the estimated coefficient for the export dummy has been transformed by 100(exp(ß)-1). The transformation shows the average percentage difference in labour productivity (ceteris paribus) between exporters and non-exporters. The number of observations of the fixed effects model is presented without singletons.

Productivity differences between firms is related to variables besides firm size and industry affiliation that are not included in the empirical model to estimate the exporter productivity premium either because information is missing or because they are unobservable to a researcher. A case in point is management quality (see Syverson (2011) and the recent study by Bloom and Van Reenen (2010)). In the data set used here (and in all other data sets used to empirically investigate international firm activities that we are aware of) variables that measure management quality are missing. This would not pose a big problem if management quality would be uncorrelated with the other variables included in the empirical model (e.g., the exporter status) – of course it would not be possible to investigate the role of management quality for productivity differences between firms empirically, but the estimated coefficient for the exporter dummy variable would be an unbiased estimate of the exporter productivity premium (given all other assumptions for the applicability of OLS are fulfilled). However, one would not expect that management quality is uncorrelated with either the exporter status or other variables like firm size. Not controlling for management quality then leads to biased estimates for the exporter premium.

A standard solution for this problem that is widely used in the literature on the micro-econometrics of international firm activities is the estimation of fixed effects models for panel data (see e.g. ISGEP (2008)). Using pooled cross-section time-series data for firms and including fixed firm effects in the empirical model allows to control for time invariant unobserved firm heterogeneity, and to estimate the coefficients for the time variant variables that are included in the models without any bias caused by the non-inclusion of the unobserved variables that are correlated with these included variables.

In a second step, the exporter productivity premium in German business services firms is estimated using pooled data for the years 2003 – 2007 adding fixed firm effects to the model used in step 1.[18] The result reported in the third column of row one in table 3 shows that the estimated premium is positive, statistically highly significant but considerably smaller than the estimated premium from the pooled model without fixed firm effects; the productivity differential of 3.4 percent, however, can still be considered to be relevant from an economic point of view.[19] These results are again in line with previous findings concerning the export productivity premia of business services firms. After controlling for fixed effects Vogel (2011) and Temouri et al. (2010) find much smaller export productivity premia compared to the pooled regression. Still significant productivity differences are found in France and Germany.

Results from step 1 and step 2 where the standard approach based on pooled data with and without fixed firm effects is used point to the existence of a significant and relevant positive exporter productivity premium in German business services firms. In the remaining steps we will look at the role of extreme observations, or outliers, in shaping these results.

[18] All models with fixed effects include a full set of year dummy variables plus the number of employees and its squared value; standard errors are computed using the firm as a cluster. Note that observations from firms that are in the sample for one year only (the singletons) are not used in the estimation because they do not contribute to the identification of the regression coefficients. Therefore, the number of observations used here is smaller than the number used to estimate the pooled model. Information on the industry affiliation is not included in the fixed effects models because this is a time-invariant variable in our sample.

[19] A drop in the size of the estimated exporter productivity premium when fixed firm effects are added to a an empirical model is found in many studies from the micro-econometrics of international firm activities; a case in point is the study using data from 14 countries by ISGEP (2008).

If one investigates a sample of heterogeneous firms it often happens that some variables for some firms are far away from the other observations in the sample. For example, in the sample of exporting and non-exporting firms that is analyzed here according to table 1 there are a few firms with labour productivity values that are extremely low or extremely high compared to the mean values. These extreme values might be the result of reporting errors (and, therefore, wrong), or due to idiosyncratic events (like in the case of a software developer who works on a system over a long time and reports the sales in the year when the program is completed and delivered), or due to firm behavior that is vastly different from the behavior of the majority of firms in the sample. Observations of this kind are termed outliers. Whatever the reason may be, extreme values of labour productivity may have a large influence on the mean value of labour productivity computed for the exporters and non-exporters in the sample, on the tails of the distribution of labour productivity, and on the estimates of the exporter premium. Conclusions with regard to the productivity differences between exporters and non-exporters, therefore, might be influenced by a small number of firms with extremely high or low values of productivity.

