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Exports and Productivity in Germany

by

Joachim Wagner
University of Lueneburg,
Institute for the Study of Labor, Bonn, and
Max Planck Institute of Economics, Jena

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Max Planck Institute of Economics
Group Entrepreneurship, Growth and Public Policy
Kahlaische Str. 10
07745 Jena, Germany
Fax: ++49-3641-686710

Exports and Productivity in Germany

Joachim Wagner

University of Lueneburg, Institute of Economics

Institute for the Study of Labor (IZA), Bonn

Max Planck Institute of Economics, Jena

wagner@uni-lueneburg.de

Abstract:

Using unique recently released nationally representative high-quality longitudinal data at the plant level, this paper presents the first comprehensive evidence on the relationship between exports and productivity for Germany, a leading actor on the world market for manufactured goods. It applies and extends the now standard approach from the international literature to document that the positive productivity differential of exporters compared to non-exporters is statistically significant, and substantial, even when observed firm characteristics and unobserved firm specific effects are controlled for. For West German plants (but not for East German plants) some empirical evidence for self-selection of more productive firms into export markets is found. There is no evidence for the hypothesis that plants which start to export perform better in the three years after the start than their counterparts which do not start to sell their products on the world market. Results for West Germany support the hypothesis that the productivity differential between exporters and non-exporters is at least in part the result of a market driven selection process in which those export starters that have low productivity at starting time fail as a successful exporter in the years after the start, and only those that were more productive at starting time continue to export.

Keywords: Exports, productivity, micro data, Germany

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Address for correspondence:

Prof. Dr. Joachim Wagner
University of Lueneburg
Institute of Economics
PO Box 2440
D-21314 Lueneburg
Germany
Phone: +49-4131-677-2330
Fax: +49-4131-677-2026
http://www.uni-lueneburg.de/fb2/vwl/wifo

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1. Motivation

While the role of exports in promoting growth in general, and productivity in particular, has been investigated empirically using aggregate data for countries and industries for a long time (see the surveys by Baldwin (2000), Giles and Williams (2000a, 2000b), and López (2005)), only recently have comprehensive longitudinal data at the firm level been used to look at the extent and causes of productivity differentials between exporters and their counterparts which sell on the domestic market only. In this literature two alternative but not mutually exclusive hypotheses why exporters can be expected to be more productive than non-exporting firms are discussed and investigated empirically (see Bernard and Jensen 1999; Bernard and Wagner 1997):

The first hypothesis points to self-selection of the more productive firms into export markets. The reason for this is that there exist additional costs of selling goods 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 for foreign consumption. These costs provide an entry barrier that less successful firms cannot overcome. 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.

The second hypothesis points to the role of learning-by-exporting. Knowledge flows from international buyers and competitors help to improve the post-entry performance of export starters. Furthermore, 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.

A recent survey of 54 micro-econometric studies with data from 34 countries, published between 1995 and 2006, shows that, details aside, exporters are more productive than non-exporters, and the more productive firms self-select into export markets, while exporting does not necessarily improve productivity (see Wagner 2007).

Empirical evidence for Germany (reported in Bernard and Wagner (1997, 2001), Wagner (2002, 2006a, 2006b), and Arnold and Hussinger (2005a, 2005b), and summarized in tabular form in Wagner (2007)) is in line with these international patterns. This evidence, however, is only based on data from one single federal state (namely, Lower Saxony), or from a highly unbalanced panel of enterprises (the Mannheim Innovation Panel) that is not well suited to investigate the performance of firms over time.

Given that Germany is a leading actor on the world market for manufactured goods, and that exports tend to play a key role for the macroeconomic development in Germany in the short and in the long run, this absence of comprehensive evidence on the relationship between exports and productivity which is based on nationally representative high-quality recent longitudinal data at the firm level is a serious gap. This paper attempts to fill this gap. It uses a unique recently released panel data set (described in more detail in section 2 below) covering nearly all manufacturing establishments that produced in at least one year between 1995 and 2004 in Germany to apply and extend the now standard approach from the international literature to document the extent of the difference in productivity between exporters and non-exporters, and to investigate empirically the direction of causality between exports and productivity.

The rest of the paper is organised as follows: Section 2 introduces the newly available panel data set and reports descriptive evidence. Section 3 presents results from econometric tests for the existence and size of exporter productivity premia. Section 4 looks for evidence related to the self-selection hypothesis, while section 5 deals with the learning-by-exporting hypothesis. In section 6 the role of productivity at export starting time for the survival of exporters is investigated. Section 7 concludes.

2. Data and Descriptive Evidence

The empirical investigation uses data from an unbalanced panel of establishments (local production units, plants)[1] built from cross section data collected in regular surveys by the Statistical Offices of the German federal states. The surveys cover all establishments from mining[2] and manufacturing industries that employ at least twenty persons in the local production unit or in the company that owns the unit. Participation of firms in the survey is mandated in official statistics law, and the firms have to report the true figures. In this paper annual data for 1995 (when the new WZ93 classification scheme and the new definition of the population of establishments to be surveyed was introduced) to 2004 are used. Panel data of this type have been available for some federal states in the past, and the data for one federal state, Lower Saxony, have been used for empirical studies of the linkages between exports and productivity (see Bernard and Wagner (1997, 2001), and Wagner (2002, 2006b)). Only recently these data sets were matched over all federal states to form a panel that covers Germany as a whole. Note that the micro level data are strictly confidential and for use inside the Statistical Office only, but not exclusive. Further information on the content of the data set and how to access it is given in Wagner (2000) and in Zühlke et al. (2004).

[1] In this paper we will use the terms *firm*, *establishment*, and *plant* interchangeably to describe the (local production) unit of analysis.

[2] Given that there are only a few establishments from mining industries we will use the term manufacturing industries to describe our sample in this paper.

It should be noted that in this data set *export* refers to the amount of sales to a customer in a foreign country plus sales to a German export trading company; indirect exports (for example, tires produced in a plant in Germany that are delivered to a German manufacturer of cars who exports some of his products) are not covered by this definition. Furthermore, note that single or multiple establishment enterprises with less than 20 employees in total do not report to the survey.

Productivity is measured as total sales (in constant prices) per employee, i.e. labor productivity.[3] More appropriate measures of productivity like value added per employee (or per hour worked), or total factor productivity, cannot be computed because of a lack of information on hours worked, value added, and the capital stock[4] in the surveys. Controlling for the industry affiliation at the detailed 4-digit-level in the econometric investigations, however, can be expected to absorb much of these differences in the degree of vertical integration and capital intensity.[5] Some establishments reported either tiny or very huge amounts of turnover in some years, leading to tiny or very huge values of labor productivity. Due to data protection rules it is impossible to investigate the reasons for these implausible figures, and to

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[3] Note that the number of employees is computed as the average value reported in the monthly surveys; establishments with less than twelve reports in a year were excluded from all computations because they were not active during the whole year, and are therefore not comparable to the rest of the establishments. Furthermore, note that the number of employees includes the owners of the firm if they worked in the firm.

[4] The survey has information about investment that might be used to approximate the capital stock. A close inspection of the investment data, however, reveals that many establishments report no or only a very small amount of investment in many years, while others report huge values in one year. Any attempt to compute a capital stock measure based on these data would result in a proxy that seems to be useless.

[5] 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. Furthermore, Foster, Haltiwanger and Syverson (2005) show that productivity measures that use sales (i.e. quantities multiplied by prices) and measures that use quantities only are highly positively correlated.

discriminate between reporting errors, idiosyncratic events, or other causes. Given that outliers of this kind might influence findings from both descriptive statistics and econometric investigations, establishments from the bottom and top one percent of the labor productivity distribution were excluded from all computations.[6]

Given that the panel data set starts in 1995, five years after the German re-unification, and that the East German economy still differs in many respects form the West German economy, all computations were done for both parts separately.[7]

For the period under consideration the share of exporting firms in all firms, and the share of foreign sales in total sales, are reported in column one and two of table 1 and table 2 for West Germany and East Germany, respectively. In West Germany about two in three manufacturing firms were exporters, and the share of exporting firms increased between 1995 and 2005.[8] During these years the average share of foreign sales in total sales increased from 22.5 to 29.5 percent for exporting firms. This demonstrates that in the manufacturing sector of West Germany the importance of exporters and exporting is high and increasing. The same holds, although at a somewhat lower level, for East Germany. Here, the share of exporters among all manufacturing firms increased from one in three in 1995 to one in two in 2004, while the share of exports in total sales rose from 17 percent to 24 percent.[9]

[6] Results including these outliers are documented in the appendix tables.

