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Exports and Productivity: An Empirical Analysis of German and Austrian Firm-Level Performance

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Abstract

This paper studies the relationship between export activities and firm-level productivity. Unique matching of German and Austrian micro data from 1994 to 2003 suggests that exporters are more productive by around 40 percent compared with non-exporters. Moreover, beside other analysis techniques, instrumental variable estimations suggest that exporting causes a rise in firm-level productivity. That is, the annual average growth rate of an exporting firm's productivity is between about 1 and 1.5 percent higher than that of non-exporters. It allows the conclusion that, against other findings of existing studies, both directions hold: more productive firms self-select themselves into export markets and being active in foreign markets boosts firm-level productivity.

JEL classification: **D24; F13; F23; L22; L23; O47**

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1 Introduction

Investigating the causal relationship between exports and productivity is not new. However, there is a crucial difference between past and more recent studies. The early literature considers comovement between exporting and productivity on the macro-level using aggregate data. For instance, Kunst and Marin (1989) and Marin (1992) analyze for Germany and Austria, respectively, whether exports Granger cause productivity or productivity has an impact on exports. For Germany, Kunst and Marin (1989) find that export growth causes productivity gains, whereas for the Austrian analysis, Marin (1992) has to reject the mentioned link.

More recent literature on the interaction between exporting and firm performance argues that there is interdependence between the two of them on the micro-level. That is, the literature reveals that only the most productive firms self-select themselves into the export market and that exporting improves firm performance. From a theoretical point of view, Clerides et al. (1998) argue that only the highly productive firms are able to cover their sunk costs and this in turn allows them to export. This well-known relationship between exporting and firm-level productivity is also modeled by Melitz (2003). He shows that, due to fixed costs, only the most productive firms start to export. This in turn raises productivity at the industry level because less efficient firms have to leave the market. The results suggest that a higher productivity increases the probability of exporting due to additional distribution, marketing, or production costs (Wagner 2007). Therefore, causality runs from productivity to exports.

However, exporting can also generate higher firm-level productivity via learning-by-exporting (Clerides et al. 1998). For instance, derived from the management and policy literature, Arnold and Hussinger (2005, p.223) mention that technological and managerial inputs from foreign contacts boost

firm performance. Closely related to this argument, Wagner (2007) states that an international knowledge flow increases the exporter's performance. Involvement in export markets and therefore serving a larger market offers the possibility to exploit additional economies of scale and to overcome domestic reductions in demand (Wagner 2002). Further, intense competition may lead exporters to faster improvements (Wagner 2002), force firms to keep costs low (Kunst and Marin 1989), and give greater incentives to innovate (Holmes and Schmitz 2001, Kunst and Marin 1989). In other words, exporting boosts firm-level productivity.

This paper tries to find empirical evidence of the association between exporting and firm performance. That is, it deals with the question of an underlying causality. It focuses on the causal effect that exporters become more productive compared with non-exporters. For this study, a unique matching of micro-level data for German and Austrian firms in the period from 1994 to 2003 is employed. The results suggest that German and Austrian exporters are more productive by on average 40 percent compared with non-exporters. Moreover, contrary to other prominent empirical findings in the literature, the study reveals that exporting additionally raises the annual average productivity growth by approximately 1 to 1.5 percent. The robustness of the results relies, beside other techniques, mainly on an instrumental variable approach. This analysis suggests that exporting as well as the export intensity (export-to-sales ratio) boost labor productivity and total factor productivity (TFP) significantly. In this context, estimating TFP follows Levinsohn and Petrin (2003) to circumvent endogeneity problems as a result of unobserved productivity shocks. Therefore, the results allow the conclusion that both directions hold: more productive firms self-select themselves into export markets and exporting to foreign markets boosts firm-level productivity.

The underlying methodology is based on empirical studies focusing on

the distinction between causality and a simple correlation of export status and productivity. The first to mention here is that of Bernard and Jensen (1999). They use labor productivity as well as TFP to find differences between exporters and non-exporters. The underlying technique is based on a feasible chronological dependency between exporting and productivity.[1] The authors argue that their results suggest that there is more evidence of self-selection than of productivity growth by exports. A similar result is found in another study by Bernard and Jensen (2004). They give indirect evidence of the existence of sunk costs because of the greater importance of existing exporters than new entrants for raising US exports between 1987 and 1992. In this context, Roberts and Tybout (1997, p.559) quantify the presence of sunk costs as exporting activities raise the probability of further exporting by approximately 60 percentage points. Against these findings, De Loecker (2007b) gives evidence for the learning-by-exporting hypothesis. Employing micro data for Slovenia from 1994 to 2000, the author uses a matching technique comparing exporting firms with similar non-exporting firms. The estimations show that the instantaneous impact of export starters on productivity is 8.8 percent whereas the effect is larger for exports to high-income regions than exports to low-income regions (De Loecker 2007b, p.86). The study by Hahn (2004) provides evidence of both effects of the relationship between exporting and, amongst others, TFP. Using annual plant level data for Korean firms from 1990 to 1998, especially entry into the export market raises TFP whereas exporters are more productive before they start exporting. As the author mentioned, this result is in contrast to the findings by Aw, Chung, and Roberts (1998). Their results suggest that for South Korea as well as for Taiwan self-selection is much more supported than learning-by-exporting. Baldwin and Gu (2003) analyze the Canadian manufacturing sector from 1974 to 1996. They find that both export starters are more

[1] See also Lachenmaier and Wößmann 2006, p.318ff.

productive by around 21 percent and exporting improves annual labor productivity growth and TFP by 6 and 2 percent, respectively.[2]

The balance of this paper is organized as follows. Section 2 gives a short overview of German and Austrian export behavior within the considered period from 1994 to 2003. It emphasizes German and Austrian trade openness and the potential link of exporters becoming more productive, which provides the main motivation for this analysis. Section 3 gives an overview of the data and the underlying methodology, illustrating the basic estimation equations. Following Levinsohn and Petrin (2003), it also presents some data-related intuition about the simultaneity bias concerning the input and output variables within the TFP calculations. Section 4 gives a more detailed descriptive analysis of the underlying data. Section 5 presents the empirical results of the causality analysis between exporting and productivity. The following Section 6 provides robustness from an instrumental variable approach to give evidence of the existence of a causality running from exports to productivity. Finally, Section 7 concludes.

2 Exports and Productivity in Germany and Austria

As mentioned in the first section, Kunst and Marin (1989) find for Germany a causal relationship running from exports to productivity. This finding does not hold for Austria (Marin 1992). Considering more recent German firm-level studies on the causal relationship between exporting and productivity suggests that mainly one direction holds: firm performance determines the

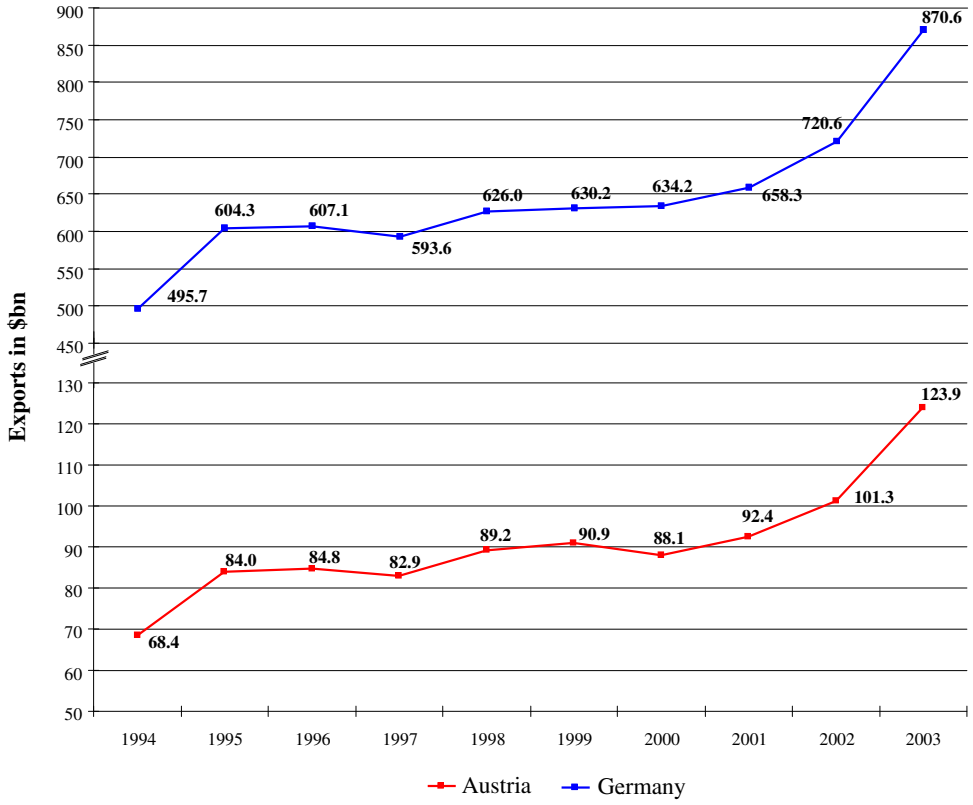
[2] A more extensive summary and evaluation of the literature on the causal relationship between exports and productivity is given by Greenaway and Kneller (2007) and Wagner (2007, 2008). Also closely related, another set of literature studies the relationship between exports and innovation, e.g. Lachenmeier and Wößmann (2006). They show a causality running from innovation to exports. Using an instrumental variable approach, the authors conclude that innovation raises the export share by an additional 7 percentage points.

export status (Arnold and Hussinger 2005, Bernard and Wagner 1997, 2001, Wagner 2007). For instance, employing data of the Statistical Office of Lower Saxony, Wagner (2002) uses a matching approach comparing export starters with non-starters. Beside the well-known fact that exporters are *better* in a range of different firm characteristics, the author finds only weak evidence of the impact of exporting on labor productivity. Arnold and Hussinger (2005) use 389 German firm-level data from the Mannheim Innovation Panel between 1992 and 2000. Applying a propensity score matching approach, the authors conclude that productivity causes exports and therefore self-selection is existent; however, the other way round does not hold. The only analysis that finds empirical evidence of causality running from exporting to productivity in Germany is the study by Fryges and Wagner (2008). Allowing for continuous treatment, the authors apply the generalized propensity score methodology to German micro-level data in Lower Saxony from 1995 to 2005. Their results show that only within different sub-intervals of the exports-to-sales ratio does exporting raise labor productivity growth.

