

ABSTRACT. This paper explores the relationships between exports, firm size, and firm dynamics. It is based on a unique longitudinal data set collected at the establishment level, covering some 7000 manufacturing German firms. We present stylized facts on exports and firm size, showing that the probability that a firm is an exporter increases with firm size; however, there are many successful exporters among small firms, and non-exporters among larger firms, too, while most of the exports are from the top size groups of firms. An econometric study shows a picture that is consistent with theoretical considerations: The impact of firm size on exports is positive but decreasing, while human capital intensity, domestic market share, and advanced technology all have a positive influence on the export performance of a firm. Firm growth and export performance are positively related, as is expected from a model of a price-discriminating monopolist.

1. Introduction

It is a truism that Germany is an *open* economy that is intensively integrated into the world markets for goods, services, and factors of production. Exports account for about one third of total sales by manufacturing firms. Evidently, therefore, results from empirical studies on the causes and consequences of exports are important not only for economists interested in testing implications from theoretical models – they are (or, at least, should be) important for shaping and evaluating economic policy measures in fields like industrial policy or promotion of human capital formation, too.

Empirical studies dealing with German exports, however, are almost exclusively either descriptive or based on rather highly aggregated industry level data (see Wagner (1991) for a survey). Results from econometric studies using industry level data

tend to depend to a large extent on details of the specification of the empirical model used (e.g., data used to measure variables like “human capital” or “innovation”, inclusion or exclusion of some industries, period covered, etc.). Furthermore, heterogeneity between firms in an industry is, by definition, ignored. Therefore, econometric studies using industry level data can neither form a solid basis for testing implications of theoretical models, nor for shaping and evaluating economic policies.

While empirical studies on exporting using firm level data from other countries abound (cf. the recent surveys by Madsen (1987) and Miesenbock (1988)), econometric investigations on the causes and consequences of exports based on comprehensive micro level data sets are missing for Germany. A reason for this “state of the art” surely is that suitable data sets are not available for public use, and not collected by researchers due to budget constraints.

However, the Statistical Offices regularly collect firm level data on a large number of topics, including exports. For obvious reasons, these data are not published at the firm level. In a joint project with the Lower Saxonian Ministry of Economics and the Lower Saxonian Statistical Office we are allowed to use these confidential micro data for econometric investigations, strictly following the strong German data protection rules. This paper reports results for causes and consequences of exports.¹ It makes three contributions to the current state of knowledge: it presents evidence on the determinants of export performance of German firms from an econometric investigation based on a comprehensive set of micro data, and it tests econometrically the hypothesis that firm growth and export performance are positively related by applying methods of panel econometrics to the same micro data. Furthermore, it informs the readers of the wealth of data (and its limitations) which are available

Final version accepted on February 25, 1994

Joachim Wagner
University of Lüneburg
D-21332 Lüneburg
Germany

from German official statistics for research in various fields of Small Business Economics.

The rest of the paper is organized as follows: Section 2 gives information on the establishment level longitudinal data base of manufacturing firms from Lower Saxony, section 3 reports stylized facts on exports and firm size, section 4 presents results from an econometric study of the determinants of the export/sales ratio, section 5 considers the relationship between firm growth and exports, and section 6 concludes.

2. The establishment level longitudinal data base of manufacturing firms from Lower Saxony

The empirical investigation is based on establishment level data (i.e. data for local production units) for some 7000 manufacturing firms located in Lower Saxony (one of the northern old federal states of Germany). The panel data set covers firms which produced in at least one of the years between 1978 and 1989, and all data are annual sums or averages. Data were collected in official surveys regularly performed by the Lower Saxonian Statistical Office. Usually, all establishments from manufacturing industries have to reply to the surveys, provided that at least 20 persons are working in either the local production unit itself or (in case of multi-establishment firms) in the company that owns the unit.

The data base includes information for each establishment as regards status (part of a multi-establishment enterprise or not), detailed geographical location, detailed industry code, hours worked by blue collar workers, sum of gross wages paid, sum of gross salaries paid, number of people working in the establishment, number of blue collar workers, domestic sales, foreign sales, investments (in land without buildings, land with buildings, and machinery), costs for leasing, and value of production. Information is for annual sums or averages, as appropriate. More details as regards the data base are given in Wagner (1992b), the questionnaires used in the official surveys are reproduced in Methner (1992).

