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Exports, Foreign Direct Investments and Productivity: Are Services Firms different?*

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Abstract:

This paper contributes to the literature on international firm activities and firm performance by providing the first evidence on the link of productivity and both exports and foreign direct investment (fdi) in services firms from a highly developed country. It uses unique new data from Germany - one of the leading actors on the world market for services - that merge information from regular surveys and from a one-time special purpose survey performed by the Statistical Offices. Descriptive statistics, parametric and non-parametric statistical tests and regression analyses (with and without explicitly taking differences along the conditional productivity distribution and firms with extreme values, or outliers, into account) indicate that the productivity pecking order found in numerous studies using data for firms from manufacturing industries – where the firms with the highest productivity engage in fdi while the least productive firms serve the home market only and the productivity of exporting firms is in between – does not exist among firms from services industries. In line with the theoretical model and the empirical results for software firms from India provided by Bhattacharya, Patnaik and Shah (2010) there is evidence that firms with fdi are less productive than firms that export.

JEL classification: F14, F21

Keywords: Exports, foreign direct investments, productivity, services firms

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1. Motivation

During the past fifteen years a huge literature emerged that investigates the causes and consequences of international firm activities in theoretical models of heterogeneous firms and in micro-econometric studies that use large sets of firm-level data (see Helpman (2011) for a review). For a long time the focus of this literature has been on export activities of firms and on the links of exports and productivity.[1] Numerous empirical studies with data from countries from all over the world document that exporting firms are more productive than firms that serve the national market only. This positive exporter productivity differential qualifies as a stylized fact, and it has recently been documented for firms from services industries, too.[2]

The reason for this positive exporter productivity premium is the existence of additional costs of selling goods or services in foreign countries. The range of extra costs include transportation costs, distribution or marketing costs, personnel with skill to manage foreign networks, or production costs in modifying current domestic products or services for use in foreign countries. These costs provide an entry barrier that less successful firms cannot overcome profitably. Furthermore, the behaviour of firms might be forward-looking in the sense that the desire to export tomorrow leads a firm to improve performance today to be competitive on the foreign market, too. Cross-section differences between exporters and non-exporters, therefore, may in part be explained by ex ante differences between firms. The more productive firms become exporters. Furthermore, knowledge flows from international buyers and

[1] See Wagner (2007) for a survey.

[2] See Wagner (2011) for a summary of the findings from seven micro-econometric studies on trade and productivity based on services firm data from six countries published in 2010 and 2011.

competitors might help to improve the post-entry performance of export starters. Firms participating in international markets are exposed to more intense competition and must improve faster than firms who sell their products domestically only. Exporting makes firms more productive.

Another form of international firm engagement that has been investigated in a number of studies with a view on its links to firm productivity is foreign direct investment (fdi). Foreign direct investment is closely related to trade because firms may consider a production facility in a foreign country that produces products identical to or similar to the products produced in the home country as a substitute for exports.

In a seminal paper Helpman, Melitz and Yeaple (2004) introduce a multi-country, multi-sector general equilibrium model to investigate the decision of heterogeneous firms to serve foreign markets either through exports or through foreign direct investment, i.e. by building new production facilities in a foreign county or by acquiring existing firms there. They show that, in equilibrium, only the more productive firms choose to serve the foreign markets, and the most productive among this group will further choose to serve these markets via foreign direct investment. The intuition behind this theoretical result can be outlined as follows (see the textbook treatment of the model in Helpman (2011, p. 138ff.)): FDI is associated with higher fixed costs (for setting up or buying a production facility abroad) than exporting, while exports have variable trade costs (for transport, insurance, trade barriers) that subsidiary sales do not have. “Firms invest abroad when the gains from avoiding trade costs outweigh the costs of maintaining capacity in multiple markets. This is known as the proximity-concentration trade-off.” (Helpman, Melitz and Yeaple (2004, p. 300)) In a profits-productivity diagram the line representing profits from

subsidiary sales has a lower intercept (due to the higher fixed costs) but is steeper (due to no variable costs of serving the foreign market) than the line representing profits from exporting. These two profit lines intersect at a certain (positive) profit. Firms that are more productive than the critical value of productivity that is associated with this intersection point choose to export, while the more productive firms choose to set up or buy a production facility abroad.