The existing literature on Germany finds empirical evidence that exporters are more productive than non-exporters. However, empirical evidence of the impact of German exporting on firm performance is weak. This finding as well as the undoubted importance of trade liberalization and, in the true sense, exports motivate this analysis.

Marin (2008) accounts for the importance of Germany and Austria. She shows that the two countries are most integrated into the world economy compared with other European countries (Marin 2008, p.3): from 1994 to 2006, exports plus imports as a percentage of GDP (trade openness) increased in Germany from 37 to 69 percent and in Austria from 49 to 85 percent. Figure 1 and 2 demonstrate in this context the increasing importance of exports in Germany and Austria, separately. From 1994 to 2003, the total exports almost doubled in both countries. Within this period, exports as

a percentage of GDP increased by 14.9 percentage points in Austria, from 33.6 to 48.5 percent, and by 12.5 percentage points in Germany, from 23.1 to 35.6 percent. Moreover, this rise can be ascribed to a small number of top firms. Mayer and Ottaviano (2007a, 2007b) show that in Germany the top 10 percent of exporters account for 90 percent of exports.[3]

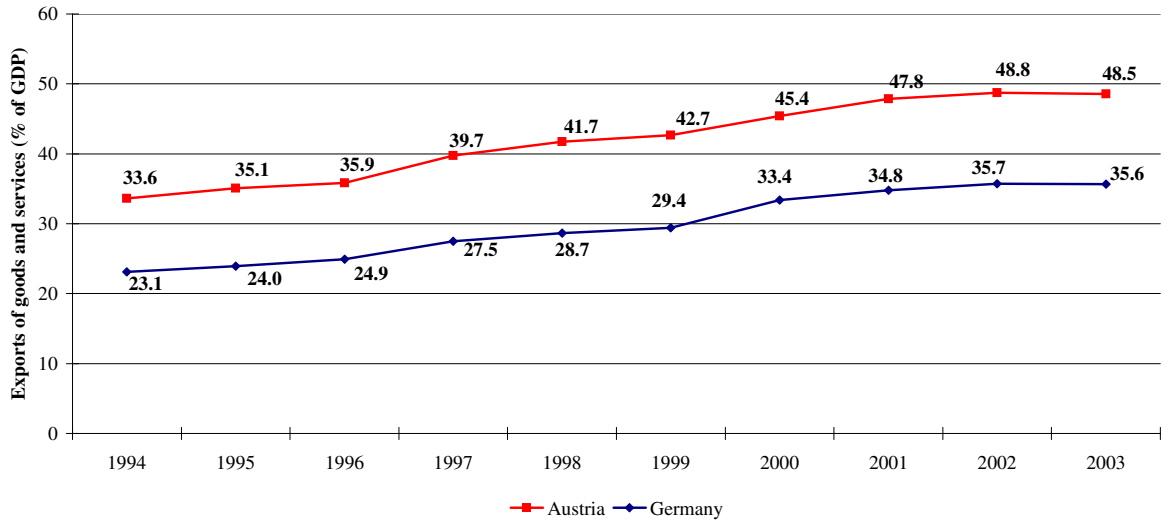


Source: The World Bank Group (2009), World Development Indicators.

Figure 1: Total exports in Austria and Germany (1994 - 2003)

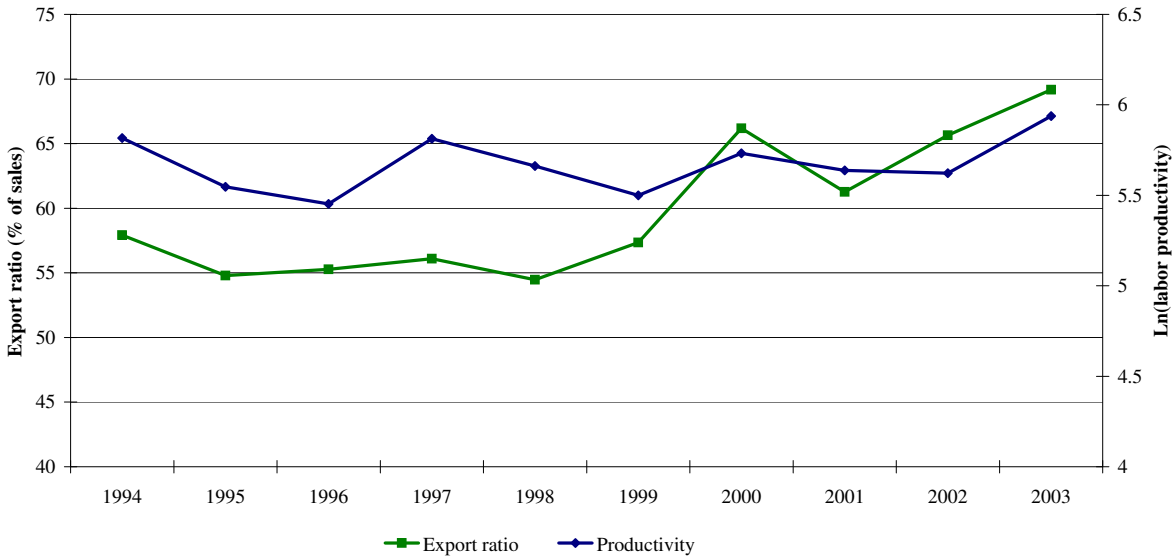
[3] This fact also motivates the study of the potential relationship with a small number of roughly 380 firms over 10 years. See Section 3 for more details.

Moreover, Mayer and Ottaviano (2007a, 2007b) present that German employment and wage premia are larger for exporters than purely domestic firms. The authors conclude that exporters show a better firm performance than non-exporters. These results are also supported by Figures 3 and 4. Both figures show, for Austria and Germany separately, movements of the export ratio (as a percentage of sales) and the related firm's labor productivity from 1994 to 2003. In general, an increase in the export ratio is associated with an increase in productivity. In more detail, an increase in the export ratio in period t is linked with an increase in productivity in period $t + 1$. In Austria, this holds true for five out of eight periods. The other periods in Austria generally illustrate a comovement in the same period. In Germany, the lagged relationship is more precise. For instance, a rise in the export ratio in 1996 is linked with an increase in labor productivity one period later. A decrease in the export ratio in 1997 is followed by a decrease in the firm-level productivity in 1998. This relationship can be found from 1994 to 2002, that is, in seven out of eight possible periods. In addition, owing to the Asian and Russian crises occurring in 1997 and 1998, respectively, and the subsequent falling export ratios, the data seem to be reliable. These facts, from German data more than from Austrian data, allow us to infer gently that exporting may promote productivity.



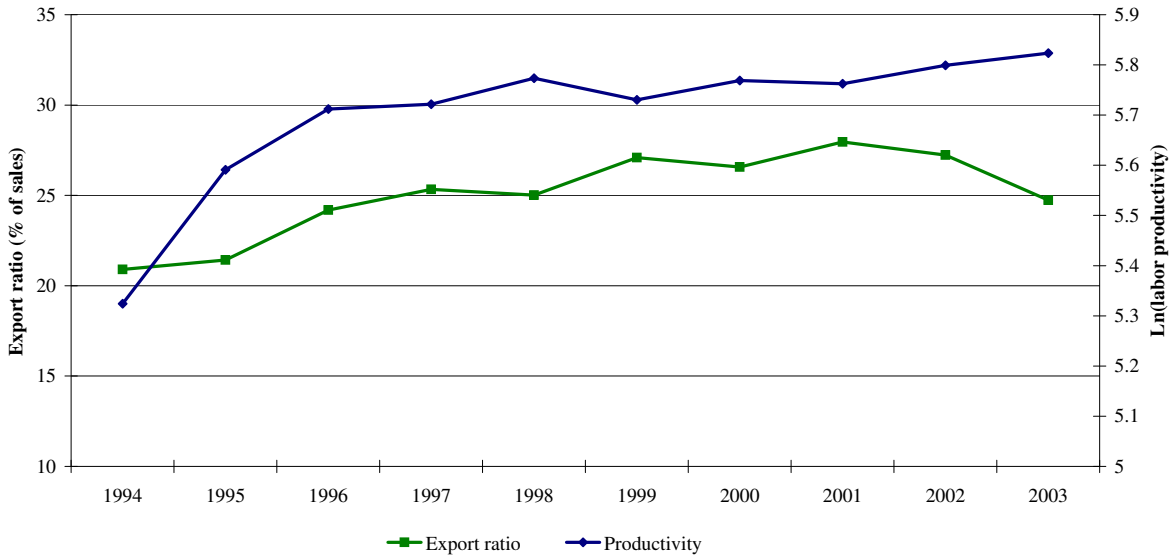
Source: The World Bank Group (2009), World Development Indicators.