In our econometric investigations we used data at the level of the local production unit (for short: at the firm level). When descriptive results are reported, firms are classified into four broad

groups of industries (i.e., *basic products, capital goods, consumer goods, and food, beverages, and tobacco products*) and three size classes (*small firms* with up to 50 employees, *medium firms* with 51 to 250 employees, and *large firms* with more than 250 employees). A more detailed breakdown is not allowed by data protection laws.

3. Stylized facts on exports and firm size

It has been found for several countries that exporting tends to be concentrated in the larger production units in an industry (Caves, 1989, p. 1236). The positive relationship between firm size and export/sales ratio is a *stylized fact* of modern industrial economies.

This section presents descriptive evidence on firm size and exports for manufacturing establishments in Lower Saxony based on the firm level data described above. *Exports* are defined here to cover all sales in a foreign country directly exported by a firm only, including sales via export agents. Therefore, goods that are exported indirectly (i.e. via sales of intermediate goods that become part of finished goods that are exported by the buyer later) are counted as domestic sales. *Firm size* is measured using the number of persons working in an establishment, and firms are grouped into three size classes, i.e. small (up to 50 persons), medium (51 to 250 persons) and large (more than 250 persons) firms.

Table I reports export/sales ratios for firms from *capital goods* industries in each year between 1978 and 1989. Three patterns emerge:

- The average export/sales ratio of all firms increased over time from 9.32% in 1978 to 13.00% in 1989, and this increase can be found for the average ratios of the firms from all three size classes. Note, however, that these are *unweighted* averages – the export/sales ratio for capital goods sector of Lower Saxony as a whole was 45% in 1989.
- The probability that a firm is an exporter increases with firms size: in 1989, 30% of all small firms, 59% of all medium firms, and 84% of all large firms sold part of their products abroad. On the other hand, there are successful exporters among small firms, and non-exports among three firms, too.
- The average export/sales ratio increases with

TABLE I
Export/sales ratios for firms from capital goods industries in Lower Saxony (1978-1989)

Firms	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
All firms	9.32 [1747]	9.25 [1718]	9.68 [1691]	10.14 [1748]	11.06 [1678]	10.98 [1643]	11.75 [1614]	12.43 [1588]	12.61 [1587]	12.82 [1574]	13.10 [1545]	13.00 [1611]
All exporting firms	23.52 [692]	23.51 [676]	23.99 [682]	25.59 [693]	27.48 [675]	26.36 [684]	27.86 [681]	27.42 [720]	27.64 [724]	27.34 [738]	27.21 [744]	27.40 [764]
All small firms (up to 50 persons)	4.19 [1021]	4.17 [981]	4.53 [945]	4.77 [1001]	5.20 [957]	4.83 [925]	5.15 [902]	5.70 [878]	6.26 [850]	6.76 [815]	6.95 [784]	6.03 [813]
All exporting small firms	17.32 [247]	17.34 [236]	17.55 [244]	19.27 [248]	20.90 [238]	18.45 [242]	18.51 [251]	18.95 [264]	21.47 [248]	22.22 [248]	21.80 [250]	20.11 [244]
All medium sized firms (51 to 250 persons)	12.91 [517]	12.27 [526]	12.26 [535]	13.01 [537]	13.96 [514]	14.19 [520]	15.22 [521]	16.06 [513]	15.07 [532]	15.18 [556]	14.63 [562]	15.48 [597]
All exporting medium sized firms	22.93 [291]	22.64 [285]	23.17 [283]	23.93 [292]	25.72 [279]	26.07 [283]	28.43 [279]	27.65 [298]	25.78 [311]	25.80 [327]	25.07 [328]	26.26 [352]
All large firms (more than 250 persons)	25.47 [209]	25.34 [211]	26.18 [211]	28.41 [210]	30.92 [207]	31.26 [198]	33.47 [191]	33.01 [197]	32.53 [205]	30.69 [203]	33.02 [199]	33.76 [201]
All exporting large firms	34.57 [154]	34.50 [155]	35.64 [155]	39.00 [153]	40.51 [158]	38.93 [159]	42.34 [151]	41.16 [158]	40.42 [165]	38.22 [163]	39.59 [166]	40.39 [168]

firm size; the increase, however, is non-linear and decreasing: In 1978 the average export/sales ratio for all medium size firms was about 3 times the average ratio of all small firms (12.91% compared to 4.19%), while the large firm ratio was only about two times the ratio of medium firms (25.47% compared to 12.91%).