Researchers from the field of micro-economics of international firm activities usually are aware of all of this. Given that due to confidentiality of the firm level data single observations as a rule cannot be inspected closely enough to detect and correct reporting errors, or to understand the idiosyncratic events that lead to extreme values, a widely used procedure to keep these extreme observations from shaping the results is to drop the observations from the top and bottom one percent of the distribution of the variable under investigation. A case in point is the international comparison study on the exporter productivity premium by the International Study Group on Exports and Productivity (ISGEP) (2008, p. 610).

To illustrate the effects of trimming the sample this way in a third step the empirical model for pooled data is estimated without and with fixed firm effects for a sample without the observations from the top and bottom one percent of the productivity distribution as well as for a sample without the observations from the top and bottom ten percent of the productivity distribution.[20] Results are reported in row five and six of table 3. First we look at the results for the sample without the observations from the top and bottom one percent of the productivity distribution. While the estimates for the exporter productivity premia are still positive and highly statistically significant they are smaller in both models. This demonstrates that a small share of observations from both ends of the productivity distribution with very low or high values of labor productivity do have a large impact on the estimated values for the exporter premium at least in the model including fixed effects. Thus, dropping the firms from the top and the bottom one percent of the productivity distribution and comparing the results of empirical investigations with and without these firms with extremely high or extremely

[20] More precisely, in a first step we compute the 1st and 99th percentile (or the 10th and 90th percentile respectively) of the productivity distribution using the pooled dataset. In a second step we drop all firms (and not only the respective observation) that belong to the 1st or 99th percentile (or the 10th and 90th percentile respectively) of the productivity distribution in at least one of the considered years 2003 to 2007.

low values of labour productivity might be considered as a first and useful step to check the sensitivity of results.

However, while using the sample without the observations from the top and bottom ten percent of the productivity distribution, the picture is entirely different: The estimated premium in the pooled model is only 23.3 percent, that is more than 20 percentage points lower than the export premium based on the sample without the observations from the top and bottom ten percent of the productivity distribution. The estimated premium in the fixed effects model is only 0.7 percent and is neither relevant from an economic point of view nor significant on the 5 percent level. Thus, the results show that the choosing of the cut-off thresholds is in some sense arbitrary. The question occurs, why the top and bottom one or ten percent and why not choose a larger or smaller cut-off point?

Before we will turn to alternative approaches to deal with extreme observations (outliers) that are substantiated in statistics, we look in a fourth step to another often used standard solution: Quantile Regressions. In contrast to OLS (that gives information about the effects of the regressors at the conditional mean of the dependent variable only) quantile regression can provide parameter estimates at different quantiles. Therefore, it gives information on the variation in the effect of independent variables on the dependent variable at different quantiles. The estimated regression coefficients can be interpreted as the partial derivative of the conditional quantile of the dependent variable (here: labour productivity) with respect to a particular regressor (e.g., being an exporter or not), i.e. the marginal change in productivty at the kth conditional quantile due to a change in exporter status. For each quantile it can be shown whether the effect of a particular independent variable is positive or negative, and how large this effect is compared to other quantiles. Note that for each quantile regression estimate all of the data are being used; some observations, however, get more weight than others.

Estimation results for the exporter productivity premium from quantile regressions are reported in row two, three and four of table 3. Overall, the picture is similar to the results presented above. The estimated exporter premium is statistically different from zero, positive, and large from an economic point of view for all quantiles. Note that due to the lack of a suitable estimator it is not possible to perform Quantile Regression with fixed effects; therefore, this approach is limited to the pooled data.

In a fifth step we will look at robust estimation of the exporter productivity premium based on the model for pooled data that does not include fixed firm effects. Following Rousseeuw and Leroy (1987) we distinguish three types of outliers that influence the OLS estimator: vertical outliers, bad leverage points, and good leverage points. Verardi and Croux (2009, p. 440) illustrate this terminology in a simple linear regression framework (the generalization to higher dimensions is straightforward) as follows: “Vertical outliers are those observations that have outlying values for the corresponding error term (the y dimension) but are not outlying in the space of explanatory variables (the x dimension). Their presence affects the OLS estimation and, in particular, the estimated intercept. Good leverage points are observations that are outlying in the space of explanatory variables but that are located close to the regression line. Their presence does not affect the OLS estimation, but it affects statistical inference because they do deflate the estimated standard errors. Finally, bad leverage points are observations that are both outlying in the space of explanatory variables and located far from the true regression line. Their presence significantly affects the OLS estimation of both the intercept and the slope."