[7] Note that the federal state of Berlin is included in East Germany here.

[8] The decrease in the share of exporting firms between 1995 and 1997 is due to a change in the sampling frame used for the survey the data are taken from. Starting in 1997 a large number of establishments that reported to the craft sector survey in earlier years were included in the survey covering the manufacturing sector. Given that these craft establishment (e.g., butchers or bakers) tend to produce goods for the local market only, the share of exporting firms decreased even if the numbers of exporting firms increased.

[9] Table A.1 and A.2 in the appendix show that these results are not affected by the exclusion or inclusion of outliers.

[Table 1 and Table 2 near here]

Following the now standard approach in the empirical literature on exports and productivity (that was introduced by Bernard and Jensen (1995, 1999)) we start by looking at differences in average labor productivity (total value of shipments per worker) between exporters and non-exporters to document the existence and size of the unconditional productivity differential. In West Germany this differential was statistically significant in all years between 1995 and 2004, and this was the case in East Germany in every year since 1997.[10]

If one looks at differences in the mean value for both groups only, one focuses on just one moment of the productivity distribution. A stricter test that considers all moments is a test for stochastic dominance of the productivity distribution for exporters over the productivity distribution for non-exporters. More formally, let F and G denote the cumulative distribution functions of productivity for exporters and non-exporters. Then first order stochastic dominance of F relative to G means that F(z) – G(z) must be less or equal zero for all values of z, with strict inequality for some z. Whether this holds or not is tested non-parametrically by adopting the Kolmogorov-Smirnov test. This method has been used to discuss the issue of exports and productivity for the first time by Delgado, Farinas and Ruano (2002); applications for German data are Arnold and Hussinger (2005b) and Wagner (2006a). For both West Germany and East Germany, and for each year between 1995 and 2004, the prob-value for the Kolmogorov-Smirnov test of the null-hypothesis that the distribution of labor productivity for non-exporters and exporters are identical against the alternative

[10] Note that the difference between exporters and non-exporters is not statistically significant at a conventional level for firms from West Germany in 1995 – 1997 when outliers are included; see table A.1.

hypothesis that the distribution for exporters first-order stochastically dominates the distribution for non-exporters is 0.000, indicating that the null-hypothesis can be rejected in favour of the alternative hypothesis at any usual error level.[11]

Exporters and non-exporters do differ with respect to other dimensions, too. As can be seen from table 1 and table 2, on average, exporters are larger (according to the number of employees), and have higher values of human capital intensity (proxied by the sum of wages and salaries paid per employee). All of these differences between exporters and non-exporters are statistically significant at an error level of five percent or better. The Kolmogorov-Smirnov test uniformly shows the same result – the prob-value is 0.000, pointing to first-order stochastic dominance of the distribution of size, and human capital intensity, of exporters over non-exporters.[12]

This picture is familiar from earlier studies comparing exporting and non-exporting firms (see Bernard and Wagner 1997 for Lower Saxony, Bernard and Jensen 1995 for the U.S., and several studies for other countries surveyed in Wagner 2007): Exporters are more productive, larger, and have a higher intensity of human capital than non-exporters.

3. Exporter Productivity Premia

After documenting the existence of an unconditional productivity differential in favour of exporters compared to non-exporters the next step in our investigation is a test for the existence or not of so-called exporter premia, defined as the ceteris paribus percentage difference of labor productivity between exporters and non-exporters.

[11] Given the uniformity of results tables reporting them are omitted to economize on space. Note that these results do not change when outliers are included.

[12] These results do not differ if outliers are included in the sample.

This is motivated by the fact that exporters tend to be larger and more human capital intensive than non-exporters (as demonstrated in section 2 above), and concentrated in different industries (which tend to be more capital intensive, and have higher research and development intensities) than non-exporters. Therefore, a positive unconditional productivity differential in favour of exporters comes at no (or only a small) surprise. The question is whether or not this differential exists if other factors related to productivity are controlled for. To test for these exporter productivity premia log labour productivity is regressed on the current exporter status dummy and a set of control variables:

$$\ln LP_{it} = a + ß\ Export_{it} + c\ Control_{it} + e_{it} \qquad (1)$$

where i is the index of the firm, t is the index of the year, LP is labor productivity, Export is a dummy variable for current exporter status (1 if the firm exports in year t, 0 else), Control is a vector of control variables (the number of employees – also included in squares -, human capital intensity, and four-digit industry dummies), and e is an error term. The exporter premium, computed from the estimated coefficient ß as 100(exp(ß)-1), shows the average percentage difference between exporters and non-exporters controlling for the characteristics included in the vector Control.[13]

[13] Note that the regression equation specified in (1) is not meant to be an empirical model to explain labor productivity at the plant level; the data set at hand here is not rich enough for such an exercise. Equation (1) is just a vehicle to test for, and estimate the size of, exporter premia controlling for other plant characteristics that are in the data set. Furthermore, note that productivity differences at the firm level are notoriously difficult to explain empirically. “At the micro level, productivity remains very much a measure of our ignorance.” (Bartelsman and Doms 2000, p. 586)

Instead of using a dummy variable for the current exporter status, variants of (1) include either the share of exports in total sales, or the share of exports in total sales and its squared value, to test for a relationship between export intensity and the difference in labor productivity between exporters and non-exporters.

To control for unobserved plant heterogeneity due to time-invariant firm characteristics which might be correlated with the variables included in the empirical model and which might lead to a biased estimate of the exporter premia, (1) is estimated using pooled data for the years 1995 to 2004 and including fixed plant effects, too. When the model is estimated with pooled data, the industry dummy variables are replaced by a complete set of industry-year interaction dummy variables to control for time and industry specific effects like variations in output prices and labor costs (see Lichtenberg 1988, p. 425).

Results are reported in table 3 for West Germany and in table 4 for East Germany. The exporter productivity premia computed from the estimates for the coefficient of the exporter status dummy variable are positive and statistically significant at an error level of less than one percent for all years and both parts of Germany. At least for the years after 1996 these premia have about the same order of magnitude in West and East Germany. Furthermore, the pemium is large from an economic point of view – some 17 percent according to the estimate from the regression using pooled data, and seven or six percent after controlling for unobserved heterogeneity in the model including fixed firm effects in West and East Germany, respectively.

[Table 3 and Table 4 near here]

According to the results reported in column two of table 3 and table 4, labour productivity is higher the higher is the share of exports in total sales. Again, the estimated coefficients are highly significant statistically, of the same order of magnitude in West and East Germany, and lower in the model controlling for unobserved firm heterogeneity. Augmenting this empirical model by including the squared share of exports in total sales points to a relationship between labor productivity and export intensity that is non-linear and has the shape of an inverted u when the regression is run with cross section data for single years or with pooled data not including fixed firm effects (see columns three and four of table 3 and table 4). This non-linearity, however, is due to unobserved time-invariant firm effects that are not controlled for in these regressions; in the fixed effects model the coefficient of the term “share of exports in total sales (squared)” is not statistically significant at any conventional level for West and East Germany.

The bottom line, then, is that exporters have a higher labor productivity than non-exporters of the same size and with the same human capital intensity which are from the same industry, and that this exporter productivity premium is increasing in the share of exports in total sales; these results hold when unobserved firm heterogeneity is controlled for by including fixed firm effects in the empirical model.[14]

4. Do more productive firms self-select into export markets?

As stated in the introductory section of this paper, one of two hypotheses discussed in the literature on the linkages between productivity and exporting points to self-

[14] By and large, this big picture is the same when outliers are included in the sample (see tables A.3 and A.4), although the estimated premia tend to be somewhat higher then, and the non-linear relationship between productivity and the share of exports in total sales is found for West Germany after controlling for unobserved firm heterogeneity, too.

selection of the more productive firms into export markets. To shed light on the empirical validity of the hypothesis that the more productive firms go abroad the pre-entry differences in productivity between export starters and non-exporters are investigated next.

If good firms become exporters then we should expect to find significant differences in performance measures between future export starters and future non-starters several years before some of them begin to export. A way to test whether today's export starters were more productive than today's non-exporters several years back when all of them did not export is to select all firms that did not export between year t-3 and t-1, and compute the average difference in labor productivity in year t-3, t-2, and t-1, respectively, between those firms who did export in year t and those who did not. If one looks at differences in the mean value for both groups only, one focuses on just one moment of the productivity distribution. A stricter way that considers all moments is to test for stochastic dominance of the productivity distribution for future exporters over the productivity distribution for future non-exporters, and to apply the Kolmogorov-Smirnov test (discussed in more detail in Section 2 above) to the data for year t-3, t-2, and t-1.