Several recent empirical papers take the Helpman-Melitz-Yeaple (2004) model as a point of departure. Wagner (2011) summarizes the findings from 14 micro-econometric studies on the productivity pecking order among firms with different forms of international activities. All but two of these studies use data for highly industrialized countries, and all studies but one (discussed below) look at firms from manufacturing industries only. The big picture that emerges from the results of the studies using data for firms from manufacturing industries is well in line with the predictions derived from the theoretical model by Helpman, Meltiz and Yeaple (2004) – firms that serve the home market only are the less productive group, followed by firms that export and by firms that engage in outward foreign direct investment (usually these firms are exporters, too).

Bhattacharya, Patnaik and Shah (2010) argue that the productivity pecking order between exporters and firms with fdi differs between firms from manufacturing industries and firms from services industries. They set up a theoretical model in which less productive profit maximising services firms choose fdi and more productive firms choose export as the mode of serving foreign markets.[3] The intuition behind the model can be outlined as follows: The authors assume that the choice by

[3] Note that Bhattacharya, Patnaik and Shah (2010) do not consider firms that sell their services on the national market only.

firms from services industries between exports and fdi differs from the same choice by firms from manufacturing industries in two important aspects. First, transportation costs for exporting services are roughly zero.[4] Second, in contrast with internationally traded goods where all aspects of the product can be tested by the prospective buyer before purchase, in services production where certain aspects of the quality are intrinsic to the producer this is not the case. Bhattacharya, Patnaik and Shah (2010) assume that physical proximity of the provider reduces the risk perception of the customer - the risk perceived by a customer is greater when services are purchased from a foreign company than from a local provider. Hence the probability that a provider realises a positive demand for his service is higher for a firm with fdi than for a firm that exports services from a foreign country. This uncertainty dimension encourages services firms to engage in fdi (and not in exports), while the absence of transport costs discourages fdi (and encourages exports). The costs of exporting are assumed to be lower than the costs of producing abroad. The model shows that if the probability of realisation of zero demand is sufficiently higher for exporters of services compared to firms with fdi the threshold productivity for exporting is higher than for fdi.[5]

Bhattacharya, Patnaik and Shah (2010) test this implication of their model with data for firms from software services in India. As predicted by the model they find that less productive software companies engage in outward foreign direct investments and more productive firms export. Given the absence of other empirical studies on

[4] Note, however, that transport costs do matter if services exports require experts to travel to the destination country for consulting activities or after sales services.

[5] See Bhattacharya, Patnaik and Shah (2010, p. 8) for a profits-profitability diagram illustrating this and a comparison with the diagram used by Helpman, Meltiz and Yeaple (2004) and Helpman (2011) for the case of firms from manufacturing industries.

exports, foreign direct investment and productivity with data for firms from services industries[6] it is an open question whether this result should be considered as an anomaly that is only relevant for one special case - firms from software services in India - or whether it does point to fundamental differences in the way firms from manufacturing industries and from services industries choose between forms of international activities.

This paper contributes to the literature by providing the first evidence on the link of productivity and both exports and foreign direct investment in services firms from a highly developed country. It uses unique new data from Germany - one of the leading actors on the world market for services - that merge information from regular surveys and from a one-time special purpose survey performed by the Statistical Offices. To anticipate the most important results it turns out that the productivity pecking order found in numerous studies using data for firms from manufacturing industries does not exist among firms from services industries. In line with the theoretical model and the empirical results for software firms from India provided by Bhattacharya, Patnaik and Shah (2010) there is evidence that firms with fdi are less productive than firms that export.

The rest of the paper is organized as follows. Section 2 introduces the data and the definition of variables used in the empirical investigation. Section 3 presents descriptive statistics for firms from four groups, namely firms without exports and without foreign direct investments (fdi), firms that export but are not engaged in fdi, firms with fdi but without exports, and firms with both exports and fdi. Furthermore, it reports results from parametric and nonparametric statistical tests for differences in

[6] At least, I am not aware of other studies looking at the productivity pecking order of services firms with different forms of international activities.

productivity between these different types of internationally active firms. In section 4 estimates for the productivity premia of different types of internationally active firms compared to firms that sell their services on the German market only are discussed. These premia are estimated from empirical models by ordinary least squares, quantile regression and fully robust MM-regression. Section 5 concludes.