Results for firms from *basic products, consumer goods, and food, beverages and tobacco products* industries (available on request) show similar patterns.

Next, consider the *relative* importance of firms from various size classes for domestic and foreign sales: Firms are sorted according to their size (number of persons) in increasing order, and divided into twenty groups, each group having the same number of firms. The first group covers the smallest five percent of all firms, the first two groups the smallest ten percent, etc., with the top group formed by the five percent largest firms. For each of these groups the share in total domestic sales and total foreign sales of all firms considered is computed. The results are plotted in a *Lorenz-curve* with the cumulated percentage of firms ordered according to size on the horizontal axis, and the cumulated shares of the groups of firms in total domestic sales and total foreign sales

on the vertical axis. Both axes start at zero percent and end at one hundred percent, and a rectangle is constructed by drawing parallel lines passing through the endpoints. If the groups of firms are all of the same relative importance for domestic sales and foreign sales, the Lorenz-curve is the diagonal starting at point zero, with the smallest five percent of all firms having five percent of all domestic sales, etc. If only the largest firm exports, the Lorenz curve for foreign sales is the right line of the rectangle. The more the Lorenz-curve differs from the diagonal, the more unequal is the relative importance of the firms from the various size classes for total domestic sales and total foreign sales (for a discussion of Lorenz-curves and measures of concentration or inequality, see, e.g., Coulter (1989)).

The Lorenz-curves for domestic sales and foreign sales in 1989 by firms from the capital goods industries in Lower Saxony are given in Figure 1. It turns out that both domestic and foreign sales are concentrated in the large firms, while exports are more concentrated than domestic sales. The smallest fifty percent of all firms cover less than one percent of all exports, and more than eighty percent of all foreign sales (but only slightly more than sixty percent of all domestic sales) are from firms in the top group.

Again, results for firms from *basic products,*

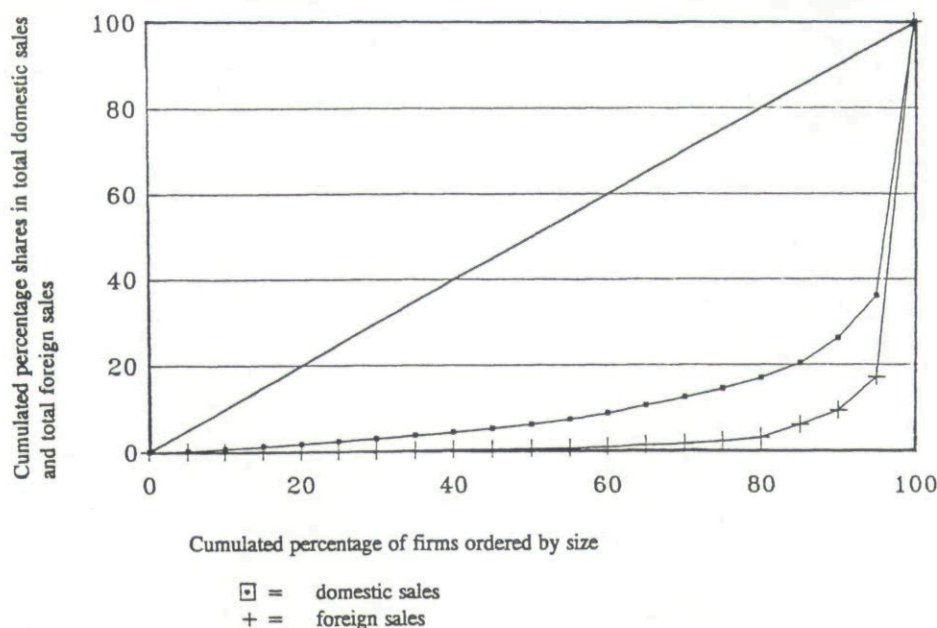


Fig. 1. Lorenz-curves for domestic sales and exports by firms from capital goods industries in Lower Saxony, 1989.

consumer goods, and food, beverages and tobacco products industries (available on request) show similar patterns.