Table 5 to table 10 report for West German and East German plants the results for t-tests (testing for the significance of differences in the mean values) and Kolmogorov-Smirnov tests (testing for first order stochastic dominance of the distribution for future exporters over the distribution for future non-exporters) for the cohorts 1998 to 2004 (using data from 1995 to 2001) three, two, and one years before some of these plants started to export. To give a broader impression results for plant size and human capital intensity are reported, too.

[Table 5 to table 10 near here]

From table 5 it turns out that future West German exporters were not on average more productive than future non-exporters three years before starting to export; they were, however, often larger and more human capital intensive. In all but one cases (the exception being productivity for the cohort 1999), however, the prob-value for the Kolmogorov-Smirnov test of the null-hypothesis that the distribution of the performance variable for future non-exporters and future exporters are identical against the alternative hypothesis that the distribution for future exporters first-order stochastically dominates the distribution for future non-exporters is smaller than 0.05, indicating that the null-hypothesis can be rejected in favour of the alternative hypothesis at the usual error level of five percent or better. The picture is similar for two years and one year before the start (see table 7 and table 9).

Furthermore, labor productivity premia of future exporters compared to future non-exporters were estimated controlling for plant size, human capital intensity, and industry affiliation by estimating the empirical model

$$\ln LP_{it-n} = a + ß\ Export_{it} + c\ Control_{it-n} + e_{it} \tag{2}$$

where i is the index of the firm, t is the index of the year, LP is labor productivity in year t-n (where n is either 3, or 2, or 1), Export is a dummy variable for current export status (1 if the firm exports in year t, 0 else), Control is a vector of control variables (the number of employees – also included in squares -, human capital intensity, and four-digit industry dummies), and e is an error term. The pre-entry premium, computed from the estimated coefficient ß as 100(exp(ß)-1), shows the average percentage difference between today's exporters and today's non-exporters n years before starting to export, controlling for the characteristics included in the vector

Control. While the point estimates of these premia for t-3 are positive (with the exception of the cohort 2004), only the coefficient for the cohort 2003 is statistically significantly different from zero at a conventional error level. Two years and one year before the start these premia were statistically significant at an error level of five percent or better for two and four (out of seven) cohorts.

The big picture for West German plants, then, is that we have some empirical evidence for self-selection of more productive (and larger, and more human capital intensive) plants into export markets.[15]

Results reported in table 6, table 8, and table 10 indicate that the big picture is different for plants from East Germany: On average, future non-exporters were more productive than future exporters in all but one year (see cohort 2003) three years before the start, and this difference in the mean was statistically significant at a usual error level for three cohorts (see table 6). Results from the Kolmogorov-Smirnov test point to more productive future exporters in two years only (namely, 2003 and 2004) when an error level of five percent is applied. The picture is quite similar when one looks at human capital intensity; however, future exporters were larger than future non-exporters. The estimates for the ceteris paribus productivity premia for future exporters three years before the start are insignificant for all years but 2003. Results for two years and one year before the start (reported in table 8 and table 10) show a similar picture. In short, we have no empirical evidence for self-selection of more productive East German plants into export markets.[16]

[15] Inclusion of outliers does not change this big picture; see table A.5, A.7, and A.9.

[16] Again, the inclusion of outliers makes no difference; see table A.6, A.8, and A.10.

5. Do export starters become more productive?

The second hypothesis why exporters can be expected to be more productive than their counterparts that sell on the domestic market only points to the role of learning-by-exporting. Knowledge flows from international buyers and competitors help to improve the post-entry performance of export starters. Furthermore, firms participating in international markets are exposed to more intense competition and must improve faster than firms who sell their products domestically only. Exporting, therefore, can be expected to make firms more productive.

If exporting improves productivity then we should expect to find significant differences in the rate of growth of labor productivity between export starters and firms that continue to produce for the national market only during the years after the start. This hypothesis is tested by looking at the growth rate of labor productivity over the period t+1 to t+3 for a cohort of export starters in year t compared to the growth performance of non-exporters over the same period. Furthermore, differences in productivity growth between export starters and non-exporters are investigated based on the empirical model

$$\ln LP_{it+3} - \ln LP_{it+1} = a + ß\ Start_{it} + c\ Control_{it} + e_{it} \qquad (3)$$

where i is the index of the firm, t is the index of the year, LP is labor productivity, Start is a dummy variable for export starters (1 if the firm starts to export in year t, 0 else), Control is a vector of control variables (the number of employees – also included in squares -, human capital intensity, and four-digit industry dummies), and e is an error term. The post-entry premium, computed from the estimated coefficient ß as 100(exp(ß)-1), shows the average labor productivity growth premium of export starters compared to non-exporters three years after starting to export, controlling for the characteristics included in the vector Control.

Results for four cohorts (1998, 1999, 2000, and 2001) are reported in table 11 for West Germany and table 12 for East Germany. On average, the productivity growth performance of export starters was better compared with non-exporters in West Germany in three of the four cohorts This difference, however, is statistically different from zero at a conventional error level for the first cohort only, and the Kolmogorov-Smirnov test points to a better productivity growth performance of export starters in two cohorts only (namely, 1998 and 2001) when an error level of five percent is applied. The starter premia estimated using the empirical model given in (3) are positive for three out of four cohorts, but never statistically significant at a conventional level of significance. The bottom line, then, is that we have no convincing evidence for the hypothesis that West German plants which start to export perform better in the three years after the start than their counterparts which do not start to sell their products on the world market. The results for East German plants reported in table 8 are even less in favour of the learning-by-exporting hypothesis.[17]

[Table11 and table 12 near here]

In line with a recent development in the literature on the impact of exporting on productivity an alternative approach to test for productivity enhancing effects of starting to export is applied next. To motivate this approach, consider the following situation: Assume that a study reports that plants entering the export market have substantially faster productivity growth in the following years than firms that keep selling their products on the domestic market only. Does this point to a causal effect

[17] These conclusions are the same if outliers are included; see table A.11 and table A.12

of starting to export on productivity? The answer is, obviously, no: If better firms self-select into export-starting, and if, therefore, today's export starters are 'better' than today's non-exporters (and have been so in the recent past), we would expect that they should, on average, perform better in the future even if they do not start to export today. However, we cannot observe whether they would really do so because they do start to export today; we simply have no data for the counterfactual situation. So how can we be sure that the better performance of starters compared to non-exporters is caused by exporting (or not)? This closely resembles a situation familiar from the evaluation of active labor market programs (or any other form of treatment of units): If participants, or treated units, are not selected randomly from a population but are selected or self-select according to certain criteria, the effect of a treatment cannot be evaluated by comparing the average performance of the treated and the non-treated. However, given that each unit (plant, or person, etc.) either participated or not, we have no information about its performance in the counterfactual situation. A way out is to construct a control group in such a way that every treated unit is matched to an untreated unit that has been as similar as possible (ideally, identical) at the time before the treatment. Differences between the two groups (the treated, and the matched non-treated) after the treatment can then be attributed to the treatment (for a comprehensive discussion, see Heckman, LaLonde and Smith 1999).

The use of a matching approach to search for causal effects of starting to export on productivity (and other dimensions of firm performance) has been pioneered by Wagner (2002), and it has been used in a growing number of empirical studies (surveyed in Wagner (2007)) ever since.

Here, export starters in year t from the four cohorts (1998, 1999, 2000, and 2001) were matched with "twins" from the large group on non-exporters based on characteristics of the plants in t-1 (the year before the starters start),[18] and the difference in the average rate of growth of labour productivity over the period t+1 to t+3 between export starters and matched non-exporters is computed. This difference is the so-called average treatment effect on the treated, or ATT, the estimated causal effect of export start on the growth of labor productivity (see Wagner (2002) for a discussion of this method).