Full robustness in a regression based on pooled cross-section data can be achieved by using the so-called MM-estimator that can resist contamination of the data set of up to 50% of outliers (i.e., that has a breakdown point of 50 % compared to zero percent for OLS).[21]

A discussion of the details of this estimator is beyond the scope of this paper (see Verardi and Croux (2009) and the Appendix to Verardi and Wagner (2011)). The result is reported in column one of row three in table 3. The estimated exporter productivity premium is again statistically highly significant and very large from an economic point of view. The point estimate is only slightly smaller than the point estimate reported for the application of the non-robust standard approach using OLS for the complete sample and only slightly larger than OLS applied to the trimmed sample.

Therefore, neither using the standard approaches (namely trimming the data and quantile regressions) nor using a highly robust estimator and the full sample does make a large difference when fixed firm effects are not included in the empirical model. In the last step of our empirical study we will investigate whether this is also the case when a model with fixed firm effects is estimated. Note that when working with panel data a fourth category of outliers (besides vertical outliers, bad leverage points, and good leverage points) should be considered, namely block concentrated outliers that correspond to a situation in which most of the outlying observations are concentrated in a limited number of time series (see Bramati and Croux, 2007). To deal with the presence of any of these types of outliers we apply a robust estimator for the linear fixed effects model suggested in Verardi and Wagner (2011). Again, a discussion of the details of this estimator is beyond the scope of this paper. Suffice it to say here that we first center all variables by removing the median (and not the mean as in the non-robust standard approach) to remove individual fixed effects and then run a robust estimator to identify the outliers. Outlying individuals are then awarded a weight zero and a standard fixed effect model is fitted to the remaining observations. The robust estimator we use for the outlier identification step is an S-estimator which is known to be particularly robust to outliers. The logic behind this estimator is that, instead of minimizing the variance of the residuals as

[21] The breakdown point of an estimator is the highest fraction of outliers that an estimator can withstand, and it is a popular measure of robustness. Using the terminology of Rousseeuw and Leroy one can state that the median regression estimator (also known as Least Absolute Deviations, or LAD) protects against vertical outliers but not against bad leverage points (Verardi and Croux 2009, p. 441). Another quite popular robust estimator is the M-estimator proposed by Huber that generalizes median regression to a wider class of estimators. However, as pointed out by Verardi and Croux (2009, p. 442), this estimator can only identify isolated outliers and is inappropriate when clusters of outliers exist where one outlier can mask the presence of another, and the initial values for the algorithm is not robust to bad leverage points.

in OLS, another measure of dispersion of the residuals, less sensitive to outliers, is minimized. The measure of spread minimized here is an M-estimator of scale (see Verardi and Croux (2009) for further details).

The results are reported in last two columns of row three in table 3. Note first that 25,946 (or 22 percent)[22] of all observations are identified as outliers and dropped from the estimation sample. This is a large fraction of outliers, and this may come as a surprise. Remember, however, that a huge number of firms in the complete sample report tiny or extremely large values of turnover per employee (see table 1).

Using the sample without outliers the estimated exporter productivity premium is no longer statistically different from zero at any conventional error level, and the point estimate is close to zero. Controlling for observed firm size (and time invariant industry affiliation) and unobserved time invariant firm characteristics there is no such thing as an exporter premium!

This result (that is in line with findings from two other studies that estimate exporter productivity premia in models with fixed effects for firms from manufacturing industries reported by Verardi and Wagner (2010, 2011)) demonstrates that it is extremely important to identify outliers and document their role in shaping the results from estimation of linear fixed effects models. Furthermore, it illustrates that trimming the sample by dropping the smallest and largest one percent observations from the productivity distribution is no valid solution.[23]

5. CONCLUDING REMARKS

Researchers active in applied micro-econometrics are often aware of the fact that extreme observations, or outliers, can have a large impact on the results of statistical analyses, and that conclusions based on a sample with and without these units may differ drastically. To our experience, however, the detection of outliers and their appropriate treatment is often dealt with in a rather sloppy manner. We demonstrate that outliers drive the results of the estimate of the exporter productivity premium, a figure that plays a prominent role in the *Micro-econometrics of International Firm Activities* (and in the *New New Trade Theory* as well).