To summarize, the probability that a firm is an exporter, and the export/sales ratio, tends to increase with firm size (the increase being non-linear and decreasing), while most of the exports are from the top size groups of firms.

4. Determinants of the export/sales ratio: An econometric study

Export/sales ratios of firms differ between industries and size classes, and between firms of the same size from narrowly defined industries. Why?

4.1. Theoretical considerations

A comprehensive theoretical model for the export decisions of a firm that discriminates between exporters and non-exporters and that determines the export/sales ratio is lacking. Therefore, an empirical model is to be based on elements of a theory of the exporting firm:

A starting point is the stylized fact that exporting tends to be concentrated in the larger production units in an industry. In his classical study on the export performance of firms from six manufacturing industries in Denmark, Holland, and Israel Seev Hirsch (1971, p. 64ff.) argues that, on the one hand, firms with sub optimal or above optimum size may lack efficiency and not be competitive in international markets, and that, on the other hand, exporting may help firms to escape the consequences of a small domestic market. Size, therefore, could be both cause and effect of export performance. The importance of size as a determinant of exports follows from economies of scale in production, a more fully utilization of (specialized) executives, the opportunity to raise financing at a lower cost, benefits from bulk purchasing, own marketing department plus own sales force, and a higher capacity for taking risks (e.g., development of new products) due to internal diversification. Obviously, there are limits to the advantages of size, because coordination costs mount as the scale of operations increases, and at some point further expansion ceases to be profitable.

An additional argument is based on the nature

of foreign marketing. As Hirsch (1971, p. 82) puts it, "... at least some of the costs involved in setting up an export department in the home office, in retooling and redesigning products for foreign markets, in doing market studies abroad, and in providing pre-sales and post-sales services, etc., are fixed in nature. To keep unit costs at a minimum, fixed costs must be divided by the largest possible number of units. Firms whose sales volume is large obviously enjoy an advantage in that respect over small firms. Hence, we expect large firms to have a higher export performance than smaller ones."

We, therefore, expect a positive relationship between firm size and exports, at least up to a point. The direction of causality, however, is not clear, because exports may induce growth of the firm, too, and the relationship between size and export performance might be a simultaneous one. Furthermore, the size/export performance relationship may look different for establishments (local production units) that are part of a multi-establishment company, because an establishment of a given size can play its role as either an exporter or as a manufacturer of parts that are delivered to another production site in the network of related establishments that form the company.

A starting point of further elements of an empirical model to explain the export performance of firms is given by the neoclassical theory of international trade. Here trade is linked to international differences in relative prices of goods, that are caused by differences in production costs due to differences in the relative prices of factors of production, which follow from international differences in relative factor endowments. Under well-known conditions (discussed at some length in textbooks on international trade) a country will export goods that use the relative abundant factors of production relative intensively (and import goods that are produced using the scarce factors intensively). Even if in general for the case of arbitrarily many goods and factors and for non-trivial production technologies and market structures this factor proportion theory does not hold, coefficients from regressions relating exports of a country or industry to factor inputs can be viewed as a tool to describe the average relationship between the use of one factor of production (e.g., human capital) and the export performance,

controlling for influences from other factors (cf. Harkness, 1981, p. 1044). The same argument holds for studies using data at the firm level, and we will look for the relevance of inter-firm differences in the use of factors of production for the export performance of firms.

From a theoretical point of view this makes sense only in a world that differs from the simple textbook economy: "In a purely competitive industry that exports part of its output, we expect the allocation of each seller's output between exports and domestic sales to be indeterminate and random. That is, at the market clearing price n identical pure competitors each place equal amounts of output on the market, and which units are taken by foreign and which by domestic buyers is entirely random with respect to the originating producers." (Caves, 1986, p. 189) Taking market imperfections into account, the picture changes: "Thus in an imperfect world (with differential access to factor markets, different technological capabilities, different rates of skill creation 'on the job', different information about final markets and different entrepreneurial and organizational capabilities), different firms from a given industry are apt to exhibit markedly varying success in international markets." (Lall and Kumar, 1981, p. 453)

We will, therefore, look at the role played by factor inputs (fixed capital, human capital, and advanced technology) in determining the export/sales ratio of firms. Based on considerations related to the factor proportions theory we expect that firms using highly qualified workers and new technology will *ceteris paribus* have a high export/sales ratio, because Germany is relatively well endowed with these factors of production compared to its most important trading partners (cf. Wagner, 1991, p. 40ff.).