Results are reported in table 13 for plants from West Germany and in table 14 for East German plants. The big picture arising from comparing export starters with matched non-exporters is the same as the one sketched above based on the comparison of export starters and all non-exporters. The estimated ATT is positive for three out of four cohorts in West Germany, but it is never statistically significantly different from zero. For East Germany, the ATT is negative for three out of four cohorts, but again statistically insignificant in all cases. Therefore, from the matching approach we have no evidence in favour of the learning-by-exporting hypothesis for German manufacturing plants.[19]

[Table 13 and table 14 near here]

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[18] Matching was done by nearest neighbours propensity score matching. The propensity score was estimated from a probit regression of a dummy variable indicating whether or not a plant is an export starter in year t on the log of labor productivity, number of employees, human capital intensity, and 4-digit industry dummy variables (all measured in year t-1) plus the rate of growth of labor productivity in the years t-3 to t-1. Matching was successful; the difference in means of the variables used to compute the propensity score were never statistically significant between the starters and the matched non-starters. The common support condition was imposed by dropping export starters (treated observations) whose propensity score is higher than the maximum or lower than the minimum propensity score of the non-exporters (the controls). Matching was done using Stata 9.2 and the psmatch2 command (version 3.0.0), see Leuven and Sianesi (2003).

[19] Including the outliers does not change the conclusions; see table A.13 and table A.14.

6. Do the fittest export starters survive?

On the one hand, according to the results reported in section 2 and section 3 exporters in both West and East Germany are more productive than non-exporters; on the other hand, we have some empirical evidence for self-selection of more productive firms into export markets for West German plants only (see section 4), and no convincing evidence in favour of the learning-by-exporting hypothesis (see section 5) for plants from both parts of Germany. This might be the result of a market driven selection process in which those export starters that have low productivity at starting time fail as a successful exporter in the years after the start, and only those that were more productive continue to export.

This hypothesis is tested by looking at plants from a cohort of export starters, and dividing these plants into two groups. One group is formed by all plants that still reported exports in the survey in 2004, the last year of the data set used in this investigation. The other group is made of all other plants from the starter cohort.[20] For the starter cohorts from 1998 to 2001 table 15 and table 16 report average values of labor productivity at the starting year for both groups, and results of t-tests and Kolmogorov-Smirnov-tests of the difference in productivity between plants from these groups.

[Table 15 and table 16 near here]

[20] Note that this group includes plants that reported to the survey in 2004 that they did not export, and plants that did no longer report to the survey in 2004. The latter sub-group is made of all plants that dropped out of the sampling frame of the survey (because they crossed the threshold of the minimum number of employees detailed in section 2, or switched to the service sector) or that exited the market before 2004. With the data at hand it is not possible to discriminate between these types of firms within the second group.

For West Germany the big picture is in favour of the market selection hypothesis: On average labor productivity was higher among the "surviving" exporters at starting time in three out of four cohorts and about the same as in the other group of plants in one cohort; in two out of four cohorts this difference is statistically highly significant, and in three cohorts the Kolmogorov-Smirnov test shows that the distribution of productivity for the "survivors" first-order stochastically dominates the productivity distribution of the other group. For East Germany there is no evidence in favour of the market selection hypothesis.

7. Conclusions

Using unique recently released nationally representative high-quality longitudinal data at the plant level, this paper presents the first comprehensive evidence on the relationship between exports and productivity for Germany, a leading actor on the world market for manufactured goods. It applies and extends the now standard approach from the international literature to document the extent of the difference in productivity between exporters and non-exporters, and to investigate empirically the direction of causality between exports and productivity. The main conclusions can be summarized as follows:

- Exporters in both West and East Germany are more productive, larger, and have a higher intensity of human capital than non-exporters. The positive productivity differential of exporters compared to non-exporters is statistically significant, and substantial, even if observed firm characteristics (size, human capital intensity, and 4-digit-level industry affiliation) and unobserved firm specific effects are controlled for.

- For West German plants, but not for East German plants, we have some empirical evidence for self-selection of more productive (and larger, and more human capital intensive) firms into export markets.

- We have no convincing evidence for the hypothesis that West German plants which start to export perform better in the three years after the start than their counterparts which do not start to sell their products on the world market. The results for East German plants are even less in favour of the learning-by-exporting hypothesis.

- Results for West Germany support the hypothesis that the productivity differential between exporters and non-exporters is at least in part the result of a market driven selection process in which those export starters that have low productivity at starting time fail as a successful exporter in the years after the start, and only those that were more productive at starting time continue to export.

While the findings for West German plants are broadly in accordance with the results from earlier studies using data from one West German federal state (surveyed in Wagner (2007)), results for East German plants are not. A closer investigation of the reasons for these differences between both parts of Germany – that might at least in part be caused by the high amount of subsidies received by plants in East Germany - is an important issue that could enhance our understanding of the mutual relationship of exporting and productivity. It is, however, is beyond the scope of this paper.

Results presented here form the country study for Germany in an international comparison projects on exports and productivity. Cross-country comparisons are notoriously difficult because the studies often differ in many details regarding definition of variables and the empirical approach applied. Therefore, the jury is still out on many of the issues regarding the relationship between exporting and productivity. The approach used in this project to generate stylised facts in a more convincing way is to co-ordinate micro-econometric studies for many countries ex-ante, and to agree on a common approach and on the specification of the empirical models estimated. The outcome of such a joint effort, hopefully, will be a set of results that can be compared not only qualitatively (i.e. with regard to the signs and the statistical significance of the estimated coefficients) but with a view on the magnitude of the estimated effects, too. This will help in understanding the causes of differences over space (including differences between West and East Germany), and form a more solid basis for drawing policy conclusions from stylized facts.

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Table 1: Descriptive statistics – West Germany

Year	Total number of firms	Percentage share of exporting firms	Average share of exports in total sales of exporting firms	Average labor productivity non-exporting firms	Average labor productivity exporting firms	Test for difference in labor productivity between exporters and non-exporters (p-value)
1995	36788	62.60	22.53	124016	132433	0.000
1996	36484	62.85	23.56	126149	135923	0.000
1997	37953	60.89	24.07	121353	141179	0.000
1998	37343	61.47	24.57	124167	147148	0.000
1999	37588	61.46	24.94	128294	149488	0.000
2000	37523	61.68	26.10	127553	152632	0.000
2001	37547	62.20	26.99	124384	150426	0.000
2002	37752	62.74	27.92	123490	151273	0.000
2003	36443	65.46	28.37	124229	153489	0.000
2004	35998	65.53	29.47	126646	162165	0.000

Table 1 (continued): Descriptive Statistics – West Germany

Year	Average number of employees: non-exporting firms	Average number of employees: exporting firms	Test for difference in number of employees between exporters and non-exporters (p-value)	Average human capital intensity: non-exporting firms	Average human capital intensity: exporting firms	Test for difference in human capital intensity between exporters and non-exporters (p-value)
1995	64.71	199.04	0.000	27664	29852	0.000
1996	64.62	193.74	0.000	27614	30186	0.000
1997	59.21	191.38	0.000	26915	30604	0.000
1998	60.12	193.87	0.000	27015	30976	0.000
1999	58.94	192.60	0.000	26853	31171	0.000
2000	60.48	192.46	0.000	26943	31529	0.000
2001	60.02	191.83	0.000	26733	31572	0.000
2002	59.51	185.25	0.000	26837	31544	0.000
2003	59.07	180.62	0.000	26974	31653	0.000
2004	58.05	179.36	0.000	27056	32120	0.000

Note: Exports, domestic sales, and total sales are in constant prices (1995 = 100), wages and salaries are in constant prices (2000 = 100); all values are in Euro. Labor productivity is measured by total sales per employee; human capital intensity is measured by wages and salaries per employee. The firms with the bottom / top one percent of labor productivity are excluded from all computations. The statistical test for differences between the mean values of the two groups is a t-test not assuming equal variances for the groups. A p-value of 0.05 or less indicates that the difference between non-exporters and exporters is statistically significant at an error level of 5 percent or less.