Evidence for a vanishing exporter productivity premium in models with fixed firm effects that are estimated using data from "cleaned" samples without outliers, however, is (to the best of our knowledge) as of today limited to results from studies using data for

[22] To be more precise, 24,881 of all observations are identified as outliers and 1,080 are additional singletons resulting from dropping out the identified outliers. 1,834 of the observations are identified as outliers by xtregrob as well as by dropping the 1st and 99th percentile. 10,096 of the observations are identified as outliers by xtregrob as well as by dropping the 10th and 90th percentile.

[23] For a demonstration that trimming leads to biased coefficient estimates in the presence of outliers see the Monte Carlo study in Verardi and Wagner (2011).

German firms from manufacturing and business services. An important next step in research in this area consists in similar empirical investigations that are based on data from other countries. Given that we cannot access these data for confidentiality reasons we suggest that researchers from other countries replicate our study – and inform us about any results.

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APPENDIX

Table A1: *Exporter productivity premia of business services enterprises (2003-2007) Full regression results of the Non robust standard approach – Original Data (no control for outliers)*

	Estimation of the turnover per employee on export status and controls in t	
	pooled regression	**fixed effects model**
	coefficient (p-value)	**coefficient (p-value)**
Non robust standard approach – Original Data (no control for outliers)		
Turnover per employee (log)	54.68** (0.000)	3.37** (0.000)
Employees	-0.06** (0.000)	-0.04** (0.000)
Employees squared	0.00** (0.000)	0.00** (0.000)
interaction terms of year and economic activity	yes	
year dummies		yes
Number of observations	126,157	117,640

Source: Research Data Centres of the Federal Statistical Office and the statistical offices of the Länder, The German Business Services Statistics Panel 2003-2007, Author's own calculations.
Note: The estimated regression coefficients and the levels of significance (** indicates significance at the 1% level, based on cluster robust standard errors) are presented for estimations of the logarithmic turnover per employed persons on the export status at t. In the pooled regression model it is controlled for a full set of interaction terms of year and economic activity (2-digit) dummies, the number of employed persons and its squared value. In the fixed effects model it is controlled for fixed enterprise effects, year dummies, the number of employed persons and its squared value. To facilitate the interpretation, the estimated coefficient for the export dummy has been transformed by 100(exp(ß)-1). The transformation shows the average percentage difference in labour productivity (ceteris paribus) between exporters and non-exporters. The number of observations of the fixed effects model is presented without singletons.

Table A2: *Exporter productivity premia of business services enterprises (2003-2007) Full regression results of the Non-robust standard approach – Quantile Regression*

	Estimation of the turnover per employee on export status and controls in t	
	pooled regression	**fixed effects model**
	coefficient (p-value)	**coefficient (p-value)**
Non-robust standard approach – Original Data – Quantile Regression (control for outliers by running a quantile regression)		
25. Quantil		
Turnover per employee (log)	49.19** (0.000)	-
Employees	-0.22** (0.000)	-
Employees squared	0.00 (0.336)	-
interaction terms of year and economic activity	yes	-
50. Quantil		
Turnover per employee (log)	45.39** (0.000)	-
Employees	-0.12** (0.000)	-
Employees squared	0.00* (0.012)	-
interaction terms of year and economic activity	yes	-
75. Quantil		
Turnover per employee (log)	36.37** (0.000)	-
Employees	-0.08** (0.000)	-
Employees squared	0.00* (0.017)	-
interaction terms of year and economic activity	yes	-
Number of observations	126,157	-

Source: Research Data Centres of the Federal Statistical Office and the statistical offices of the Länder, The German Business Services Statistics Panel 2003-2007, Author's own calculations.
Note: The estimated quantile regression coefficients and the levels of significance (** indicates significance at the 1% level, (* indicates significance at the 5% level, p-values are based on standard errors bootstrapped with 100 replications) are presented for estimations of the logarithmic turnover per employed persons on the export status at t. In the model it is controlled for a full set of interaction terms of year and economic activity (2-digit) dummies, the number of employed persons and its squared value. To facilitate the interpretation, the estimated coefficient for the export dummy has been transformed by 100(exp(ß)-1). The transformation shows the average percentage difference in labour productivity (ceteris paribus) between exporters and non-exporters. The number of observations of the fixed effects model is presented without singletons.