A third starting-point for an empirical model to explain the export/sales ratios of firms can be found in the theory of the multinational firm where the central role of firm-specific knowledge is discussed: "Successful firms in most industries possess one or two types of intangible assets. An asset may represent technology – knowledge about how to produce a cheaper or better product at a lower cost than competing firms. This intangible asset might take the specific form of a patented process or design, or it might simply rest on know-how shared among employees of the firm.

Or the intangible might take the form of a marketing asset. . . . An intangible asset . . . makes the firm appear successful." (Caves, 1982, p. 3f.)

Exports are one way (besides foreign direct investment and licensing) to use this firm-specific knowledge in foreign markets. *Ceteris paribus*, therefore, we expect that a firm will have a higher export/sales ratio than other firms if it has more firm specific knowledge. Intangible assets, however, by their very nature resist direct measurement, and proxy variables (e.g., number of patents or registered trademarks) are not available from the official surveys of firms. But if firm specific knowledge is linked to a firm's success, we expect the domestic market share to be related to the amount of firm specific knowledge, and to form a useful proxy for it. Intangible assets of the kind discussed above can be expected to have a positive impact on exports and, therefore, a positive relationship between export performance and domestic market share is expected. This follows, too, from an alternative interpretation of a high domestic market share as a constraint imposed on a firm by a domestic market too small to expand output further, so that firms with a high market share are obliged to export if they want to grow.

4.2. Definition of variables

Firm size is measured as the number of persons that worked in an establishment on average during a given year, normalized by the average number of persons in all establishments in the 4-digit industry of the firm in Lower Saxony. This normalization is important, because a firm with 500 employees might be a small one in industry A, but a rather large one in industry B, compared to its competitors. A dummy variable, taking the value one if a firm is part of a *multi-establishment enterprise*, and zero otherwise, is included in the empirical model as a control variable.

Human capital intensity is proxied by gross wages and salaries per head.

Advanced technology and new products cannot be measured directly at the firm level because no information on it is collected in the official surveys. A dummy variable, taking the value one if the industry the firm is in is considered to be technologically advanced according to its R&D

intensity, and zero otherwise, is included in the empirical model (for details and an industry list, see Legler *et al.*, 1992).

Data for the stock of fixed capital are not available from the official surveys. Information on investment in fixed capital in each year, however, is. A rough estimate of the capital stock in a firm is constructed based in investment figures in years t , $t-1$, $t-2$, . . . , $t-5$, assuming linear depreciation. *Capital intensity*, then, is measured by capital stock per head, and the percentage of capital from the three most recent vintages is used as a proxy for the *degree of modernization of fixed capital*. Data from the surveys are available for each year since 1978, so capital stock figures for firms can be constructed for years starting 1983.

Domestic market share is computed as the percentage of a firm's sales in its 4-digit-industry in Germany.

The correlation matrices (not reproduced here to save space) reveal no strong linear relationships between the variables considered. Notably, the correlation coefficient between firm size and domestic market share in 1989 is only +0.25, +0.23, +0.22, and +0.47 for firms producing basic products, capital goods, consumer goods, and food, beverages, and tobacco, respectively.

4.3. Results

In an econometric investigation empirical models for the export/sales ratio were estimated separately for firms from each of the four broad groups of industries (i.e., basic products, capital goods, consumer goods, and food, beverages, and tobacco products) and for each year from 1978 to 1989, including the following exogenous variables: firm size and its square, dummies for multi-establishment firms and firms from technologically advanced industries, human capital intensity, and domestic market share. For years from 1983 onwards alternative models were estimated, too, including the variables just mentioned plus proxies for capital intensity and degree of modernization of capital stock. The export/sales ratio is a limited dependent variable with values either zero or positive, and, therefore, TOBIT was used as a method to estimate the models.