2. Data and definition of variables

The data used in this study come from two sources. The first source is the business services statistics (*Strukturerhebung im Dienstleistungsbereich*) collected by the German Federal Statistical Office and the statistical offices of the Federal States. The data cover units from the NACE 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 business services statistics include, among other data, 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. Small enterprises with an annual sum of turnover and other operating income lower than 250,000 € are given a shorter questionnaire, so information about export activities is missing for these enterprises. Therefore, in this investigation 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 from the NACE sector classification 72-74 are used.[7]

The business services statistics are the source of information on export activities and productivity plus the number of employees (that is included in the empirical models as a control variable):

- *Export* is dummy variable that is coded 1 for firms that reported turnover for business with companies located abroad (and 0 else).

- *Productivity* is measured as labour productivity, defined as turnover per employee (in Euro). More elaborate 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. Therefore, productivity is measured here as the relation of a firm's productivity to the average productivity of all firms in the three-digit level industry the firm comes from. To take care of the large gap in labour productivity between West Germany and East Germany all computations were performed separately for the two

[7] For more details about the dataset and how to access it see Vogel (2009). See Eickelpasch and Vogel (2011), Vogel (2011) and Vogel and Wagner (2011) for studies on exports of German business services firms using these data.

parts of Germany. The relative firm productivity is expressed as a percentage of the industry average.[8]

Note that no information about foreign direct investment is available from the business services statistics. Therefore, a second source of data is used. This is the so-called special purpose survey (*Erhebung für besondere Zwecke*, see §7 of the federal statistics law BStatG) on relocation of economic activities (*Verlagerung wirtschaftlicher Aktivitäten*) conducted by the German federal statistical office in 2006 (see Zwania 2008).[9] A representative sample of enterprises with at least 100 employees was, among others, asked whether they are the headquarter of a national enterprise group, the headquarter of an international enterprise group, a part of a national enterprise group, a part of an international enterprise group, or an independent firm. This information is used to identify firms with foreign direct investments:

- *Foreign direct investment (FDI)* is a dummy variable that is coded 1 if the firm stated that it was the headquarter of an international enterprise group (and 0 else).

[8] 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 measured. 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.

[9] Participation in a special purpose surveys is voluntary, and the sample is limited to 20.000 units. A prerequisite for this kind of survey is either a pressing need for data in the process of preparing or substantiating a planned decision by a high government agency, or the clarification of a methodological question in statistics.

Data from this survey on relocation of economic activities were matched with the data from the business services statistics using an enterprise identifier that is identical in both data sets. Information on FDI is available from the special purpose survey for the year 2006 only. Therefore, the data used in the empirical investigation is a cross-section for 2006.[10]

3. Descriptive statistics and tests for productivity difference between types of internationally active firms

As a first step in the empirical investigation of the links between productivity, exports and foreign direct investments (fdi) we will look at descriptive statistics for firms from four groups, namely firms without exports and without fdi, firms that export but are not engaged in fdi, firms with fdi but without exports, and firms with both exports and fdi. Table 1 reports the mean and the standard deviation of labour productivity for firms from each group, plus the values at the 25th, 50th and 75th percentile of the productivity distribution and the average value of the productivity of the three firms with the lowest and highest productivity, respectively.[11]

[Table 1 near here]

[10] Note that only enterprises with at least 100 employees in 2006 were sampled in the relocation survey, and all results, therefore, are for larger firms only. However, it can be argued that foreign direct investment might well be considered to be a rare event among smaller enterprises. Furthermore, in the empirical models estimated in this study firm size is controlled for by the number of employees (also included in squares to take care for non-linearity).

[11] Note that the minima and maxima cannot be reported because these are values that are for single observations and that have, therefore, to be treated as confidential.

The largest group of firms (about two thirds of the firms in the sample) is neither engaged in exports nor in fdi. Exporters without fdi are the second largest group (about a quarter of the firms in the sample). Firms with fdi are rare – only eight percent of the firms in the sample – and about half of these firms with fdi are exporters, too. From the mean values for productivity we see that, in line with findings from the literature (mentioned in section 1) for firms from both manufacturing industries and services industries, firms that export (group 2 and group 3) are on average more productive than firms that do not export (group 1 and group 3). Contrary to the implications of the theoretical model by Helpman, Melitz and Yeaple (2004) and to the big picture from micro-econometric studies on the productivity pecking order using data for firms from manufacturing industries (again mentioned in section 1), however, firms with fdi do not have the highest average labour productivity. Firms with fdi but without exports are on average as productive as firms that sell their services on the national market only; firms that are engaged in both exports and fdi are on average less productive than firms that only export.