Figure 2: Austrian and German export evolution as a percentage of GDP (1994 - 2003)



Notes: Labor productivity is the revenue-to-employee ratio.
Sources: Hoppenstedt (Hoppenstedt 2009), Thomson ONE Banker (Thomson Reuters 2009), Amadeus (Bureau van Dijk 2005), and Chair for International Economics, University of Munich. Author's calculations.

Figure 3: Austrian export ratio and labor productivity (1994 - 2003)



Notes: Labor productivity is the revenue-to-employee ratio.
Sources: Hoppenstedt (Hoppenstedt 2009), Thomson ONE Banker (Thomson Reuters 2009), Amadeus (Bureau van Dijk 2005), and Chair for International Economics, University of Munich. Author's calculations.

Figure 4: German export ratio and labor productivity (1994 - 2003)

3 Data and Methodology

3.1 Dataset

The dataset is built on a matching for 660 German and Austrian firms investing in Central and Eastern European countries. That is, the sample of the empirical study relies mainly on a survey between 1997 and 2001 by the Chair of International Economics at the University of Munich. It provides information on the micro-level for the investors as well as for the corresponding affiliates covering firms of all size classes. For this period, the sample represents 80 percent of the German total investments in Eastern Europe and 100 percent of the total Austrian investments in Eastern Europe.[4]

To enhance the underlying data, the cross-sectional firm information is matched with the pan-European micro database *Amadeus* released by the Bureau van Dijk (Bureau van Dijk, Electronic Publishing 2005). The underlying version includes firm-level data for more than 1.5 million national and multinational establishments in 38 European countries for up to 13 years, finishing in 2005.[5] This results in an unbalanced panel of 417 German and Austrian firm-level data covering a period of 10 years from 1994 to 2003. Unfortunately, this database gives information on the export turnover neither for Germany nor for Austria. However, it offers values for the peer group's export turnover. This group is defined as companies with information on their export turnover, being active in the parent firm's same first two-digit industry classification (ISIC), and having a similar capital as well as labor endowment. The obtained peers' export turnover is the simple average per employee over all comprised peers available for the sample period from 1997 to 2003.[6] This variable is used for the instrumental regressions to circumvent

[4] See Marin (2004, 2008) for a further description of the data.

[5] For further information on the *Amadeus* dataset (Bureau van Dijk 2005) available online see http://www.bvdep.com/en/Amadeus.html.

[6] It contains firm information from Croatia, France, Hungary, United Kingdom, and

the endogeneity problem prevailing and discussed in the literature.

The measure for German and Austrian export activities is provided by *Hoppenstedt* (Hoppenstedt 2009) and *Thomson ONE Banker* data (Thomson Reuters 2009).[7] It allows the matching out of a total of 417 firms of 367 German (65 percent) and Austrian (35 percent) corporations with information on the global export status as well as exporting ratio as a percentage of firm sales. Therefore, it results in an unbalanced panel on the micro-level for each year from 1994 to 2003.

In a final step, effectively applied export tariff rates are merged for each four-digit German and Austrian firm's industry and year. The data are provided by the World Integrated Trade Solution database *(WITS)* (World Bank and UNCTAD 2008), which is fully available for the research period.[8] Beside the peers' export turnover mentioned above, this variable is also used to avoid the underlying endogeneity problem via an instrumental approach.

3.2 Total Factor Productivity and Simultaneity Bias

To study the underlying relationship between exporting and productivity, in a first step, I estimate the firm's TFP. Owing to the low number of observations, this approach is estimated for each 2-digit industry classification (ISIC) over all 209,000 German and 30,000 Austrian firms available in *Amadeus* (Bureau van Dijk 2005). TFP is defined as the difference between the natural log of the actual value Y_{it} and the natural log of the estimated value $\hat{Y_{it}}$ considering a Cobb-Douglas production function:

Switzerland.

[7] I would like to thank the Economic Business and Data Center (EBDC) for giving me access to this data. For further information on the EBDC and the mentioned datasets see http://www.cesifo-group.de/portal/page/portal/ifoHome/_EBDC_root/EBDC_Intro/EBDC_000_Intro, http://www.hoppenstedt.de and www.thomsonreuters.com/products_services/financial [August, 3rd 2009].

[8] *WITS* (World Bank and UNCTAD 2008) gives access to the major trade and tariff data from the *UN COMTRADE* database, the *TRAINS* database, and the *IDB* and *CTS* databases. For these and further information on *WITS* (World Bank and UNCTAD 2008) see http://wits.worldbank.org/witsweb

$$Y_{it} = A_{it}(E) L_{it}^{\gamma_l} K_{it}^{\gamma_k}, \tag{1}$$

where Y_{it} is the firm's value added of firm i at time t, L_{it} is the number of employees of firm i at time t, and K_{it} is the capital endowment of firm i at time t. All the variables are deflated.[9] Calculating TFP allows us to analyze whether firm-level productivity $A_{it}(E)$ is influenced by exports E. Beside ordinary least square (OLS) with fixed effects, the estimation procedure follows Levinsohn and Petrin (2003). Due to a productivity shock unobserved by econometricians, OLS is not very reliable (Ackerberg et al. 2005, Levinsohn and Petrin 2003, Olley and Pakes 1996). That is, the residuals in the production function specification contain an unobserved shock that has an impact on the firm's input factors capital and labor. The so-called transmitted component results in a simultaneous causality problem between the explained and the explanatory variables, especially between capital and the error term as stated by Levinsohn and Petrin (2003, p.319ff).[10]

Contrary to Olley and Pakes (1996), the Levinsohn and Petrin (2003) technique does not require a measurement of investments to proxy the unobserved shock. Due to zero investment observations and insufficient data on firm-level investments, Levinsohn and Petrin (2003) suggest intermediate inputs m_{it} as a proxy to solve the endogeneity problem. Assuming a strictly monotonous relationship between the proxy, the capital accumulation, and the unobserved shock allows me to estimate consistent beta coefficients on the input variables specifying the transmitted component as part of the error term by $f_t(k_{it}, m_{it})$ (Levinsohn and Petrin 2003, Olley and Pakes 1996,

[9] The manufacturing and service sectors are deflated by the producer price index and the consumer price index, respectively. Additionally, year dummies are included while estimating total factor productivity. The measures are obtained by the Austrian National Bank (OeNB 2008) and German Federal Statistical Office (2008c).

[10] See also Ackerberg et al. (2005), Alvarez and Crespi (2007), and Olley and Pakes (1996).

Pakes 1996).[11] Therefore, the following equations are estimated.[12] First, the elasticity of labor is obtained by

$$y_{it} = \gamma_1 l_{it} + \theta_t(k_{i,t}, m_{i,t}) + u_{it}, \tag{2}$$

where

$$\theta_t(k_{it}, m_{it}) = \gamma_0 + \gamma_2 k_{it} + f_t(k_{it}, m_{it}). \tag{3}$$

Second, the coefficient on capital is empirically calculated by

$$y_{it} - \gamma_1 l_{it} = \gamma_2 k_{it} + g(\theta_{t-1} - \gamma_2 k_{i,t-1}) + u_{it} + \epsilon_{it}. \tag{4}$$

The proxy variable is measured by material costs, labor is measured by the number of employees, tangible fixed assets measure capital endowment, and the dependent variable is the firm's real value added. All the variables are from the *Amadeus* database (Bureau van Dijk 2005). As already mentioned, owing to the fact that the number of observations is restricted to 367 firms per year, TFP is calculated in each 2-digit sector for Germany and Austria separately over a total of more than 239,000 firms from 1994 to 2003.

A comparison of the TFP calculations following Levinsohn and Petrin (2003) with TFP estimations by simple OLS for a two-input production function allows the determination of the simultaneity bias (Levinsohn and Petrin 2003, p.319). As argued by Levinsohn and Petrin (2003, p.319), one of the most relevant cases is a positive correlation of labor and capital with the unobserved productivity shock. However, labor is assumed to correlate more than capital, resulting in an overestimation of the $\hat{\beta}$-coefficient on labor and an underestimation of the $\hat{\beta}$-coefficient on capital. This is exactly what

[11] The relationship between materials, capital, and productivity shock is approximated by a fourth-order polynomial in k_{it} and m_{it} (Levinsohn and Petrin 2003).

[12] See Levinsohn and Petrin (2003, p.321), Olley and Pakes 1996, Pakes 1996).

the production function estimations applying OLS and Levinsohn and Petrin (2003) to Germany and Austria report.[13]

3.3 Estimation methodology

The starting point of the empirical estimation procedure is based on the approach by Bernard and Jensen (1999). This methodology is widely employed by various empirical studies as a common approach and beginning to investigate the causal relationship between exports and productivity. [14] Therefore, the basic estimation equation of interest is

$$\begin{aligned} Ln(Prod)_{it} = \beta_0 + \beta_1 Export_{it} + \beta_2 Ln(size)_{it} \\ + \beta_3 Ln(K/L)_{it} + \beta_4 \Phi + \epsilon_{it}, \end{aligned} \tag{5}$$

where $Ln(Prod)$ is the natural log of labor productivity and TFP, respectively, of firm i at period t. $Export$ is either a dummy for the firm's export status equal to 1 if the firm is exporting in period t or it measures the firm's export-to-sales ratio in period t. All the specifications include the corporation's turnover $Ln(size)$, the firm's capital-to-sales ratio $Ln(K/L)$, as well as industry, firm, and year dummies as controls (vector Φ) to avoid endogeneity problems owing to time-invariant and time-variant effects. Ignoring these effects, estimations with simple OLS would lead to biased coefficients owing to unobserved heterogeneity in the error term. To detect whether exporting improves productivity or not, the initial specification is modified by lagged values for the export variable estimating its impact on the next period's productivity level and average annual productivity growth rate, respectively (Bernard and Jensen 1999, p.6ff and p.14ff). That is, the main specification 5 gives the simple export premium for exporting compared with non-exporting

[13] See Tables A.1 and A.2 in the Appendix comparing OLS and Levinsohn and Petrin (2003) with value added as the dependent variable Y_{it} for Germany and Austria separately.