Table A3: *Exporter productivity premia of business services enterprises (2003-2007) Full regression results of the Non-robust standard approachs – Trimmed Data*

	Estimation of the turnover per employee on export status and controls in t	
	pooled regression	**fixed effects model**
	coefficient (p-value)	**coefficient (p-value)**
Non-robust standard approach – Trimmed Data (excluding outliers by excluding the 1st and 99th percentile of the distribution)		
Turnover per employee (log)	45.70**	1.38**
	(0.000)	(0.004)
Employees	-0.05**	-0.04**
	(0.000)	(0.000)
Employees squared	0.00**	0.00**
	(0.000)	(0.000)
interaction terms of year and economic activity	yes	
year dummies		yes
Number of observations	121,683	113,449
Non-robust standard approach – Trimmed Data (excluding outliers by excluding the 10th and 90th percentile of the distribution)		
Turnover per employee (log)	23.29**	0.74+
	(0.000)	(0.060)
Employees	-0.02**	-0.06**
	(0.000)	(0.000)
Employees squared	0.00**	0.00**
	(0.007)	(0.000)
interaction terms of year and economic activity	yes	
year dummies		yes
Number of observations	91,246	84,621

Source: Research Data Centres of the Federal Statistical Office and the statistical offices of the Länder, The German Business Services Statistics Panel 2003-2007, Author's own calculations.
Note: The estimated regression coefficients and the levels of significance (** indicates significance at the 1% level, (+ indicates significance at the 10% level, based on cluster robust standard errors) are presented for estimations of the logarithmic turnover per employed persons on the export status at t. In the pooled regression model it is controlled for a full set of interaction terms of year and economic activity (2-digit) dummies, the number of employed persons and its squared value. In the fixed effects model it is controlled for fixed enterprise effects, year dummies, the number of employed persons and its squared value. To facilitate the interpretation, the estimated coefficient for the export dummy has been transformed by 100(exp(ß)-1). The transformation shows the average percentage difference in labour productivity (ceteris paribus) between exporters and non-exporters. The number of observations of the fixed effects model is presented without singletons.

Table A4: *Exporter productivity premia of business services enterprises (2003-2007) Full regression results of the Robust estimation – Original Data (using mmregress and xtregrob to control for outliers)*

	Estimation of the turnover per employee on export status and controls in t	
	pooled regression	**fixed effects model**
	coefficient (p-value)	**coefficient (p-value)**
Robust estimation – Original Data (using mmregress and xtregrob to control for outliers)		
Turnover per employee (log)	51.21**	0.14
	(0.000)	(0.410)
Employees	-0.59**	0.03**
	(0.000)	(0.000)
Employees squared	0.00**	0.00**
	(0.000)	(0.000)
interaction terms of year and economic activity	yes	
year dummies		yes
Number of observations	126,157	91,694

Source: Research Data Centres of the Federal Statistical Office and the statistical offices of the Länder, The German Business Services Statistics Panel 2003-2007, Author's own calculations.

Note: The estimated regression coefficients and the levels of significance (** indicates significance at the 1% level, based on cluster robust standard errors) are presented for estimations of the logarithmic turnover per employed persons on the export status at t. In the pooled regression model it is controlled for a full set of interaction terms of year and economic activity (2-digit) dummies, the number of employed persons and its squared value. In the fixed effects model it is controlled for fixed enterprise effects, year dummies, the number of employed persons and its squared value. To facilitate the interpretation, the estimated coefficient for the export dummy has been transformed by 100(exp(ß)-1). The transformation shows the average percentage difference in labour productivity (ceteris paribus) between exporters and non-exporters. The number of observations of the fixed effects model is presented without singletons.