Results for firms from an industry group are very similar for the years 1978 to 1989, so we will

focus on the results for 1989, the most recent year. Table II reports results for models not including the proxies for capital intensity and degree of modernization of capital stock.

For firms from all four industry groups a similar picture emerges that is consistent with the theoretical considerations discussed above: The impact of firm size is positive but decreases with size, and human capital intensity, domestic market share, and advanced technology (at the industry level) all have a positive influence on the export performance of a firm.

Results for models augmented by proxies for capital intensity and degree of modernization of capital stock show a similar pattern as regards the variables included in the models from Table II, and a modern capital stock has a positive impact on the export performance of a firm (statistically significant for firms producing basic goods, and food etc.) that is in accordance with the theoretical considerations. Capital intensity has a negative sign for firms from basic goods industries, and a positive sign (that is statistically significant for firms producing capital goods and consumer goods) for the rest.

5. Firm growth and export performance

What is the relationship between firm growth and export performance: Seev Hirsch and Zvi Adar (1974) gave an answer to this question based on a textbook model of a discriminating monopolist: Consider a firm which faces a negatively sloped demand curve at home and an infinitely elastic demand curve abroad. Assume that the firm has the ability to fully discriminate between both markets. It follows immediately from a simple graphical representation of this model (not shown here to save space; cf., e.g., Wagner, 1993b) that if demand curves are constant the larger the firm the larger will be the export/sales ratio, because price and quantity in the home market will not change, and sales abroad will grow at a constant price. If the foreign demand curve is negatively sloped, too, firm growth will affect prices and quantities at home and abroad. Nevertheless, as long as local demand is less price elastic than foreign, for given demand curves there will be a positive relationship between firm size and export/sales ratio.

TABLE II
Determinants of export/sales ratios: Results of the econometric investigation (Estimation method: TOBIT)^a

Industry group		Basic products	Capital goods	Consumer goods	Food, beverages, tobacco
Exogenous variable					
Firm size	β	6.233	9.026	4.739	5.313
	t	2.932**	8.464**	4.599**	3.227**
Firm size (squared)	β	-0.376	-0.450	-0.150	-0.377
	t	1.382	5.185**	2.031*	3.045**
Part of multi-establishment enterprise (1 = yes)	β	-10.517	-10.270	0.918	-2.537
	t	4.063**	4.220**	0.385	-0.862
Human capital intensity	β	0.003	0.950	0.199	0.756
	t	0.026	10.071**	2.485*	6.030**
Advanced technology (1 = yes)	β	31.959	15.522	19.757	^b
	t	11.006**	7.795**	3.222**	
Domestic market share	β	4.308	2.321	2.472	1.990
	t	6.637**	5.335**	4.330**	3.556**
Constant	β	-17.020	-54.605	-11.422	-47.216
	t	3.360**	13.349**	3.656**	8.859**
Number of firms		923	1524	1012	675

^a For a definition of variables, see text.

β = estimated coefficient of regression

t = absolute t -value; * (**) = significant at a level of 5 (1) percent

^b There are no technologically advanced industries in the food etc. industry group.

It seems plausible that firms (at least, larger ones) usually face steeper demand curves at home than abroad due to, e.g., product differentiation by advertising. Furthermore, home and foreign markets are not fully integrated because of e.g., tariffs and non-tariff barriers of any kind. Third, at least in the short run demand curves can be considered to be (more or less) stable. Therefore, the theoretical model predicts a positive relationship between the rate of growth of total sales of a firm and the change in the export/sales ratio *over time*. This hypothesis will be tested econometrically below.

Note, however, that this hypothesis cannot be generalized for a cross-section of firms, i.e. it does not predict a positive nexus between firm size and export/sales ratio *at any point in time* for a sample of firms from different industries. As Hirsch and Adar (1974, p. 43) point out, given a sample of exporting firms, the observed variance in export/sales ratio follows from many factors, including type of product and structure of local and foreign demand in addition to size differences.