[14] See Wagner (2007), p.61ff.

behavior whereas the modification reflects more a causal relationship from the initial export activity on subsequent productivity levels and growth rates in percentage points, respectively.[15]

Therefore, following Bernard and Jensen (1999, p.14) the impact of the export status in year $t-y$ with a period of y years has the following form:

$$\begin{aligned} \%\Delta(Prod)_{it} &= 1/t\left[Ln(Prod)_{it} - Ln(Prod)_{i,t-y}\right] \\ &= \beta_0 + \beta_1 Export_{i,t-y} + \beta_2 Ln(size)_{i,t-y} \\ &\quad + \beta_3 Ln(K/L)_{i,t-y} + \beta_4 \Phi_{i,t-y} + \epsilon_{it}. \end{aligned} \tag{6}$$

Equation 6 detects causality running from exporting to productivity by indicating a chronological impact of export behavior on the performance growth rate.[16] Within this specification, the β-coefficient on the export variable explains the annual average growth rate of firm productivity by a change in the initial export status $t-y$.[17]

Furthermore, it is necessary to verify the robustness of the estimated impact of exporting. To address the simultaneity problem between exporting and productivity, the regressions are re-estimated with an instrumental variable approach (IV). For this procedure, exports are instrumented by the peer group's export ratio. A detailed description of this proceeding is given in Section 6.[18]

4 Descriptive results

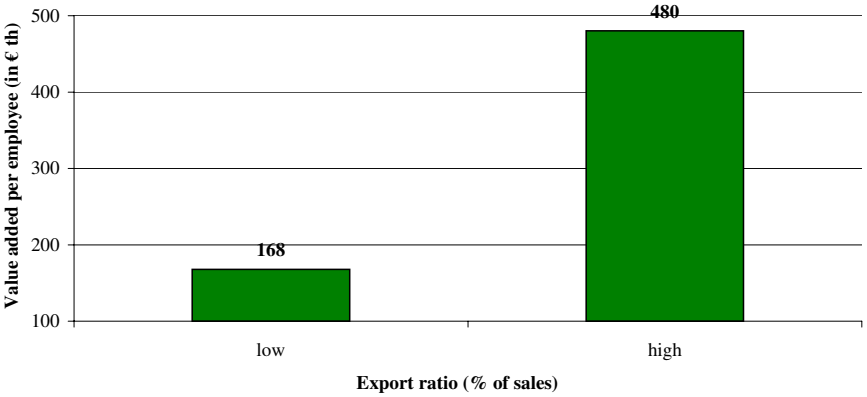
The following section documents a descriptive overview of the underlying data, focusing on the association between exporting and firm-level productivity for Germany and Austria. It illustrates how rising global integration

[15] See Bernard and Jensen (1999), p.14ff.
[16] See Lachenmaier and Wößmann (2006), p.318ff.
[17] See Bernard and Jensen (1999), p.14.
[18] See Section 3 for the definition of the peer variable.

and firm performance are linked. The question evolves from the fact that increasing trade openness contributes to German and Austrian firms developing flatter firm hierarchies and a better performance in terms of, amongst others, firm-level productivity (Marin 2008). As a result of the underlying data matching, starting with the Figures B.1 and B.2 in the Appendix suggests rather a comovement between the export ratio and TFP. Therefore, both figures again indicate a relationship between those two variables. However, contrary to Figures 3 and 4 showing labor productivity, plotting exporting and TFP does not present an unambiguous indication of causality running from exporting to productivity.

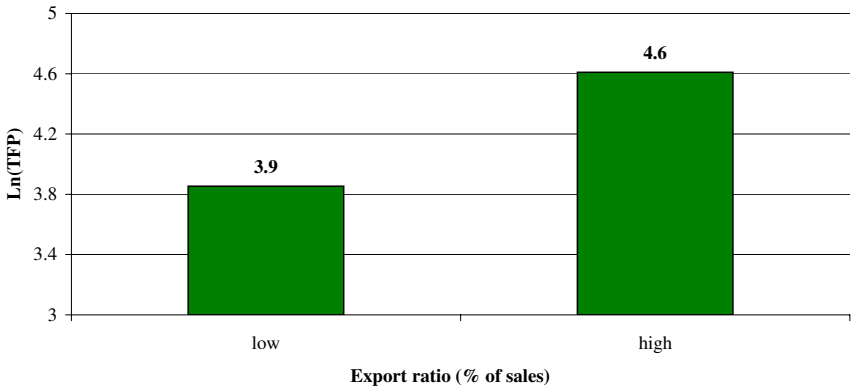
Further evidence of a present relationship is given by Figures 5 and 6. Both illustrate the association between the export ratio and productivity as a simple average over all firms in both countries from 1994 to 2003. The *export ratio* is split up into *low* and *high* values whereas a low export ratio is defined as a value below or equal to the median's export ratio and, controversially, a high export ratio is on hand when the firm is above the median. The figures show that export-intensive firms have a higher value added per employee ratio (with a multiplier of 2.9) as well as a 1.2 times higher TFP. It seems that those firms outperform low-level exporters. That is, firms with a higher export ratio have a higher productivity level.

This monotonic relationship is also confirmed by the following Figure 7. *Export ratio* is grouped into three equal percentiles, namely *low*, *medium*, and *high*. The figures show the average productivity values from 1994 to 2003 over all firms for each country separately. It illustrates that the differences are stronger for Germany than for Austria: in Germany TFP varies on average by 18 percent between all three groups of exporting firms whereas in Austria the average difference between each group (low, medium, and high export ratio) is only round about 3 percent. Both figures suggest that a rise in the



Notes: Productivity is the average of the real value added-to-employees ratio over all parent firms. *Export ratio* is the export-to-sales ratio defined as low (high) when the ratio is equal to or below (above) the median.
Sources: Hoppenstedt (Hoppenstedt 2009), Thomson ONE Banker (Thomson Reuters 2009), Amadeus (Bureau van Dijk 2005), and Chair for International Economics, University of Munich. Author's calculations.

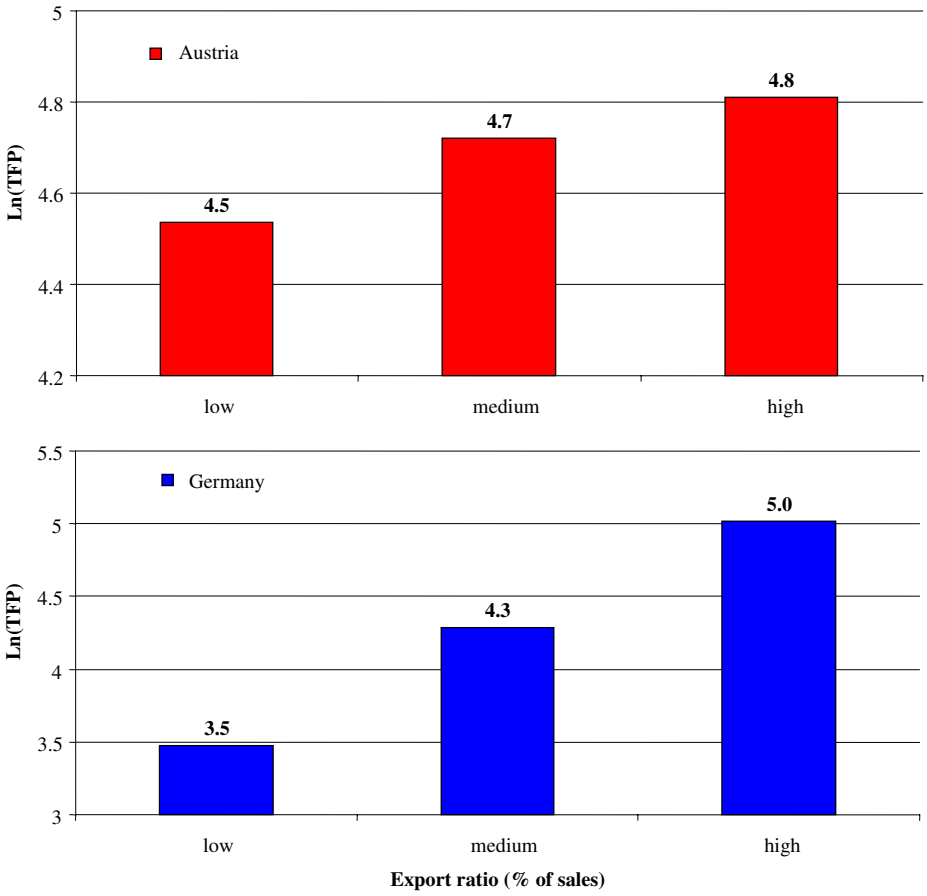
Figure 5: Export behavior and labor productivity



Notes: Ln(TFP) is the natural log of the firm's total factor productivity obtained by the Levinsohn and Petrin (2003) technique for each parent firm's sector separately. The dependent variable is the firm's real value added. *Export ratio* is the corporate's export-to-sales ratio defined as low (high) when the ratio is equal to or below (above) the median.
Sources: Hoppenstedt (Hoppenstedt 2009), Thomson ONE Banker (Thomson Reuters 2009), Amadeus (Bureau van Dijk 2005), and Chair for International Economics, University of Munich. Author's calculations.

Figure 6: Export behavior and TFP

export ratio is associated with an increase in the firm-level TFP.