Table 2: Descriptive statistics – East Germany

Year	Total number of firms	Percentage share of exporting firms	Average share of exports in total sales of exporting firms	Average labor productivity non-exporting firms	Average labor productivity exporting firms	Test for difference in labor productivity between exporters and non-exporters (p-value)
1995	6640	37.98	17.25	101538	98436	0.184
1996	6825	37.38	18.22	109458	109174	0.910
1997	7266	36.73	19.31	107859	117250	0.000
1998	7387	37.76	19.41	107592	122691	0.000
1999	7564	38.43	19.53	109638	126098	0.000
2000	7843	39.74	20.94	107455	129122	0.000
2001	7901	41.36	21.66	103997	128949	0.000
2002	8159	42.44	22.81	104209	132168	0.000
2003	8096	46.17	23.20	111438	136228	0.000
2004	8355	46.26	24.04	112206	141122	0.000

Table 2 (continued): Descriptive Statistics – East Germany

Year	Average number of employees: non-exporting firms	Average number of employees: exporting firms	Test for difference in number of employees between exporters and non-exporters (p-value)	Average human capital intensity: non-exporting firms	Average human capital intensity: exporting firms	Test for difference in human capital intensity between exporters and non-exporters (p-value)
1995	72.30	146.40	0.000	20665	21644	0.000
1996	67.92	135.08	0.000	20931	22478	0.000
1997	61.34	129.75	0.000	20647	22860	0.000
1998	59.29	130.81	0.000	20733	23115	0.000
1999	58.14	127.63	0.000	20780	23183	0.000
2000	57.83	123.48	0.000	20708	23547	0.000
2001	58.25	123.56	0.000	20668	23461	0.000
2002	55.67	119.67	0.000	20662	23593	0.000
2003	55.28	116.49	0.000	21043	23595	0.000
2004	54.00	113.90	0.000	20903	23853	0.000

Note: Exports, domestic sales, and total sales are in constant prices (1995 = 100), wages and salaries are in constant prices (2000 = 100); all values are in Euro. Labor productivity is measured by total sales per employee; human capital intensity is measured by wages and salaries per employee. The firms with the bottom / top one percent of labor productivity are excluded from all computations. The statistical test for differences between the mean values of the two groups is a t-test not assuming equal variances for the groups. A p-value of 0.05 or less indicates that the difference between non-exporters and exporters is statistically significant at an error level of 5 percent or less.

Table 3: Exporter productivity premia (percentage) – West Germany

Year		Exporter dummy	Share of exports in total sales	Share of exports in total sales *and*	Share of exports in total sales (squared)
1995	ß	16.36	0.31	0.75	-0.0067
	p	[0.00]	[0.00]	[0.00]	[0.00]
1996	ß	15.11	0.31	0.69	-0.0057
	p	[0.00]	[0.00]	[0.00]	[0.00]
1997	ß	17.73	0.37	0.76	-0.0058
	p	[0.00]	[0.00]	[0.00]	[0.00]
1998	ß	18.35	0.36	0.81	-0.0067
	p	[0.00]	[0.00]	[0.00]	[0.00]
1999	ß	15.89	0.32	0.72	-0.0060
	p	[0.00]	[0.00]	[0.00]	[0.00]
2000	ß	16.64	0.36	0.72	-0.0053
	p	[0.00]	[0.00]	[0.00]	[0.00]
2001	ß	16.78	0.37	0.73	-0.0051
	p	[0.00]	[0.00]	[0.00]	[0.03]
2002	ß	17.66	0.37	0.73	-0.0052
	p	[0.00]	[0.00]	[0.00]	[0.00]
2003	ß	19.79	0.35	0.79	-0.0062
	p	[0.00]	[0.00]	[0.00]	[0.00]
2004	ß	21.46	0.39	0.83	-0.0061
	p	[0.00]	[0.00]	[0.00]	[0.00]
Pooled	ß	17.51	0.35	0.75	-0.0057
	p	[0.00]	[0.00]	[0.00]	[0.00]
Pooled	ß	7.10	0.27	0.29	-0.00026
with fixed firm effects	p	[0.00]	[0.00]	[0.00]	[0.28]

Note: ß is the estimated regression coefficient from a OLS-regression of log (labor productivity) on a dummy variable for exporting firms (column 1), or the share of exports in total sales (column 2), or the share of exports in total sales and its squared value (columns 3 and 4). All models for data from a single year control for the number of employees and its squared value, wages and salaries per employee, and 4digit-industries. The pooled model includes a full set of interaction terms of 4digit industry-dummies and year dummies; the fixed effects model adds firm fixed effects. To facilitate interpretation the estimated coefficients for the exporter dummy variable has been transformed by 100(exp(ß)-1). p is the prob-value, indicating that all reported coefficients are statistically significant at an error level of 3 percent or better. The firms with the bottom / top one percent of labor productivity are excluded from all computations.

Table 4: Exporter productivity premia (percentage) – East Germany

Year		Exporter dummy	Share of exports in total sales	Share of exports in total sales *and*	Share of exports in total sales (squared)
1995	ß	6.71	0.08	0.46	-0.0061
	p	[0.00]	[0.00]	[0.00]	[0.00]
1996	ß	10.49	0.14	0.53	-0.0061
	p	[0.00]	[0.00]	[0.00]	[0.00]
1997	ß	16.09	0.25	0.78	-0.0080
	p	[0.00]	[0.00]	[0.00]	[0.00]
1998	ß	20.04	0.31	01.01	-0.0109
	p	[0.00]	[0.00]	[0.00]	[0.00]
1999	ß	17.45	0.28	0.94	-0.0103
	p	[0.00]	[0.00]	[0.00]	[0.00]
2000	ß	19.26	0.34	0.98	-0.0099
	p	[0.00]	[0.00]	[0.00]	[0.00]
2001	ß	17.90	0.33	0.92	-0.0088
	p	[0.00]	[0.00]	[0.00]	[0.03]
2002	ß	19.88	0.39	0.87	-0.0072
	p	[0.00]	[0.00]	[0.00]	[0.00]
2003	ß	19.98	0.37	1.02	-0.0094
	p	[0.00]	[0.00]	[0.00]	[0.00]
2004	ß	21.57	0.40	0.96	-0.0082
	p	[0.00]	[0.00]	[0.00]	[0.00]
Pooled	ß	17.30	0.31	0.87	-0.0083
	p	[0.00]	[0.00]	[0.00]	[0.00]
Pooled	ß	5.97	0.28	0.32	-0.00049
with fixed firm effects	p	[0.00]	[0.00]	[0.00]	[0.42]

Note: ß is the estimated regression coefficient from a OLS-regression of log (labor productivity) on a dummy variable for exporting firms (column 1), or the share of exports in total sales (column 2), or the share of exports in total sales and its squared value (columns 3 and 4). All models for data from a single year control for the number of employees and its squared value, wages and salaries per employee, and 4digit-industries. The pooled model includes a full set of interaction terms of 4digit industry-dummies and year dummies; the fixed effects model adds firm fixed effects. To facilitate interpretation the estimated coefficients for the exporter dummy variable has been transformed by 100(exp(ß)-1). p is the prob-value, indicating that all reported coefficients are statistically significant at an error level of 3 percent or better. The firms with the bottom / top one percent of labor productivity are excluded from all computations.

Table 5: Export-starters and Non-starters three years before the start – West Germany

Year of start	Number of firms	Average labor productivity	Average number of employees	Average human capital intensity	Labor productivity premia of export-starters (percentage) [p-value]
1998					2.68 [0.25]
Non-starters	10050	129923	66.06	27585	
Export-starters	383	118595	91.85	28211	
t-test (p-value)		0.025	0.059	0.127	
K-S-test (p-value)		0.022	0.000	0.005	
1999					0.53 [0.83]
Non-starters	9909	131119	66.25	27579	
Export-starters	420	128453	63.78	28330	
t-test (p-value)		0.619	0.515	0.085	
K-S-test (p-value)		0.076	0.000	0.037	
2000					1.93 [0.40]
Non-starters	10861	125843	63.33	26897	
Export-starters	414	116613	71.73	28503	
t-test (p-value)		0.040	0.190	0.000	
K-S-test (p-value)		0.006	0.000	0.000	
2001					3.26 [0.15]
Non-starters	10597	127556	64.88	26832	
Export-starters	405	123781	76.33	27690	
t-test (p-value)		0.428	0.229	0.038	
K-S-test (p-value)		0.000	0.000	0.001	

2002					3.40 [0.14]
Non-starters	10689	131265	64.82	26638	
Export-starters	391	130945	59.45	27966	
t-test (p-value)		0.953	0.128	0.001	
K-S-test (p-value)		0.000	0.000	0.000	
2003					12.49 [0.00]
Non-starters	9889	130486	66.79	27050	
Export-starters	815	146313	77.16	29829	
t-test (p-value)		0.000	0.023	0.000	
K-S-test (p-value)		0.000	0.000	0.000	
2004					-0.44 [0.87]
Non-starters	9554	127162	66.59	26923	
Export-starters	325	120049	97.57	29741	
t-test (p-value)		0.123	0.011	0.000	
K-S-test (p-value)		0.000	0.000	0.000	

Note: Exports, domestic sales, and total sales are in constant prices (1995 = 100), wages and salaries are in constant prices (2000 = 100); all values are in Euro. Labor productivity is measured by total sales per employee; human capital intensity is measured by wages and salaries per employee. The firms with the bottom / Top one percent of labor productivity are excluded from all computations. The t-tests for differences between the mean values of the two groups are not assuming equal variances for the groups. A p-value of 0.05 or less indicates that the difference between non-exporters and exporters is statistically significant at an error level of 5 percent or less. The Kolmogorov-Smirnow (K-S) test tests the null-hypothesis that the distribution of labor productivity (number of employees, human capital intensity) for non-starters and export-starters are identical against the alternative hypothesis that the distribution for export-starters first-order stochastically dominates the distribution for non-starters. A p-value of 0.05 or smaller indicates that the null-hypothesis can be rejected in favour of the alternative hypothesis at an error level of 5 percent or better. The labor productivity premia is estimated in a OLS-regression of log (labor productivity) on a dummy variable for export starters controlling for the number of employees and its squared value, wages and salaries per employee, and 4digit-industries, all measured three years before the start. To facilitate interpretation the estimated coefficients for the exporter dummy variable has been transformed by 100(exp(ß)-1).