To test the hypothesis of a positive relationship between the rate of growth of sales of a firm and the change in the export/sales ratio over time, data from the establishment level longitudinal data base of manufacturing firms from Lower Saxony (see section 2) are used. The sample covers all exporting firms from capital goods industries in the period 1978 to 1989. Annual data for sales in Germany and abroad were used to compute for each firm the change of the export/sales ratio (in percentage points) and the rate of growth of total sales (in percentages) for the two-years periods 1978/79, 1979/80, . . . , 1988/89. Formally, let $s_{i,t}$ be the total sales (i.e., domestic sales plus exports) of firm i in year t , and $x_{i,t}$ be the export of this firm in the same period. The change in the export/sales ratio is computed as

$$(x_{i,t+1}/s_{i,t+1}) * 100 - (x_{i,t}/s_{i,t}) * 100, \\ t = 1978, 1979, \dots, 1988,$$

while the rate of growth of total sales is defined as

$$(s_{i,t+1} - s_{i,t})/s_{i,t} * 100, t = 1978, 1979, \dots, 1988.$$

Furthermore, the firms were classified into three size groups according to the number of persons working in an establishment in 1978: *small firms* with up to 50 persons, *medium firms* with 51 to 250 persons, and *large firms* with more than 250 persons.

The econometric model has the change of the export/sales ratio as the endogenous variable and a constant and the rate of growth of total sales as the exogenous variable. Separate models were estimated for firms of the different size classes. From the theoretical considerations we expect a positive sign of the regression coefficient of the sales growth variable. Furthermore, we expect a closer relationship between exports and sales growth for the larger firms, because it seems plausible that larger firms are, on average, more successful in applying strategies like product differentiation that lead to negatively sloped demand curves. In other words, the proportion of the variance in the change of the export/sales ratio that is explained by the variance in the growth of total sales is expected to be higher for the sample of large firms than for the medium firms, and larger for medium firms than for small firms. Evidently, this process cannot go on ad infinitum, because as X/S approaches unity, the growth of this ratio approaches zero. However, descriptive statistics (not reported here to save space) show that for the firms in the sample this should not lead to any problem, because the average export/total sales ratios in 1989 were 20.11%, 26.26%, and 40.39% for small, medium, and large exporters,

respectively. The firm data were pooled over the periods 1978/79 to 1988/89 to form a panel data set.

Three types of models for panel data (cf. Hsiao, 1986) were estimated: a pooled model, a pooled model with firm dummies (to control for time invariant firm specific effects), and a pooled model with time dummies (to control for firm invariant time specific effects). F-tests revealed that the null hypothesis of no firm effects could never be rejected at a conventional level. However, the probvalue for the null hypothesis of no time effects was 3.93% (small firms), 6.50% (medium firms), and 0.10% (large firms). Therefore, at the usual level of 5% the null hypothesis of no time effects is rejected for both the small and the large firms. For reasons of comparison Table III gives the results for both types of models for firms from the three size classes.

It turns out that the results do not differ much when time effects are included. For all size classes the coefficient of sales growth has the theoretically expected positive sign which is statistically significant at a level of 1% or better. From the values of the multiple coefficient of determination it follows that the relationship between changes in the export/sales ratio and growth of total sales is stronger for firms from larger size classes. However, even for large firms in the model only 12.5% of the variance in the change of export/sales ratio is explained by the variance in the growth of total sales.

TABLE III
Firm growth and export performance: Results of the econometric investigation^a

Type of firm	Type of model	β_{GROWTH}	t-value	R ²	N
Small firms	without time-effects	0.0222	2.52**	0.006	1034
	with time-effects	0.0245	2.75**	0.024	
Medium firms	without time-effects	0.0860	10.97**	0.054	2101
	with time-effects	0.0865	10.94**	0.065	
Large firms	without time-effects	0.1222	12.57**	0.102	1386
	with time-effects	0.1229	12.51**	0.122	

a β_{GROWTH} is the estimated regression coefficient for sales growth

** shows significance at a level of 1%

R² is the value of the coefficient of determination

N is the number of observations (i.e. firms * periods)

6. Concluding remarks

This paper reports results from econometric investigations on the causes and consequences of exports using a unique set of micro data for some 7000 German firms from the establishment level longitudinal data base of Lower Saxonian manufacturing firms:

A first look at the data shows that the probability to export, and the export/sales ratio, tends to increase with firm size, while most of the exports are from the top size groups of firms. From the empirical models estimated a picture emerges that is consistent with theoretical considerations: The impact of firm size on the export/sales ratio is positive but decreases with size, and human capital intensity, a modern capital stock, advanced technology and new products, and domestic market share are positively related to the export performance of firms.