Notes: Ln(TFP) is the natural log of the Austrian and German firm's total factor productivity obtained by the Levinsohn and Petrin (2003) technique for each parent firm's sector separately. The dependent variable is the Austrian and German firm's real value added, respectively. *Export ratio* is the corporate's export-to-sales ratio defined as low, medium, and high representing three equal-sized percentiles of the export ratio distribution.
Sources: Hoppenstedt (Hoppenstedt 2009), Thomson ONE Banker (Thomson Reuters 2009), Amadeus (Bureau van Dijk 2005), and Chair for International Economics, University of Munich. Author's calculations.

Figure 7: Export intensity and TFP

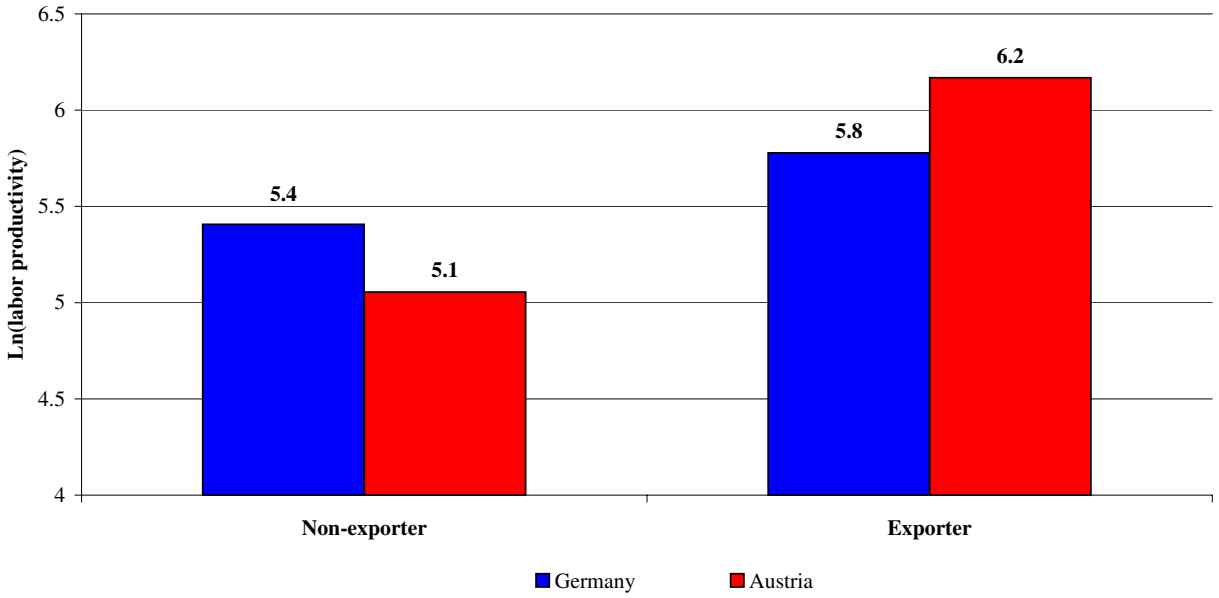
In addition, beside the results on the export ratio, a comparison of exporters versus non-exporters (Figure 8) presents exporters as having a higher productivity in both countries, Germany and Austria. Within this consideration, the difference between exporting and non-exporting is larger in Austria than in Germany. It indicates what 1 summarizes. The descriptive overview of exporters and non-exporters in both countries within the sample

shows that exporting firms are older, have an added value almost twice as high, and are larger in terms of a 6 times greater intangible and 1.5 times greater tangible endowment. Furthermore, exporters show a higher number of employees, a greater capital-to-labor ratio, and revenues that are twice as large. That is, exporters show different characteristics compared with their non-exporting counterparts (Arnold and Hussinger 2005, p.226ff, De Loecker 2007b, p.73). It demonstrates that the results are similar to other (German) studies in the literature suggesting an association between exporting firms and their productivity.

Table 1: Summary of firm characteristics

	Non-exporter	Exporter
Age (years)	39	47
Added value (Eur th)	238,182	418,918
Intangibles (Eur th)	810	4,982
Tangibles (Eur th)	152,700	236,655
Employees (number)	2,007	4,824
Capital-to-labor (Eur th)	590	665
Revenue (Eur th)	479,740	939,046

Notes: Mean characteristics of German and Austrian firms in the period from 1994 to 2003. Due to outliers, the upper 2 percent of each considered variable is dropped.
Sources: Hoppenstedt (Hoppenstedt 2009), Thomson ONE Banker (Thomson Reuters 2009), Amadeus (Bureau van Dijk 2005), and Chair for International Economics, University of Munich. Author's calculations.



Notes: Ln(labor productivity) is the natural log of the firm's revenue-to-employee ratio. The variable exporter is equal to one when a positive export status is observed; otherwise, a firm is a non-exporter when the export status is equal to zero.
Sources: Hoppenstedt (Hoppenstedt 2009), Thomson ONE Banker (Thomson Reuters 2009), Amadeus (Bureau van Dijk 2005), and Chair for International Economics, University of Munich. Author's calculations.

Figure 8: Exporting vs. non-exporting and labor productivity

5 Empirical results

The descriptive results suggest that exporting firms outperform non-exporting firms. In line with the existing literature, German and Austrian exporters show a higher performance over a wide range of firm characteristics. However, the causality between the interaction of the two variables has to be verified by a clear econometric approach. This leads to the possibility of quantifying the additional impact of exporting on firm-level productivity.

Table 2: Export status and productivity

		Explanatory variables			
	Export status	Ln(size) & Ln(K/L)	Fixed effects	R2	Observations
Firm characteristics Ln(X)					
Y/L	0.8042*** *[0.116]*	*yes*	*yes*	0.6	2150
VA/L	0.5483*** *[0.074]*	*yes*	*yes*	0.5	1850
TFP (OLS)	0.4927*** *[0.074]*	*yes*	*yes*	0.2	1805
TFP (Levpet)	0.4889*** *[0.078]*	*yes*	*yes*	0.2	1589

Notes: A constant term as well as year, industry, and firm fixed effects are included throughout all the specifications. Clustered standard errors are in brackets. Each dependent variable is at the plant level i in industry j and year t. Y/L is the parent firm's turnover per employee. VA/L is the firm's value added per employee. TFP is obtained by OLS and Levinsohn and Petrin (2003), respectively, both with real value added as dependent variable. *Export status* is a dummy equal to one if the corporate global foreign sales are greater than zero. Also included throughout all specifications is the parent firm's natural log of turnover, namely $Ln(size)$, the log of the parent firm's capital-to-labor ratio, namely $Ln(K/L)$, and a country dummy distinguishing between Germany and Austria. *, **, *** indicate significance at the 10, 5, and 1 percent level, respectively.

Table 2 starts with a fixed effects estimation using the explanatory variable *export status* to predict values of different firm productivity measures. All the specifications include the firm's size and the firm's capital-to-labor ratio as controls. The variables are given for period t. The first two firm

characteristics, Y/L and VA/L,, represent labor productivity. The last two variables show the impact on the firm's total factor productivity obtained by OLS and Levinsohn and Petrin (2003). The results show that all the coefficients are highly statistically significant with a positive sign. In detail, exporters' labor productivity is larger by roughly 0.55 to 0.80 whereas TFP is larger by 0.5 compared with non-exporters. Therefore, the average percentage difference of the productivity level ranges roughly between 60 and 70 percent.[19] This confirms the existence of an export premium, suggesting that exporting firms perform better than their non-exporting counterparts. However, as mentioned in the existing literature, this specification following Equation 5 can not be interpreted as a causality running from exports to productivity.[20]

Table 3 presents the same set-up for the impact of the corporate's export ratio as a percentage of sales as the explanatory variable on firm characteristics. The outcome is similar to the results in Table 2. For all 4 productivity measures, the β-coefficient on *export ratio* is highly significant and positive. It also shows the descending order from labor productivity to TFP. An increase in the *export ratio* by 1 percentage point raises both labor productivity measures Y/L and VA/L by roughly 1.23 percent. The same increase in the export ratio variable boosts TFP obtained by OLS by 1.09 percent and TFP obtained by Levinsohn and Petrin (2003) by 1 percent. Again, those who export more show a better firm performance. Owing to the fact of self-selection, at this point a causal interpretation is not plausible.

To gain further insight into whether exporting improves firm performance, the following regressions focus on a chronological relationship between the two variables. In more detail, Table 4 presents the results for a one- and two-period lagged export status as the independent variable on firm perfor-

[19] The differences in the productivity level are calculated by 100(expβ-1). See, amongst others, Wagner (2007), p.62ff.

[20] See, amongst others, Bernard and Jensen (1999), Hahn (2004), and Wagner (2007).

Table 3: Export ratio and productivity

	Explanatory variables				
	Export ratio	Ln(size) & Ln(K/L)	Fixed effects	R2	Observations
Firm characteristics Ln(X)					
Y/L	1.2266*** *[0.142]*	*yes*	*yes*	0.6	2115
VA/L	1.2033*** *[0.159]*	*yes*	*yes*	0.5	1840
TFP (OLS)	1.0880*** *[0.152]*	*yes*	*yes*	0.2	1795
TFP (Levpet)	0.9920*** *[0.155]*	*yes*	*yes*	0.2	1583

Notes: A constant term as well as year, industry, and firm fixed effects are included throughout all the specifications. Clustered standard errors are in brackets. Each dependent variable is at the plant level i in industry j and year t. Y/L is the parent firm's turnover per employee. VA/L is the firm's value added per employee. TFP is obtained by OLS and Levinsohn and Petrin (2003), respectively, both with real value added as dependent variable. *Export ratio* is the value of corporate exports as a percentage of sales. Also included throughout all specifications is the parent firm's natural log of turnover, namely $Ln(size)$, the log of the parent firm's capital-to-labor ratio, namely $Ln(K/L)$, and a country dummy distinguishing between Germany and Austria. *, **, *** indicate significance at the 10, 5, and 1 percent level, respectively.

mance. Moreover, it focuses on the most reliable productivity measures, namely VA/L for labor productivity and TFP by Levinsohn and Petrin (2003) as the dependent variables.