These differences in average labour productivity between the four groups of firms are, however, not statistically significant at a usual error level. Table 2 reports results from six statistical tests for differences in the means of productivity between types of internationally active firms, looking at two groups at a time. None of these tests can reject the null-hypothesis that the mean values of the two groups considered are identical. To put it differently, according to the t-test for differences in the mean of labor productivity there is no productivity pecking order that has firms with exports and fdi at the top, firms that sale their services on the national market only at the bottom, and exporting firms in between – contrary to the implications of the Helpman-Melitz-Yeaple model and to the big picture from empirical studies using

data for manufacturing firms there is no productivity pecking order among services firms with different forms of international activities at all.

[Table 2 near here]

As a first step a comparison of mean values of productivity between the groups of different firms using a parametric t-test is fine. But one should not stop here. As Moshe Buchinsky (1994: 453) put it: "'On the average' has never been a satisfactory statement with which to conclude a study on heterogeneous populations." The mean value of a variable might be heavily influenced by a small number of extremely large or small observations, especially if the number of firms is fairly small like in the exercise performed here. A look at selected percentiles of the productivity distribution for the groups of firms reported in Table 1 reveals that firms within all groups are highly heterogeneous with regard to their productivity. To mention the most extreme example, the average productivity of the three most productive firms that are neither exporters nor engaged in fdi is 410 times the average productivity of the three least productive firms from this group. Conover (1999, p. 117) argues that data with observations that are much larger or much smaller than the bulk of observations in the sample indicate that these data come from a heavy-tailed distribution. He points out that in a case like this it is important to use nonparametric methods to analyze the data because of the superior power of those methods when compared with the parametric methods (like the t-test applied above) that are based on the assumption that the data are normally distributed.

Therefore, an empirical study of heterogeneous firms should look at differences in the whole distribution of the variable under investigation between

groups of firms, not only at differences at the mean, by using a nonparametric test. The hypothesis that the productivity distribution of one group of firms stochastically dominates the productivity distribution of another group can be tested by the Kolmogorov-Smirnov test. This non-parametric test for first order stochastic dominance of one distribution over another was introduced into the empirical literature on international firm activities and productivity by Delgado, Farinas and Ruano (2002). Let F and G denote the cumulative distribution functions of productivity for two groups of firms (say, exporters and firms that serve the national market only). First order stochastic dominance of F relative to G is given if F(z) – G(z) is less or equal zero for all z with strict inequality for some z. Given two independent random samples of plants from each group, the hypothesis that F is to the right of G can be tested by the Kolmogorov-Smirnov test based on the empirical distribution functions for F and G in the samples (for details, see Conover 1999, p. 456ff.).

Results reported in Table 2 show that according to the Kolmogorov-Smirnov test the productivity distributions do differ in three out of six cases. This is a different picture than the one revealed by the t-test of differences in mean values of productivity between the groups of firms. The null-hypothesis of no difference in the distribution can be rejected at an error level of 4 percent or less for firms that neither export nor do fdi versus firms that do not export but are engaged in fdi; for firms that export but do no fdi versus firms that do not export but are engaged in fdi; and for firms that do not export but are engaged in fdi versus firms that do both export and fdi. Let us look at these three cases in turn:

- The productivity distributions of firm that sell their services on the national market only on the one hand and of firms that do not export but are engaged in fdi are different. While the null-hypothesis that this difference is in favour of the firms that

focus on the national market only cannot be rejected (the p-value is 0.898), the null-hypothesis that the difference is in favour of the non-exporting firms with fdi can be rejected at an error level of 2.4 percent. *Firms with fdi (and no exports) are less productive than firms that are active on the German market only.*

- The productivity distributions of firm that sell their services on foreign markets but who are not engaged in fdi on the one hand and of firms that do not export but are engaged in fdi are different. While the null-hypothesis that this difference is in favour of the firms that export without doing fdi cannot be rejected (the p-value is 0.961), the null-hypothesis that the difference is in favour of the non-exporting firms with fdi can be rejected at an error level of less than 1 percent. *Firms with fdi (and no exports) are less productive than firms that are exporters without fdi.*

- The productivity distributions of firms with fdi differ between firms that export and firms that do not. The Kolmogorov-Smirnov test points out that the difference is in favour of the firms with both exports and fdi. *Firms with fdi but without exports are less productive than firms that are engaged in both export and fdi.*

The bottom line, then, is that from the results of the six Kolmogorov-Smirnov tests we do not find evidence of a productivity pecking order that has firms with exports and fdi at the top, firms that sale their services on the national market only at the bottom, and exporting firms in between. The productivity distribution of exporting firms does not always dominate the productivity distribution of non-exporting firms, and firms that are engaged in both export and fdi are not more productive than firms that sell their services on the German market only or that only export without fdi. Like in the case of the results from the t-tests of the statistical difference of the mean productivity between the groups of firms, these results are contrary to the implications

of the Helpman-Melitz-Yeaple (2004) model and to the big picture from empirical studies using data for manufacturing firms.