Table 6: Export-starters and Non-starters three years before the start – East Germany

Year of start	Number of firms	Average labor productivity	Average number of employees	Average human capital intensity	Labor productivity premia of export-starters (percentage) [p-value]
1998					0.58 [0.90]
Non-starters	2712	108338	71.99	19992	
Export-starters	115	88787	80.10	19313	
t-test (p-value)		0.009	0.338	0.239	
K-S-test (p-value)		0.977	0.001	0.819	
1999					-0.12 [0.98]
Non-starters	2879	115653	69.27	19874	
Export-starters	124	93386	74.90	19601	
t-test (p-value)		0.001	0.524	0.626	
K-S-test (p-value)		0.751	0.000	0.151	
2000					7.55 [0.12]
Non-starters	3189	112799	64.67	20266	
Export-starters	110	105296	78.97	20951	
t-test (p-value)		0.333	0.672	0.457	
K-S-test (p-value)		0.057	0.027	0.136	
2001					-1.38 [0.71]
Non-starters	3229	112966	64.47	20357	
Export-starters	117	91713	59.59	20167	
t-test (p-value)		0.006	0.336	0.742	
K-S-test (p-value)		0.718	0.004	0.388	

2002					4.70 [0.34]
Non-starters	3218	113014	63.22	20282	
Export-starters	140	111757	72.09	20641	
t-test (p-value)		0.895	0.208	0.488	
K-S-test (p-value)		0.111	0.007	0.043	
2003					9.49 [0.01]
Non-starters	3140	110939	63.49	20603	
Export-starters	207	115864	81.31	21182	
t-test (p-value)		0.485	0.017	0.223	
K-S-test (p-value)		0.000	0.000	0.002	
2004					2.70 [0.55]
Non-starters	3067	107863	61.74	20548	
Export-starters	127	103271	101.95	21484	
t-test (p-value)		0.552	0.040	0.168	
K-S-test (p-value)		0.049	0.002	0.195	

Note: Exports, domestic sales, and total sales are in constant prices (1995 = 100), wages and salaries are in constant prices (2000 = 100); all values are in Euro. Labor productivity is measured by total sales per employee; human capital intensity is measured by wages and salaries per employee. The firms with the bottom / top one percent of labor productivity are excluded from all computations. The t-tests for differences between the mean values of the two groups are not assuming equal variances for the groups. A p-value of 0.05 or less indicates that the difference between non-exporters and exporters is statistically significant at an error level of 5 percent or less. The Kolmogorov-Smirnow (K-S) test tests the null-hypothesis that the distribution of labor productivity (number of employees, human capital intensity) for non-starters and export-starters are identical against the alternative hypothesis that the distribution for export-starters first-order stochastically dominates the distribution for non-starters. A p-value of 0.05 or smaller indicates that the null-hypothesis can be rejected in favour of the alternative hypothesis at an error level of 5 percent or better. The labor productivity premia is estimated in a OLS-regression of log (labor productivity) on a dummy variable for export starters controlling for the number of employees and its squared value, wages and salaries per employee, and 4digit-industries, all measured three years before the start. To facilitate interpretation the estimated coefficients for the exporter dummy variable has been transformed by 100(exp(ß)-1).

Table 7: Export-starters and Non-starters two years before the start – West Germany

Year of start	Number of firms	Average labor productivity	Average number of employees	Average human capital intensity	Labor productivity premia of export-starters (percentage) [p-value]
1998					4.55 [0.05]
Non-starters	10383	130501	65.00	27713	
Export-starters	396	124430	87.83	28463	
t-test (p-value)		0.289	0.061	0.057	
K-S-test (p-value)		0.021	0.000	0.003	
1999					3.12 [0.20]
Non-starters	10059	133022	65.77	27974	
Export-starters	427	136139	63.67	28756	
t-test (p-value)		0.598	0.579	0.057	
K-S-test (p-value)		0.034	0.000	0.011	
2000					1.27 [0.58]
Non-starters	10986	127845	64.09	27025	
Export-starters	418	118920	73.70	28782	
t-test (p-value)		0.043	0.186	0.000	
K-S-test (p-value)		0.001	0.000	0.000	
2001					4.39 [0.06]
Non-starters	10805	133122	64.74	27163	
Export-starters	415	129066	75.74	28383	
t-test (p-value)		0.411	0.235	0.003	
K-S-test (p-value)		0.000	0.000	0.000	

2002					3.58 [0.13]
Non-starters	10990	130152	65.32	26991	
Export-starters	407	130673	61.36	28851	
t-test (p-value)		0.922	0.298	0.000	
K-S-test (p-value)		0.000	0.000	0.000	
2003					12.67 [0.00]
Non-starters	10056	127716	66.80	27090	
Export-starters	820	143905	78.03	29672	
t-test (p-value)		0.001	0.014	0.000	
K-S-test (p-value)		0.000	0.000	0.000	
2004					1.29 [0.63]
Non-starters	9685	127408	65.01	27066	
Export-starters	332	122967	96.55	29750	
t-test (p-value)		0.378	0.011	0.000	
K-S-test (p-value)		0.000	0.000	0.000	

Note: Exports, domestic sales, and total sales are in constant prices (1995 = 100), wages and salaries are in constant prices (2000 = 100); all values are in Euro. Labor productivity is measured by total sales per employee; human capital intensity is measured by wages and salaries per employee. The firms with the bottom / Top one percent of labor productivity are excluded from all computations. The t-tests for differences between the mean values of the two groups are not assuming equal variances for the groups. A p-value of 0.05 or less indicates that the difference between non-exporters and exporters is statistically significant at an error level of 5 percent or less. The Kolmogorov-Smirnow (K-S) test tests the null-hypothesis that the distribution of labor productivity (number of employees, human capital intensity) for non-starters and export-starters are identical against the alternative hypothesis that the distribution for export-starters first-order stochastically dominates the distribution for non-starters. A p-value of 0.05 or smaller indicates that the null-hypothesis can be rejected in favour of the alternative hypothesis at an error level of 5 percent or better. The labor productivity premia is estimated in a OLS-regression of log (labor productivity) on a dummy variable for export starters controlling for the number of employees and its squared value, wages and salaries per employee, and 4digit-industries, all measured three years before the start. To facilitate interpretation the estimated coefficients for the exporter dummy variable has been transformed by 100(exp(ß)-1).