This comes from the fact that the present work aims to investigate the learning-by-exporting hypothesis whereas knowledge flow or technology spillovers will primarily show up in TFP (Hahn 2004, p.17). In addition, focusing on VA/L allows the comparison of the results with other studies that analyze only labor productivity due to missing data. Table 4 also reports results with the firm's labor endowment as the dependent variable. As Hahn (2004, p.17) argues, employment captures improved resource allocation that can be ascribed to exporting. In a chronological sense, Table 4 suggests that exporting improves firm performance. All the β-coefficients on the past export variables are statistically significant. In specifications (1) and (2), the lagged

export variables yield on average a 60 percent higher labor endowment in exporting firms in subsequent periods. Labor productivity as well as total factor productivity are also larger for preceding exporting activities than non-exporting. For instance, the coefficients in specifications (5) and (6) suggest that preceding exports lead to on average a 22 percent higher TFP in period t compared with non-exporting. Contrary to other mentioned studies about exports and firm level productivity, the results suggest that German and Austrian firms gain from exporting: exporters are more productive. Moreover, the productivity gap widens in the following years.[21] That is, after 2 years of exporting, the productivity is around 24 percent higher compared to non-exporting firms.

Taking these results as a basis, Arnold and Hussinger (2005, p.233) test the causal relationship using the Granger causation method. That is, in terms of exports and performance, lagged values of exporting predict TFP significantly better than lagged values of TFP.[22] Using the same underlying method, Table A.3 in the Appendix reports that TFP in period t is better explained by the lagged export variables with a significance level of 5 percent. On the contrary, lagged values of TFP do not have a statistically significant impact on the export status. This indicates the existence of an impact of exports on productivity.

Bernard and Jensen (1999, p.14) argue that the "cleanest" test for the causality question is given by Equation 6. It estimates the impact of the initial exports on the average annual growth rate of productivity. Table 5 reports the effects of the current as well as initial exporting behavior on the annual average growth rate of labor productivity and TFP. For labor pro-

[21] See De Loecker (2007b), p.80ff.

[22] See Arnold and Hussinger (2005), p.233. They use a linear model to test the impact of two lags of TFP and exports on TFP and another linear probability model to test the impact of lagged TFP and exports on the current export status. Their results show that firm performance determines export behavior. The reverse Granger causality can be excluded.

Table 4: Lagged export status

	Firm characteristics Ln(X)					
	L		VA/L		TFP (Levpet)	
	(1)	(2)	(3)	(4)	(5)	(6)
Export status$_{t-1}$	0.4440***		0.6496***		0.1360*	
	[0.123]		*[0.024]*		*[0.078]*	
Export status$_{t-2}$		0.6447**		0.5759***		0.2428***
		[0.291]		*[0.022]*		*[0.059]*
Ln(size) & Ln(K/L)	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*
Fixed effects	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*
R2	0.9	0.9	0.7	0.7	0.2	0.2
Observations	2000	1302	1251	1097	1052	932

Notes: A constant term as well as year, industry, and firm fixed effects are included throughout all the specifications. Clustered standard errors are in brackets. Each dependent variable is at the plant level i in industry j and year t. L is the parent's firm number of employees. VA/L is the firm's value added per employee. TFP is obtained by Levinsohn and Petrin (2003) with real value added as dependent variable. *Export status* is a dummy equal to one if the corporate global foreign sales are greater than zero. Also included throughout all specifications is the parent firm's natural log of turnover, namely $Ln(size)$, the log of the parent firm's capital-to-labor ratio, namely $Ln(K/L)$, and a country dummy distinguishing between Germany and Austria. *, **, *** indicate significance at the 10, 5, and 1 percent level, respectively.

ductivity, the β-coefficients on export status are highly significant at the 1 percent level. The annual impact for exporting compared with non-exporting ranges from 0.2 to 0.6 percent. Similarly, in the case of TFP, all the coefficients are statistically significant at least at the 5 percent level. The annual impact of the export status ranges between 0.2 and 1 percent. Owing to the fact that initial exports are statistically significant, it provides further evidence that exports cause performance growth. Exporting leads to higher productivity levels and growth rates. Therefore, German and Austrian exporters gain additional benefits by growing faster than their counterparts.[23] Moreover, these results confirm the findings of a larger productivity gap in the Table before. The annual average growth rate is increasing in the years of exporting.[24] It suggests that continuous export behavior may lead to higher productivity growth compared with non-exporting or an subsequent export start.

Another approach to finding growth differences in productivity is to compare continuous exporters and non-exporting firms (Bernard and Jensen 1999, p.19ff, Wagner 2007, p.62ff). In detail, this method estimates the chronological impact of preceding exports on post-entry productivity growth.[25] Therefore, following Bernard and Jensen (1999), the estimation strategy is given by

$$\begin{aligned} \%\Delta(Prod)_{it} = \beta_0 + \beta_1 Start_{it} + \beta_2 Stop_{it} + \beta_3 Cont_{it} \\ + \beta_4 Ln(size)_{it} + \beta_5 Ln(K/L)_{it} + \beta_6 \Phi_{it} + \epsilon_{it}. \end{aligned} \tag{7}$$

$Start_{it}$ is a dummy variable equal to 1 if the firm exports in t but not

[23] The same set of specifications is estimated for the firm's export ratio. The results remain qualitatively unchanged, suggesting annual growth rates between 0.3 and 1 percent. The coefficient of the export ratio in $t-2$ becomes insignificant but close to the 10-percent threshold.

[24] See De Loecker (2007b), p.80ff.

[25] See Wagner (2007), p.63.

Table 5: Impact of exports on the average annual growth rate $\%\Delta X$

	VA/L			TFP (Levpet)		
	(1)	(2)	(3)	(4)	(5)	(6)
Export status$_t$	0.4152*** *[0.114]*			0.2697** *[0.136]*		
Export status$_{t-1}$		0.2072*** *[0.049]*			0.1562** *[0.077]*	
Export status$_{t-2}$			0.6068*** *[0.076]*			0.9896*** *[0.118]*
Ln(size) & Ln(K/L)	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*
Fixed effects	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*
R2	0.4	0.3	0.5	0.3	0.5	0.4
Observations	1227	1173	801	1062	1022	706

Notes: A constant term as well as year, industry, and firm fixed effects is included throughout all the specifications. Clustered standard errors are in brackets. Each dependent variable is the average annual growth rate calculated at firm level i in industry j. In specifications (3) and (6), the annual average growth rate is calculated with a period length of 2 years. VA/L is the firm's value added per employee ratio. TFP is obtained by Levinsohn and Petrin (2003). It is calculated with real value added as dependent variable. *Export status* is equal to one if the firm exports in period t. Also included throughout all specifications is the parent firm's natural log of turnover, namely $Ln(size)$, the log of the parent firm's capital-to-labor ratio, namely $Ln(K/L)$, and a country dummy distinguishing between Germany and Austria. *, **, *** indicate significance at the 10, 5, and 1 percent level, respectively.

in the initial period $t-1$ and $t-2$, respectively. Its coefficient compares export starters with firms that do not export at all. $Stop_{it}$ is a dummy variable equal to 1 if the firm is exporting in $t-1$ $(t-2)$ but not in period t. That is, the β-coefficient subsequent productivity growth of export stoppers with non-exporters. Finally, $Cont_{it}$ is a dummy variable equal to 1 if the firm exports in $t-1$ and t. Contrary to Bernard and Jensen (1999), if the initial period is $t-2$, the $Cont_{it}$-variable equal to 1 means that the firm exports throughout all periods without a break. Therefore, it compares the productivity growth of continuous exporting with non-exporting during the considered period. Again, owing to the fact of a chronological changeover in the firm's export behavior, β_3-coefficient in Equation 7 reveals an impact of exporting on firm labor productivity and TFP growth.

Table 6 reports the results on annual average growth rates. As expected, the coefficient on the *start* variable is positive and highly significant throughout all the specifications. This suggests that export starters experience an annual increase in their productivity growth rate of roughly 0.7 percent. As expected, negative but mainly insignificant is the β_2-coefficient on the stop measurement. The sign of the coefficient on $Cont$ is positive and, specification (3) excepted, highly significant. It indicates that annual labor productivity grows between 1 and 1.5 percent. The result of the effect on the TFP growth rate in specification (4) is not very satisfying. It reports an increase of 1 percent whereas specification (3) reports a negative and insignificant coefficient. Moreover, these findings confirm an increasing productivity gap between exporters and non-exporters. The earlier a firm started to export and, additionally, if the firm shows continuous export activities, the larger the firms productivity growth rates. However, considering productivity growth the estimates for Germany and Austria show lower coefficients compared with transition economics.[26] This may suggest that productivity in these countries

[26] Compare De Loecker (2007b).

is less driven by international knowledge flow than solely influenced by the possibility to exploit additional economies of scale.[27] To summarize, beside the ambiguous results for continuous exporters on TFP growth rate, there is empirical evidence of increasing labor productivity. Beside that, starting to export is associated with an improving firm performance.