We do, however, find evidence that firms with fdi but with no exports are less productive than firms from all three other groups. This evidence only emerges from the Kolmogorov-Smirnov tests (and not from the t-tests). Given that the firms are highly heterogeneous within each group this result that is based on a non-parametric test that compares the whole productivity distributions is more convincing than the result from a comparison of average values of productivity alone using a parametric test. These findings are in line with the implications of the theoretical model for the choice between fdi and exports for services firms by Bhattacharya, Patnaik and Shah (2010) and with the results from their study that uses data for services firms from India.

4. Productivity premia for different types of internationally active firms

The next step in the empirical investigation of the links between productivity and international firm activities (exports and/or fdi) consists of the estimation of so-called productivity premia of different types of internationally active firms. A productivity premium is defined as the difference in labour productivity between firms from one group of internationally active firms (say, firms that are engaged in both export and fdi) and firms from the reference group, i. e. firms that sell their services on the national market only, after controlling for firm characteristics other than international activities.

Note that by construction the productivity differences looked at in section 3 are not unconditional productivity differences. Productivity is measured here as the relation of a firm's productivity to the average productivity of all firms in the three-digit

level industry the firm comes from. Furthermore, to take care of the large gap in labour productivity between West Germany and East Germany average productivity was computed separately for firms from the two parts of Germany. Therefore, differences in productivity are already conditional on the industry affiliation of the firms and on the part of Germany a firm is located in. Following the approach that is standard in the literature on productivity and international firm performance (surveyed in Wagner (2007, 2011)) one more firm characteristic is controlled for in the empirical models, namely firm size (measured as the number of employees in the firm which is also included in squares to take care of a non-linear relation between firm size and productivity).

In a first approach the premia are estimated by OLS. Results are reported in Table 3. The point estimates are positive for all three groups of internationally active firms; these estimates, however, are not statistically significant at any conventional level of significance pointing to no productivity pecking order among services firms with different forms of international activities at all.

[Table 3 near here]

If we acknowledge that firms are heterogeneous, we have reasons to suspect that the conditional difference in labour productivity between exporting and non-exporting firms does not need to be the same for all firms. For example, it might be the case that the productivity difference between firms from the reference group (that are not internationally active) and firms that export but without fdi that are of the same size and from the same industry in the same part of Germany is higher for firms at the lower end of the productivity distribution. If we are interested in the size of the

exporter premium, and if we regress labour productivity on a set of dummy variables that indicate the three different types of internationally active firms plus a set of control variables using OLS, there is no room for firm heterogeneity of this kind. OLS assumes that the conditional distribution of productivity, given the set of firm characteristics included in the regression, is homogeneous. This implies that no matter what point on the conditional distribution is analyzed, the estimates of the relationship between productivity (the dependent variable) and the firm characteristics (the independent variables) are the same.

If one wants to test the empirical validity of this assumption made by OLS, and if one is interested in the evaluation of the size of the premium at different points of the conditional productivity distribution, one has to apply a different estimation technique that is tailor-made for this – quantile regression. A discussion of technical details of quantile regression is beyond the scope of this paper; canonical references are the pioneering paper by Koenker and Bassett (1978), the survey by Buchinsky (1998) and the monograph by Koenker (2005), while Koenker and Hallock (2001) provide a non-technical introduction. Suffice it to say here that 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 but not a foreign investor, or not), i.e. the marginal change in productivty at the k^{th} conditional quantile due to a change in the status of international activities. 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. This provides information about the heterogeneity of plant behavior. Note that quantile regression is not the same as applying OLS to subsets of the data produced by dividing the complete data set into different percentiles of the dependent variable. This would mean that not all of the data are being used for each estimate, and it would introduce the familiar type of sample selection bias. For each quantile regression estimate all of the data are being used; some observations, however, get more weight than others.