Table 8: Export-starters and Non-starters two years before the start – East Germany

Year of start	Number of firms	Average labor productivity	Average number of employees	Average human capital intensity	Labor productivity premia of export-starters (percentage) [p-value]
1998					2.42 [0.57]
Non-starters	3045	114238	70.92	21166	
Export-starters	124	95835	80.25	20695	
t-test (p-value)		0.137	0.255	0.390	
K-S-test (p-value)		0.579	0.000	0.325	
1999					3.21 [0.46]
Non-starters	3216	112325	68.01	20977	
Export-starters	137	101519	76.46	20839	
t-test (p-value)		0.157	0.320	0.782	
K-S-test (p-value)		0.250	0.000	0.094	
2000					16.51 [0.00]
Non-starters	3189	111056	64.70	20830	
Export-starters	110	118968	78.36	21253	
t-test (p-value)		0.415	0.689	0.468	
K-S-test (p-value)		0.006	0.001	0.048	
2001					-0.07 [0.99]
Non-starters	3418	114601	63.96	20984	
Export-starters	126	95802	61.12	21057	
t-test (p-value)		0.008	0.587	0.900	
K-S-test (p-value)		0.388	0.000	0.288	

2002					5.18
					[0.28]
Non-starters	3456	108862	63.30	20781	
Export-starters	154	119010	75.09	21904	
t-test (p-value)		0.320	0.113	0.023	
K-S-test (p-value)		0.073	0.006	0.003	
2003					10.66
					[0.00]
Non-starters	3278	106747	63.62	20914	
Export-starters	220	111181	82.22	21749	
t-test (p-value)		0.485	0.010	0.077	
K-S-test (p-value)		0.002	0.000	0.002	
2004					3.78
					[0.44]
Non-starters	3228	109922	61.07	20991	
Export-starters	127	105338	100.75	22258	
t-test (p-value)		0.531	0.045	0.062	
K-S-test (p-value)		0.191	0.002	0.020	

Note: Exports, domestic sales, and total sales are in constant prices (1995 = 100), wages and salaries are in constant prices (2000 = 100); all values are in Euro. Labor productivity is measured by total sales per employee; human capital intensity is measured by wages and salaries per employee. The firms with the bottom / top one percent of labor productivity are excluded from all computations. The t-tests for differences between the mean values of the two groups are not assuming equal variances for the groups. A p-value of 0.05 or less indicates that the difference between non-exporters and exporters is statistically significant at an error level of 5 percent or less. The Kolmogorov-Smirnow (K-S) test tests the null-hypothesis that the distribution of labor productivity (number of employees, human capital intensity) for non-starters and export-starters are identical against the alternative hypothesis that the distribution for export-starters first-order stochastically dominates the distribution for non-starters. A p-value of 0.05 or smaller indicates that the null-hypothesis can be rejected in favour of the alternative hypothesis at an error level of 5 percent or better. The labor productivity premia is estimated in a OLS-regression of log (labor productivity) on a dummy variable for export starters controlling for the number of employees and its squared value, wages and salaries per employee, and 4digit-industries, all measured three years before the start. To facilitate interpretation the estimated coefficients for the exporter dummy variable has been transformed by 100(exp(ß)-1).

Table 9: Export-starters and Non-starters one year before the start – West Germany

Year of start	Number of firms	Average labor productivity	Average number of employees	Average human capital intensity	Labor productivity premia of export-starters (percentage) [p-value]
1998					5.19 [0.04]
Non-starters	10364	132088	64.32	27891	
Export-starters	397	129127	82.76	28720	
t-test (p-value)		0.631	0.102	0.046	
K-S-test (p-value)		0.017	0.000	0.002	
1999					1.41 [0.56]
Non-starters	10032	134844	66.28	27945	
Export-starters	420	136106	63.94	29150	
t-test (p-value)		0.823	0.544	0.004	
K-S-test (p-value)		0.007	0.000	0.001	
2000					1.17 [0.60]
Non-starters	10991	132970	63.66	27117	
Export-starters	418	119864	70.72	28883	
t-test (p-value)		0.002	0.252	0.000	
K-S-test (p-value)		0.003	0.000	0.000	
2001					6.21 [0.01]
Non-starters	10833	131472	64.98	27217	
Export-starters	413	131019	75.48	28334	
t-test (p-value)		0.931	0.223	0.006	
K-S-test (p-value)		0.000	0.000	0.000	

2002					5.15 [0.03]
Non-starters	10980	126719	65.13	26791	
Export-starters	402	128689	62.14	28625	
t-test (p-value)		0.713	0.466	0.000	
K-S-test (p-value)		0.000	0.000	0.000	
2003					10.95 [0.00]
Non-starters	10062	127287	64.96	27059	
Export-starters	815	141468	75.90	29737	
t-test (p-value)		0.002	0.015	0.000	
K-S-test (p-value)		0.000	0.000	0.000	
2004					-0.56 [0.83]
Non-starters	9665	126890	63.32	26868	
Export-starters	331	119793	91.81	29610	
t-test (p-value)		0.180	0.018	0.000	
K-S-test (p-value)		0.001	0.000	0.000	

Note: Exports, domestic sales, and total sales are in constant prices (1995 = 100), wages and salaries are in constant prices (2000 = 100); all values are in Euro. Labor productivity is measured by total sales per employee; human capital intensity is measured by wages and salaries per employee. The firms with the bottom / Top one percent of labor productivity are excluded from all computations. The t-tests for differences between the mean values of the two groups are not assuming equal variances for the groups. A p-value of 0.05 or less indicates that the difference between non-exporters and exporters is statistically significant at an error level of 5 percent or less. The Kolmogorov-Smirnow (K-S) test tests the null-hypothesis that the distribution of labor productivity (number of employees, human capital intensity) for non-starters and export-starters are identical against the alternative hypothesis that the distribution for export-starters first-order stochastically dominates the distribution for non-starters. A p-value of 0.05 or smaller indicates that the null-hypothesis can be rejected in favour of the alternative hypothesis at an error level of 5 percent or better. The labor productivity premia is estimated in a OLS-regression of log (labor productivity) on a dummy variable for export starters controlling for the number of employees and its squared value, wages and salaries per employee, and 4digit-industries, all measured three years before the start. To facilitate interpretation the estimated coefficients for the exporter dummy variable has been transformed by 100(exp(ß)-1).

Table 10: Export-starters and Non-starters one year before the start – East Germany

Year of start	Number of firms	Average labor productivity	Average number of employees	Average human capital intensity	Labor productivity premia of export-starters (percentage) [p-value]
1998					4.21 [0.32]
Non-starters	3031	114953	69.40	21403	
Export-starters	124	96727	81.53	20677	
t-test (p-value)		0.018	0.137	0.182	
K-S-test (p-value)		0.440	0.000	0.574	
1999					7.93 [0.05]
Non-starters	3208	110851	66.74	20943	
Export-starters	134	106494	77.72	20911	
t-test (p-value)		0.597	0.187	0.953	
K-S-test (p-value)		0.039	0.000	0.058	
2000					12.21 [0.02]
Non-starters	3410	112910	63.89	20885	
Export-starters	118	112274	68.03	21254	
t-test (p-value)		0.943	0.613	0.542	
K-S-test (p-value)		0.007	0.000	0.109	
2001					0.23 [0.96]
Non-starters	3423	111257	63.87	20881	
Export-starters	125	97386	64.88	21054	
t-test (p-value)		0.073	0.859	0.761	
K-S-test (p-value)		0.666	0.000	0.092	

2002					9.99 [0.05]
Non-starters	3449	104713	63.13	20683	
Export-starters	150	124417	76.31	21604	
t-test (p-value)		0.083	0.088	0.058	
K-S-test (p-value)		0.054	0.003	0.005	
2003					10.93 [0.00]
Non-starters	3278	107323	62.68	20875	
Export-starters	222	111729	80.86	21701	
t-test (p-value)		0.487	0.010	0.084	
K-S-test (p-value)		0.006	0.000	0.007	
2004					4.94 [0.33]
Non-starters	3225	112834	60.11	21067	
Export-starters	138	108512	95.57	22266	
t-test (p-value)		0.589	0.064	0.077	
K-S-test (p-value)		0.113	0.002	0.036	

Note: Exports, domestic sales, and total sales are in constant prices (1995 = 100), wages and salaries are in constant prices (2000 = 100); all values are in Euro. Labor productivity is measured by total sales per employee; human capital intensity is measured by wages and salaries per employee. The firms with the bottom / top one percent of labor productivity are excluded from all computations. The t-tests for differences between the mean values of the two groups are not assuming equal variances for the groups. A p-value of 0.05 or less indicates that the difference between non-exporters and exporters is statistically significant at an error level of 5 percent or less. The Kolmogorov-Smirnow (K-S) test tests the null-hypothesis that the distribution of labor productivity (number of employees, human capital intensity) for non-starters and export-starters are identical against the alternative hypothesis that the distribution for export-starters first-order stochastically dominates the distribution for non-starters. A p-value of 0.05 or smaller indicates that the null-hypothesis can be rejected in favour of the alternative hypothesis at an error level of 5 percent or better. The labor productivity premia is estimated in a OLS-regression of log (labor productivity) on a dummy variable for export starters controlling for the number of employees and its squared value, wages and salaries per employee, and 4digit-industries, all measured three years before the start. To facilitate interpretation the estimated coefficients for the exporter dummy variable has been transformed by 100(exp(ß)-1).