Table 6: Starter, stopper, and continuous export activities

	VA/L		TFP (Levpet)	
length of interval (years)	1 years	2 years	1 years	2 years
	(1)	(2)	(3)	(4)
$Start_{it}$	0.7288***	0.7221***	0.6253**	0.7147***
	[0.207]	*[0.086]*	*[0.278]*	*[0.070]*
$Stop_{it}$	-0.574	-0.214	-0.5069*	-0.0984
	[0.496]	*[0.156]*	*[0.287]*	*[0.103]*
$Cont_{it}$	1.5435***	1.0010***	-0.4034	0.5571***
	[0.127]	*[0.049]*	*[0.273]*	*[0.040]*
Ln(size) & Ln(K/L)	*yes*	*yes*	*yes*	*yes*
Fixed effects	*yes*	*yes*	*yes*	*yes*
R2	0.4	0.6	0.3	0.5
Observations	1138	842	995	740

Notes: A constant term as well as year, industry, and firm fixed effects are included throughout all specifications. Clustered standard errors are in brackets. Each dependent variable is the average annual growth rate calculated at firm level i in industry j with a length of T years. VA/L is the firm's value added-per-employee ratio. TFP is obtained by Levinsohn and Petrin (2003). It is calculated with the real value added as dependent variable. *Start* is a dummy equal to one if the firm exports in t but not in $t-1$. *Stop* is a dummy variable equal to one if the firm exports in $t-1$ but not in t. *Continuous* is equal to one if the firm shows exports greater than zero in t and the initial period $t-1$ and $t-2$, respectively. Also included throughout all specifications is the parent firm's natural log of turnover, namely $Ln(size)$, and the log of the parent firm's capital-to-labor ratio $Ln(K/L)$, and a country dummy distinguishing between Germany and Austria. *, **, *** indicate significance at the 10, 5, and 1 percent level, respectively.

[27] See Section 1.

6 Robustness: 2SLS Estimates

Owing to the simultaneous causality problem between exports and productivity, OLS provides inconsistent results. Beside the lagged value regressions to verify further the chronological and causal impact of exporting on productivity, this section applies an instrumental variable approach. This requires a valid instrument that is correlated to the export variable while at the same time it is uncorrelated with the error term. It has to identify variation in the observation's export activity that is exogenous to the firm's productivity. Therefore, it has to be checked whether the instrumental variable *peer group's export ratio* fulfills the relevance as well as the exogeneity condition.

The employed instrument is defined as the average export-to-sales ratio of the firm's related foreign peer group.[28] Owing to the instrument's relevance, there is a negative correlation between the foreign peer group's export ratio and the firm's export activity. The first-stage results show that the lower the export ratio of the peer group, the higher is the firm's exporting activity. In detail, the first-stage regressions show highly significant coefficients suggesting the instrument's relevance. As a result, the instrument is related to the firm's exports and the first condition is fulfilled. To be reasonably exogenous, the instrument must affect the firm's productivity level only indirectly. In more detail, the firm's individual total factor productivity can be understood not to influence the other countries originated peer group decision to export. That is, foreign export behavior is not directly motivated by German or Austrian labor productivity or TFP. Moreover, owing to the argument of potential spillover effects, a direct impact of the peer group's export behavior on domestic firm-level productivity can be excluded because this effect can be primarily ascribed to domestic exporting peer group members and is in the first instance caused by domestic industries. It circumvents

[28] See Section 3 for a detailed description of the peer group variable.

the endogeneity problem of reverse causation running from productivity to exporting.

Table 7 presents the results for the 2SLS estimates, instrumenting exports by the peer group variable. The table illustrates the results for labor productivity, TFP obtained by OLS, and TFP calculated with Levinsohn and Petrin (2003). It suggests that the export status as well as the export ratio have a positive and significant impact on productivity. The β-coefficients on *export status* slightly increase from 0.27 to 0.3 and 0.28 using TFP calculations by OLS and Levinsohn and Petrin (2003), respectively.

This confirms the findings presented previously in the tables: exporting firms are roughly 30 percent more productive than their non-exporting counterparts. In addition, an increase in the *export ratio* by 1 percentage point raises labor productivity by 1.7 percent, TFP (OLS) by 1.6 percent, and TFP using Levinsohn and Petrin (2003) by 1.5 percent. Also, the coefficients on the control variables $size$ and K/L show the expected positive and statistically significant signs. Therefore, they indicate a causal relationship of exports on firm productivity. To summarize, if the exogeneity of the instrument is accepted, the results confirm the findings of additional productivity gains by German and Austrian exporting activities compared with their non-exporting counterparts.

Beside the peer group instrumental approach, I have also used the annual change of global export tariffs as an instrument, expecting an increase in tariff rates to have a negative impact on exporting. In addition, the dependent variable is changed from the level into the growth rate variable. The results are quite similar to the annual growth rate estimations, confirming a causality running from exports to performance. In the case of labor productivity, the annual growth rate is roughly 0.4 percent and in the case of TFP the average annual growth rate is approximately 1.4 percent. However, in spite of the good results, one has to accept the instrument's exogeneity. This is debatable

Table 7: IV results by the peer groups' export ratio

Dependent variable	Ln(Productivity)					
	Exports, instrumented by the peer groups' export ratio					
	IV VA/L	IV VA/L	IV TFP OLS	IV TFP OLS	IV TFP LP	IV TFP LP
	(1)	(2)	(3)	(4)	(5)	(6)
Export status	0.2695***		0.3038**		0.2844*	
	[0.053]		*[0.145]*		*[0.162]*	
Export ratio		1.6951**		1.6063**		1.5371*
		[0.717]		*[0.766]*		*[0.891]*
Ln(size)	0.6333***	0.5807***	0.5580***	0.5856***	0.6743***	0.6931***
	[0.080]	*[0.072]*	*[0.105]*	*[0.104]*	*[0.095]*	*[0.132]*
Ln(K/L)	0.9035***	0.8870***	0.4906***	0.4797***	0.6157***	0.5975***
	[0.043]	*[0.046]*	*[0.070]*	*[0.073]*	*[0.071]*	*[0.084]*
Fixed effects	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*
Test of predictive power of instrument	*p-value=0.000*		*p-value=0.000*		*p-value=0.000*	
R2	0.9	0.9	0.9	0.9	0.9	0.9
Observations	975	954	932	922	765	759

Notes: 2SLS estimations with a constant term as well as year, industry, and firm fixed effects are included throughout all specifications. Clustered standard errors are in brackets. The dependent variable is firm's productivity calculated as value added per labor and total factor productivity at firm level i in industry j in year t, respectively. *Export status* is a dummy equal to one if the parent firm exports in period t. *Export ratio* is the total amount of exports as a percentage of parent sales. $Ln(size)$ is the natural log of the firm's turnover. $Ln(K/L)$ is the firms capital-to-labor ratio. Throughout all the specifications, a country dummy is included distinguishing between Germany and Austria. Alternative specifications also include the subsidiaries' total asset endowment and the parent firms' cost of employees without any substantial change for the coefficients on exports. The first stage results are significant at the 1 percent level. *, **, *** indicate significance at the 10, 5, and 1 percent level, respectively.

because of an (indirect) impact of tariffs on productivity.[29]

7 Conclusion

This paper is a contribution to the huge amount of empirical studies on the relationship between exports and firm performance. Following the approach by Bernard and Jensen (1999), it studies the relationship between German and Austrian export activities and the related firm-level productivity. Therefore, the underlying analysis tries to say that an interdependency of the considered variables exists in both directions: more productive firms self-select themselves into the export market as well as exports raising firm performance. In more detail, the paper shows, on the one hand, that exporters are more productive and, on the other hand, the extent to which exporting behavior leads to a rise in productivity levels and growth rates. The empirical results of a unique data matching suggest that exporters compared with non-exporters are more productive by roughly 40 percent. Moreover, exporting yields an additional annual average productivity growth rate by roughly 1 percent compared with non-exporting. These results are robust to different productivity measurements, estimation specifications, and regression techniques like an instrumental variable approach. Contrary to German findings by e.g. Arnold and Hussinger (2005) and Wagner (2002), firms benefit from exporting. Moreover, contrary to the annual productivity gains of exporting firms in transition economies like Slovenia (De Loecker 2007), my results for Germany and Austria indicate significant but lower productivity growth rates. It implies that the learning-by-exporting hypothesis in terms of new knowledge might be even more true when exporting of firms in less developed countries is analyzed. In the case of Germany and Austria the results indicate that exporters rather experience a productivity boost owing

[29] For instance, see Amiti and Konings (2007).

to economies of scale and further investment incentives than through gaining additional technical knowledge.