Estimation results for the productivity premia for firms from various groups of internationally active firms compared to firms that sell their services on the German market only are reported in Table 3 for the 10^{th}, 25^{th}, 50^{th}, 75^{th} and 90^{th} quantile. The estimated premium is statistically different from zero at a conventional error level in five out of fifteen cases only. At the lower end of the conditional productivity distribution we find evidence for a productivity pecking order that is in line with the big picture reported in studies using data for firms from the manufacturing industries – firms that both export and perform fdi have the highest productivity premium, followed by firms that only export. In line with the findings from the Kolmogorov-Smirnov tests (discussed in section 3) firms with fdi but without exports have a negative premium compared to firms from the reference group that have no international activities (and compared to firms from the other groups of internationally active firms, too). This picture, however, only describes the lower end of the conditional productivity distribution. No evidence for a productivity pecking order is found at the rest of the conditional productivity distribution.

The bottom line, then, is that the relationship between international firm activities and labour productivity is not the same at each point of the conditional

productivity distribution of German services industries firms. At least in my view, therefore, results based on a comparison across different quantiles of the conditional distribution are more convincing than results for the conditional mean from OLS regressions when firms are as heterogeneous as it is the case here.

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 services industries 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 firm that develops a new complex set of programs over a long time and that reports the first sales in the year when the programs are completed and delivered to customers for the first time), 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 various groups of firms 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 different types of internationally active firms, 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).

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 low values of labour productivity might be considered as a first and useful step to check the sensitivity of results. However, although this approach seems to be rather popular 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. One approach that is advocated in the literature has already been applied in our exercise. Quantile regression is often used to deal with outliers. As Yasar, Nelson and Rejesus (2006, p. 682) put it: “Quantile regression estimates are considered robust relative to least squares estimates. In contrast to the least squares estimator, the quantile regression estimates place less weight on outliers and are found to be robust to departures from normality.” Quantile regression at the median is identical to least absolute deviation (LAD) regression that minimizes the sum of the absolute values of the residuals rather than the sum of their squares (as in OLS). This estimator is also known as the L_1, or median regression, estimator. LAD regression, however, is not a panacea against outliers. To see why, 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.”

Using this terminology one can state that the median regression estimator protects against vertical outliers but not against bad leverage points (Verardi and Croux 2009, p. 441; Koenker 2005, p. 268). Full robustness 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[12] of 50 % compared to zero percent for OLS). A discussion of the details of this estimator is beyond the scope of this paper (see Verardi and Croux (2009) for this estimator and for Stata commands to compute it). Suffice it to say here that this estimator combines a breakdown point of 50 percent with a high efficiency (the degree of which can be chosen by the researcher). An explicit formula for the estimator is not available, it is computed by numerical optimization.

[12] 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.

Given that the presence of outliers can be expected to be the rule in data sets for heterogeneous firms it is important to document the extent to which estimation results are influenced by extreme observations. Results for the productivity premia of groups of firms with different forms of international activities compared to firms that sell their services on the German market only computed by the fully robust MM-estimator are reported in the last column of Table 3.[13] While the point estimates show a pattern that is in accordance with the results from quantile regression at the lower end of the conditional productivity distribution, none of the estimated regression coefficients is statistically different from zero at any conventional error level.

Thus, from estimates of productivity premia for different types of internationally active German services firms that are computed by OLS, quantile regression and a fully robust MM-estimator no evidence for a productivity pecking order is found but for the least productive firms from the lower end of the conditional productivity distribution.

5. Discussion

This paper contributes to the literature on international firm activities and firm performance by providing the first evidence on the link of productivity and both exports and foreign direct investment (fdi) in services firms from a highly developed country, Germany, that is one of the leading actors on the world market for services. Descriptive statistics, results from parametric and non-parametric statistical tests and from various types of regression analyses (OLS, quantile regression, robust MM-

[13] Computations were done using the ado-files provided by Verardi and Croux (2009) with the efficiency parameter set at 0.7 as suggested there based on a simulation study; details are available on request.

regression) indicate that the productivity pecking order found in numerous studies using data for firms from manufacturing industries – where the firms with the highest productivity engage in fdi while the least productive firms serve the home market only and the productivity of exporting firms is in between – does not exist among firms from services industries in the sample used in this study. Services industries firms are different. While exporters tend to be the most productive firms, there is evidence that, in line with the theoretical model and the empirical results for software firms from India provided by Bhattacharya, Patnaik and Shah (2010), firms with fdi are less productive than firms that export.