Table 11: Export-starters and Non-starters three years after the start – West Germany

Year of start	Number of firms	Growth rate of labor productivity (percentage)	Labor productivity growth premia of export starters (%) [p-value]
1998			0.98 [0.52]
Non-starters	8685	-5.58	
Export-starters	324	-2.16	
t-test (p-value)		0.024	
K-S-test (p-value)		0.031	
1999			0.22 [0.88]
Non-starters	8320	-4.21	
Export-starters	354	-4.11	
t-test (p-value)		0.946	
K-S-test (p-value)		0.163	
2000			-0.73 [0.62]
Non-starters	8767	-1.58	
Export-starters	335	-2.19	
t-test (p-value)		0.685	
K-S-test (p-value)		0.445	
2001			1.05 [0.46]
Non-starters	8503	-0.21	
Export-starters	331	1.58	
t-test (p-value)		0.193	
K-S-test (p-value)		0.026	

Note: Total sales are in constant prices (1995 = 100), all values are in Euro. Labor productivity is measured by total sales per employee. The firms from the bottom / top one percent of labor productivity are excluded from all computations. The t-tests for differences between the mean values of the two groups are not assuming equal variances for the groups. A p-value of 0.05 or less indicates that the difference between non-starters and export-starters is statistically significant at an error level of 5 percent or less. The Kolmogorov-Smirnow (K-S) test tests the null-hypothesis that the distribution of the growth rate of labor productivity for non-starters and export-starters are identical against the alternative hypothesis that the distribution for export-starters first-order stochastically dominates the distribution for non-starters. A p-value of 0.05 or smaller indicates that the null-hypothesis can be rejected in favour of the alternative hypothesis at an error level of 5 percent or better. The labor productivity growth premia is estimated in a OLS-regression of the growth rate of labor productivity on a dummy variable for export starters controlling for the number of employees and its squared value, wages and salaries per employee, and 4digit-industries, all measured at the start year. To facilitate interpretation the estimated coefficients for the exporter dummy variable has been transformed by 100(exp(ß)-1).

Table 12: Export-starters and Non-starters three years after the start – East Germany

Year of start	Number of firms	Growth rate of labor productivity (percentage)	Labor productivity growth premia of export starters (%) [p-value]
1998			-0.48 [0.86]
Non-starters	2195	-10.47	
Export-starters	97	-5.81	
t-test (p-value)		0.093	
K-S-test (p-value)		0.156	
1999			2.33 [0.42]
Non-starters	2410	-2.52	
Export-starters	110	-2.48	
t-test (p-value)		0.145	
K-S-test (p-value)		0.049	
2000			-2.65 [0.33]
Non-starters	2495	1.72	
Export-starters	101	-3.22	
t-test (p-value)		0.048	
K-S-test (p-value)		0.990	
2001			-2.47 [0.26]
Non-starters	2541	2.51	
Export-starters	91	2.51	
t-test (p-value)		0.900	
K-S-test (p-value)		0.140	

Note: Total sales are in constant prices (1995 = 100), all values are in Euro. Labor productivity is measured by total sales per employee. The firms from the bottom / top one percent of labor productivity are excluded from all computations. The t-tests for differences between the mean values of the two groups are not assuming equal variances for the groups. A p-value of 0.05 or less indicates that the difference between non-starters and export-starters is statistically significant at an error level of 5 percent or less. The Kolmogorov-Smirnow (K-S) test tests the null-hypothesis that the distribution of the growth rate of labor productivity for non-starters and export-starters are identical against the alternative hypothesis that the distribution for export-starters first-order stochastically dominates the distribution for non-starters. A p-value of 0.05 or smaller indicates that the null-hypothesis can be rejected in favour of the alternative hypothesis at an error level of 5 percent or better. The labor productivity growth premia is estimated in a OLS-regression of the growth rate of labor productivity on a dummy variable for export starters controlling for the number of employees and its squared value, wages and salaries per employee, and 4digit-industries, all measured at the start year. To facilitate interpretation the estimated coefficients for the exporter dummy variable has been transformed by 100(exp(ß)-1).

Table 13: Causal effects of export start on growth of labor productivity:
Results from a matching approach – West Germany

	Growth of labour productivtiy between t+1 and t+3 (percent)			
Year of start (Number of starters)	Starter	Matched non-starters	ATT	Statistical significance of the ATT (p-value)
1998 (303)	-2.46	-4.04	1.58	no
1999 (360)	-4.41	-5.56	1.15	no
2000 (315)	-2.97	-3.18	0.20	no
2001 (323)	-1.37	-0.43	-0.95	no

ATT is the *average treatment effect on the treated*, the estimated causal effect of export start on the growth of labor productivity in the three years after the export start. It is the difference between the average growth rate of labor productivity of the export starters and a group of matched non-starters. For details of the matching method see text. The firms from the bottom / top one percent of labor productivity are excluded from all computations. The statistical significance of the ATT was evaluated by bootstrapping with 1000 replications. *No* means that the estimated 95 percent confidence interval for the ATT includes the value zero.

Table 14: Causal effects of export start on growth of labor productivity: Results from a matching approach – East Germany

	Growth of labour productivtiy between t+1 and t+3 (percent)			
Year of start (Number of starters)	Starter	Matched non-starters	ATT	Statistical significance of the ATT (p-value)
1998 (89)	-3.84	0.26	-4.10	no
1999 (88)	-1.53	-4.00	2.46	no
2000 (90)	-3.14	-0.68	-2.46	no
2001 (90)	-5.75	5.72	-11.47	no

ATT is the *average treatment effect on the treated*, the estimated causal effect of export start on the growth of labor productivity in the three years after the export start. It is the difference between the average growth rate of labor productivity of the export starters and a group of matched non-starters. For details of the matching method see text. The firms from the bottom / top one percent of labor productivity are excluded from all computations. The statistical significance of the ATT was evaluated by bootstrapping with 1000 replications. *No* means that the estimated 95 percent confidence interval for the ATT includes the value zero.

Table 15: Productivity of export-starters in year of start by exporter status in 2004 – West Germany

Year of start	Average labor productivity in firms that still exported in 2004 [number of firms]	Average labor productivity in firms that did not report exports in 2004 [number of firms]	t-Test [p-value]	Kolmogorov-Smirnov Test [p-value]
1998	147401 194	132724 204	0.218	0.001
1999	159341 198	130629 222	0.014	0.002
2000	126233 208	127304 204	0.903	0.119
2001	144825 219	114540 190	0.002	0.009

Note: Labor productivity is measured by total sales per employee (in Euro, constant prices, 1995 = 100). Plants that were still exporting in 2004 are compared to plants that did not report exports to the survey in 2004; for details, see text. The firms from the bottom / top one percent of labor productivity are excluded from all computations. The t-tests for differences between the mean values of the two groups are not assuming equal variances for the groups. A p-value of 0.05 or less indicates that the difference between firms that still exported in 2004 and those that did not is statistically significant at an error level of 5 percent or less. The Kolmogorov-Smirnow (K-S) test tests the null-hypothesis that the distributions of labor productivity for both groups of firms are identical against the alternative hypothesis that the distribution for firms that still exported in 2004 first-order stochastically dominates the distribution for those that did not. A p-value of 0.05 or smaller indicates that the null-hypothesis can be rejected in favour of the alternative hypothesis at an error level of 5 percent or better.

Table 16: Productivity of export-starters in year of start by exporter status in 2004 – East Germany

Year of start	Average labor productivity in firms that still exported in 2004 [number of firms]	Average labor productivity in firms that did not report exports in 2004 [number of firms]	t-Test [p-value]	Kolmogorov-Smirnov Test [p-value]
1998	98457 68	102062 52	0.805	0.375
1999	124951 69	102370 65	0.248	0.041
2000	117624 71	114660 47	0.877	0.839
2001	99589 65	96987 54	0.878	0.241

Note: Labor productivity is measured by total sales per employee (in Euro, constant prices, 1995 = 100). Plants that were still exporting in 2004 are compared to plants that did not report exports to the survey in 2004; for details, see text. The firms from the bottom / top one percent of labor productivity are excluded from all computations. The t-tests for differences between the mean values of the two groups are not assuming equal variances for the groups. A p-value of 0.05 or less indicates that the difference between firms that still exported in 2004 and those that did not is statistically significant at an error level of 5 percent or less. The Kolmogorov-Smirnow (K-S) test tests the null-hypothesis that the distributions of labor productivity for both groups of firms are identical against the alternative hypothesis that the distribution for firms that still exported in 2004 first-order stochastically dominates the distribution for those that did not. A p-value of 0.05 or smaller indicates that the null-hypothesis can be rejected in favour of the alternative hypothesis at an error level of 5 percent or better.