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Appendix - Tables and Figures

Table A.1: Production function estimates: German industries

Dependent variable: *real added value* $_{it}$				
	OLS		Levpet	
industry	capital	employees	capital	employees
14: Other mining and quarrying	0.242	0.766	0.591	0.201
15: Manufacturing - food products and beverages	0.281	0.709	0.275	0.608
17: Manufacturing - textiles	0.158	0.709	0.49	0.588
20: Manufacturing - wood and products of wood	0.095	0.931	0.056	0.591
21: Manufacturing - pulp, paper and paper products	0.232	0.72	0.469	0.41
22: Publishing, printing, reproduction of rec. media	0.182	0.734	0.179	0.701
24: Manufacturing - chemicals and chemical products	0.114	0.886	0.028	0.607
25: Manufacturing - rubber and plastic products	0.321	0.554	0.069	0.542
26: Manufacturing - non-metallic mineral products	0.248	0.625	0.281	0.596
27: Manufacturing - basic metals	0.27	0.685	0.342	0.527
28: Manufacturing - fabricated metal products	0.212	0.71	0.1	0.534
29: Manufacturing - machinery and equipment n.e.c.	0.161	0.776	0.382	0.695
31: Manufacturing - electrical machinery	0.151	0.815	0.402	0.685
32: Manufacturing - radio, television, communication	0.4	0.6	0.257	0.706
33: Manufacturing - medical, precision, optical instruments	0.204	0.758	0.065	0.733
34: Manufacturing - motor vehicles, trailers, semi-trailers	0.286	0.668	0.381	0.648
35: Manufacturing - transport equipment	0.188	0.745	0.404	0.593
36: Manufacturing - furniture, n.e.c.	0.182	0.753	0.242	0.751
40: Electricity, gas and water supply	0.308	0.571	0.395	0.367
45: Construction	0.223	0.733	0.186	0.738
50: Sale, repair of motor vehicles and motorcycles	0.256	0.633	0.28	0.43
51: Wholesale trade and commission trade	0.155	0.672	0.165	0.669
52: Retail trade	0.201	0.731	0.068	0.705
60: Land transport, transport via pipelines	0.423	0.395	0.311	0.585
62: Air transport	0.09	0.973	0.444	0.011
64: Post and telecommunications	0.186	0.818	0.387	0.921
67: Activities auxiliary to financial intermediation	0.267	0.369	0.587	0.192
72: Computer and related activities	0.23	0.744	0.196	0.784
74: Other business activities	0.23	0.424	0.135	0.608
90: Sewage and refuse disposal	0.175	0.54	0.004	0.6

Notes: The dependent variable is the firm's real added value at plant level i in industry j and year t. All the variables are given in natural logs. A constant term as well as year dummies are included throughout all the specifications. The coefficients for each industry are obtained from simple OLS estimations and Levinsohn and Petrin (2003) estimations, respectively. The calculations run at a two-digit ISIC industry level.
Source: Amadeus (Bureau van Dijk 2005). Author's calculations.

Table A.2: Production function estimates: Austrian industries

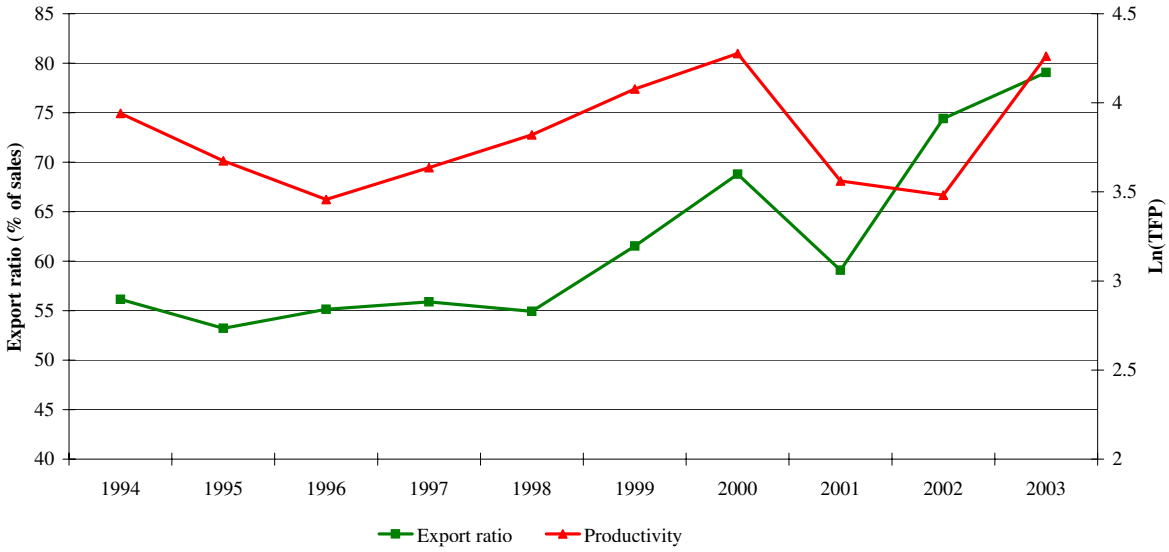
Dependent variable: *real added value* $_{it}$				
	OLS		Levpet	
industry	capital	employees	capital	employees
15: Manufacturing - food products and beverages	0.438	0.638	0.215	0.702
17: Manufacturing - textiles	0.093	0.924	0.619	0.691
20: Manufacturing - wood and products of wood	0.01	0.393	0.456	0.609
26: Manufacturing - non-metallic mineral products	0.152	0.864	0.559	0.654
27: Manufacturing - basic metals	0.333	0.647	0.711	0.631
28: Manufacturing - fabricated metal products	0.116	0.903	0.51	0.724
29: Manufacturing - machinery and equipment n.e.c.	0.049	0.893	0.376	0.813
32: Manufacturing - radio, television, communication	0.236	0.665	0.585	0.809
36: Manufacturing - furniture, n.e.c.	0.19	0.864	0.657	0.322
40: Electricity, gas and water supply	0.688	0.268	0.49	0.597
45: Construction	0.26	0.699	0.206	0.502
50: Sale, repair of motor vehicles and motorcycles	0.26	0.614	0.419	0.36
51: Wholesale trade and commission trade	0.179	0.671	0.423	0.113
52: Retail trade	0.15	0.806	0.309	0.886
60: Land transport, transport via pipelines	0.181	0.921	0.398	0.663
63: Supporting and auxiliary transport activities	0.146	0.797	0.607	0.028
67: Activities auxiliary to financial intermediation	0.442	0.27	0.502	0.123
74: Other business activities	0.165	0.476	0.504	0.425

Notes: The dependent variable is the firm's real added value at plant level i in industry j and year t. All the variables are given in natural logs. A constant term as well as year dummies are included throughout all the specifications. The coefficients for each industry are obtained from simple OLS estimations and Levinsohn and Petrin (2003) estimations, respectively. The calculations run at a two-digit ISIC industry level.
Source: Amadeus (Bureau van Dijk 2005). Author's calculations.

Table A.3: Granger causality

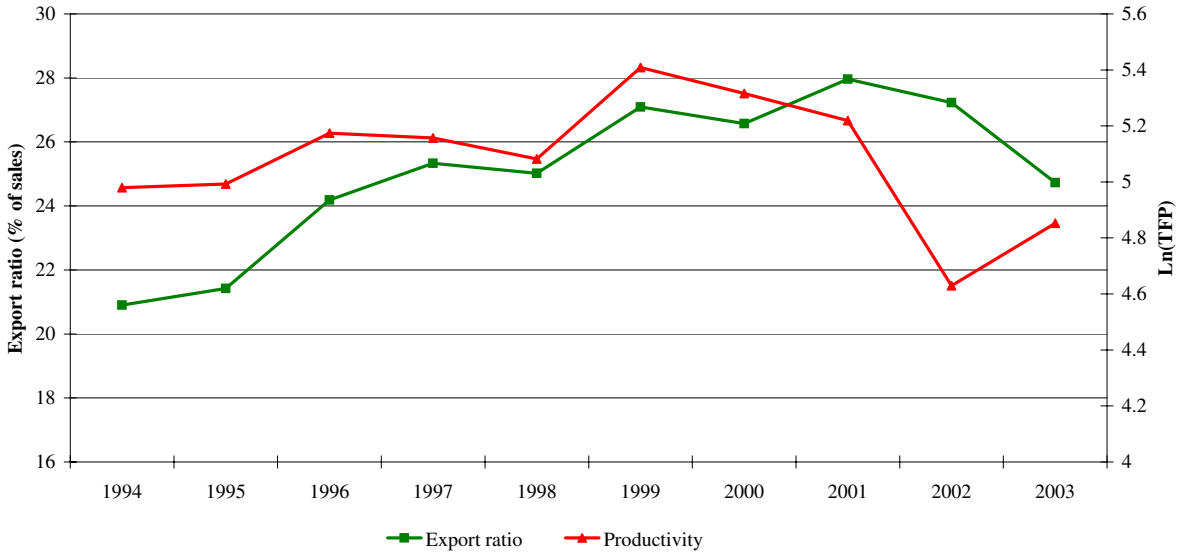
Dependent variable	F-statistic	
TFP_t (Levpet)	$\text{Export status}_{t-1} = 0$, $\text{Export status}_{t-2} = 0$	F(2,547)=2.96 Prob>F=0.05
Export status_t	$TFP_{t-1} = 0$, $TFP_{t-2} = 0$	F(2,596)=1.2 Prob>F=0.3

Notes: A constant term as well as year, industry, and firm fixed effects are included throughout all the specifications. Robust errors are in brackets. Each dependent variable is at the plant level i in industry j and current year t. TFP is obtained by Levinsohn and Petrin (2003) with real value added as dependent variable. *Export status* is a dummy equal to one if corporate global foreign sales are greater than zero. Beside that, also included throughout all specifications is the parent firm's natural log of turnover $Ln(size)$ as well as the log of the parent firm's capital-to-labor ratio $Ln(K/L)$, and a country dummy distinguishing between Germany and Austria. The F-statistic tests the joint significance of the lagged values of exports and productivity, respectively.



Notes: TFP is obtained by Levinsohn and Petrin (2003) with real value added as dependent variable.
Sources: Hoppenstedt (Hoppenstedt 2009), Thomson ONE Banker (Thomson Reuters 2009), Amadeus (Bureau van Dijk 2005), and Chair for International Economics, University of Munich. Author's calculations.

Figure B.1: Austrian export ratio and TFP (1994 - 2003)



Notes: TFP is obtained by Levinsohn and Petrin (2003) with real value added as dependent variable. *Sources*: Hoppenstedt (Hoppenstedt 2009), Thomson ONE Banker (Thomson Reuters 2009), Amadeus (Bureau van Dijk 2005), and Chair for International Economics, University of Munich. Author's calculations.

Figure B.2: German export ratio and TFP (1994 - 2003)