To put these findings into perspective it should be pointed out that the data used in the empirical investigation are limited in an important dimension. The data are cross section data only because the information about fdi of services firms is available from the special purpose survey for one year (namely 2006) only. The lack of panel data for several years makes it impossible to control for unobserved heterogeneity between firms via estimation of empirical models including fixed firm effects. Unobserved firm characteristics that are correlated with the variables included in the empirical models – like management quality – might well play a role in shaping the decision how to serve a foreign market. Furthermore, with cross-section data it is only possible to look at correlations. It is impossible to investigate the direction of causality between, say, productivity and fdi, and to see whether a high (or a low) productivity determines starting fdi or whether fdi activities influence productivity (or whether both is the case). Therefore, the picture drawn based on these data is necessarily incomplete. Given the lack of empirical studies on exports, fdi and productivity for services firms, however, the findings reported should be interesting none the less.

An important next step in research in this area consists in similar empirical investigations using (panel) data from other countries. Given that these data cannot accessed by me for confidentiality reasons I suggest that researchers from other countries replicate and extend this study – and inform me about any results.

References

Bartelsman, Eric J. and Mark Doms (2000), Understanding Productivity: Lessons from Longitudinal Micro Data. *Journal of Economic Literature* XXXVIII (3), 569-594.

Bhattacharya, Rudrani, Ila Patnaik and Ajay Shah (2010), Exports versus FDI in services. International Monetary Fund IMF Working Paper WP/10/290, December.

Buchinsky, Moshe (1994), Changes in the U.S. Wage Structure 1963 – 1987: Application of Quantile Regression. *Econometrica* 62 (2), 405-458.

Buchinsky, Moshe (1998), Recent advances in quantile regression models. A practical guideline for empirical research. *Journal of Human Ressources* 33 (1), 88-126.

Conover, W. J. (1999), *Practical Nonparametric Statistics*. Third edition. New York etc.: John Wiley.

Delgado, Miguel A., Jose C. Farinas and Sonia Ruano (2002), Firm productivity and export markets: a non-parametric approach. *Journal on International Economics* 57 (2), 397-422.

Eickelpasch, Alexander and Alexander Vogel (2011), Determinants of the export behaviour of German business services companies. *The Services Industries Journal* 31 (3-4), 513-526.

Foster, Lucia, John Haltiwanger and Chad Syverson (2008), Reallocation, Firm Turnover, and Efficiency: Selection on Productivity or Profitability? *American Economic Review* 98 (1), 394-425.

Helpman, Elhanan (2011), Understanding Global Trade. Cambridge and London: Harvard University Press.

Helpman, Elhanan, Marc J. Melitz and Stephen R. Yeaple (2004), Export versus FDI with Heterogeneous Firms. *American Economic Review* 94 (1), 300-316.

International Study Group on Exports and Productivity (ISGEP) (2008), Understanding Cross-Country Differences in Exporter Premia: Comparable Evidence for 14 Countries. *Review of World Economics* 144 (4), 596-635.

Koenker, Roger (2005), *Quantile Regression*. Cambridge etc.: Cambridge University Press.

Koenker, Roger and Gilbert Bassett (1978), Regression quantiles. *Econometrica* 46 (1), 33-50.

Koenker, Roger and Kevin F. Hallock (2001), Quantile regression. *Journal of Economic Perspectives* 15, Fall, 143-156.

Rousseeuw, Peter J. and Annick M. Leroy (1987), *Robust Regression and Outlier Detection.* New York etc.: John Wiley and Sons.

Syverson, Chad (2011), What determines productivity? *Journal of Economic Literature* 49 (2), 326-365.

Verardi, Vincenzo and Christophe Croux (2009), Robust regression in Stata. *The Stata Journal* 9 (3), 439-453.

Vogel, Alexander (2009), The German Business Services Statistics Panel 2003 – 2007. *Schmollers Jahrbuch / Journal of Applied Social Science Studies* 129 (4), 515 – 522

Vogel, Alexander (2011), Exporter Performance in the German Business Services Sector. *The Services Industries Journal* 31 (7), 1015 - 1031.

Vogel, Alexander and Joachim Wagner (2011), Robust estimation of exporter productivity premia in German business services enterprises. University of Lueneburg Working Papers in Economics No. 207, July.

Wagner, Joachim (2007), Exports and Productivity: A Survey of the Evidence from Firm-Level Data. *The World Economy* 30 (1), 60-82.

Wagner, Joachim (2011), International Trade and Firm Performance: A Survey of Empirical Studies since 2006. University of Lueneburg Working Paper Series in Economics 210, August.

Yasar, Mahmut, Carl H. Nelson and Roderick Rejesus (2006), Productivity and Exporting Status of Manufacturing Firms: Evidence from Quantile Regressions. *Review of World Economics* 142 (4), 675-694.

Zühlke, Sylvia, Markus Zwick, Sebastian Scharnhorst and Thomas Wende (2004), The research data centres of the Federal Statististical Office and the statistical offices of the Länder. *Schmollers Jahrbuch / Journal of Applied Social Science Studies* 124(4): 567-578.

Zwania, Jacek (2008), Verlagerung wirtschaftlicher Aktivitäten. Theoretischer Hintergrund zur Erhebung. *Wirtschaft und Statistik* 6/2008, 477-482.

Table 1: Descriptive statistics

Type			No. of Firms	Labour productivity[1] Mean	Std. dev.	Average lowest three	p25	p50	p75	Average highest three
1	Export: No	FDI: No	487	95.54	115.52	2.75	51.99	71.07	104.82	1,127.08
2	Export: Yes	FDI: No	181	109.68	155.23	13.74	52.61	78.28	124.70	989.99
3	Export: No	FDI: Yes	30	95.45	161.74	4.89	29.46	70.89	98.93	417.65
4	Export: Yes	FDI: Yes	27	102.56	62.98	47.45	60.62	76.81	122.99	254.95

[1] Turnover per employee; measured as percentage of the 3-digit-level industry mean in West Germany or East Germany

Table 2: Tests for differences in labour productivity between different types of internationally active firms

Group A		Group B		t-test[1]	Kolmogorov-Smirnov test[2]		
				H_0: no difference (p-value)	H_0: no difference (p-value)	H_0: difference in favour of Group A (p-value)	H_0: difference in favour of Group B (p-value)
Export: No	FDI: No	Export: Yes	FDI: No	0.301	0.170	0.092	0.966
Export: No	FDI: No	Export: No	FDI: Yes	0.971	0.040	0.898	0.024
Export: No	FDI: No	Export: Yes	FDI: Yes	0.651	0.270	0.155	0.925
Export: Yes	FDI: No	Export: No	FDI: Yes	0.656	0.009	0.961	0.006
Export: Yes	FDI: No	Export: Yes	FDI: Yes	0.672	0.381	0.218	0.783
Export: No	FDI: Yes	Export: Yes	FDI: Yes	0.825	0.013	0.011	0.969

[1] The t-test is a test for the statistical significance of the difference in mean values of labor productivity of the firms from Group A and Group B.
[2] The Kolmogorov-Smirnov test is a test for first-order stochastic dominance between the productivity distributions of the firms from the two groups.

Table 3: Productivity premia for different types of internationally active firms[1]

Type of firm				Estimation method: OLS	Quantile regression q10	q25	q50	q75	q90	Robust MM-regression
2	Export: Yes	FDI: No	Premium	11.35	9.01	0.35	6.86	18.88	20.96	3.21
			p-value	0.377	0.001	0.913	0.169	0.016	0.259	0.425
3	Export: No	FDI: Yes	Premium	5.64	-13.63	-22.81	2.15	6.61	5.47	-8.36
			p-value	0.854	0.065	0.004	0.872	0.698	0.966	0.413
4	Export: Yes	FDI: Yes	Premium	4.94	20.17	8.37	6.34	15.30	69.26	9.32
			p-value	0.707	0.000	0.134	0.620	0.599	0.217	0.149

[1] The premia are the estimated regression coefficients of dummy variables for firms from the type indicated; the reported premium is the difference in labour productivity between the firms from the respective group and the firms from the reference group (i.e. firms without export and fdi). Besides the dummy variables for the three groups of internationalized firms the empirical model includes the number of employees (also included in squares) and a constant. Productivity is measured here as the relation of a firm's productivity to the average productivity of all firms in the three-digit level industry the firm comes from. Furthermore, to take care of the large gap in labour productivity between West Germany and East Germany average productivity was computed separately for firms from the two parts of Germany. Therefore, differences in productivity are already conditional on the industry affiliation of the firms and on the part of Germany a firm is located in.

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