A theoretical model of a price discriminating monopolist predicts a positive relationship between the rate of growth of total sales of a firm and an increase in the export/sales ratio over time. Applying methods of panel data analysis we find that the coefficient of sales growth has the theoretically expected positive sign in all size classes, and that the relationship between growth of total sales and increase in export/sales ratio is stronger for large firms.

Although results presented here shed some new light on important aspects of causes and consequences of exports by German firms, important questions remain open:

What role do innovations (new products, new processes of production) play for the export performance of firms? In official statistics no information about the innovative activities of firms are collected, and, therefore, its role in determining exports could not be investigated in detail here. The way in which the use of advanced technology and new products was included in the empirical model to explain the export/sales ratio here is rather unsatisfactory, because this proxy is measured at the industry level, and not at the firm level.

What role do objective characteristics, and subjective attitudes and habits, of managers in a firm play for the exporting behavior? There is evidence that these factors can be important (cf.

Miesenbock, 1988). However, no information on it is collected in official statistics.

Furthermore, exporting should be seen as *one* way to earn profits from firm specific knowledge besides selling in domestic markets and serving international markets via foreign direct investment, licensing, etc. Data on other forms of international linkages of firms, however, are not collected in official surveys.

Data from official statistics, therefore, are an important source of information that should be investigated much more intensively by researchers, but these data have to be supplemented. What we need is a comprehensive *panel of firms* based on surveys designed to collect a suitable longitudinal micro data set. Work on this is in progress: Together with colleagues from the University of Hannover, in 1994 I will start "*Das Hannoveraner Firmenpanel*", a panel study covering some 1000 manufacturing firms during a period of, at least, four years.

Acknowledgement

This paper is part of the project "Production, Employment Growth, and Exports by Lower Saxonian Firms". Financial support from the Lower Saxonian government is gratefully acknowledged. The computations based on the establishment level data from the official surveys were made possible by a special arrangement between the Lower Saxonian Ministry of Economics, the Lower Saxonian Statistical Office, and the Labour Research Group at the Department of Economics, Hannover University. I am grateful to Uwe Rode for preparing the data base. Furthermore, I thank two anonymous referees for helpful comments.

Notes

- ¹ For a more comprehensive discussion of some of the issues and a presentation of more detailed empirical results, see Wagner (1992a and 1993a) and a series of project reports on which this paper is based.

References

- Caves, Richard E., 1982, *Multinational Enterprise and Economic Analysis*, Cambridge: Cambridge University Press.

- Caves, Richard E., 1986, 'Exporting Behavior and Market Structure: Evidence from the United States', in H. W. de Jong and W. G. Shepherd (Eds.), *Mainstreams in Industries Organization*, Dordrecht: Kluwer.
- Caves, Richard E., 1989, 'International Differences in Industrial Organization', in Richard Schmalensee and Robert Willig (eds.), *Handbook of Industrial Organization*, Vol. II, Amsterdam: North-Holland.
- Coulter, Philip B., 1989, *Measuring Inequality: A Methodological Handbook*, Boulder: Westview Press.
- Harkness, Jon, 1981, 'Cross-Section Tests of the Heckscher-Ohlin Theorem: Reply', *American Economic Review* 71, 1044-1048.
- Hirsch, Seev, 1971, *The Export Performance of Six Manufacturing Industries: A Comparative Study of Denmark, Holland, and Israel*, New York: Praeger.
- Hirsch, Seev and Zvi Adar, 1974, 'Firm Size and Export Performance', *World Development* 2(7), 41-46.
- Hsiao, Cheng, 1986, *Analysis of Panel Data*, Cambridge: Cambridge University Press.
- Lall, Sanjaya and Rajiv Kumar, 1986, 'Firm-Level Export Performance in an Inward-Looking Economy: The Indian Engineering Industry', *World Development* 9, 453-463.
- Legler, Harald et al., 1992, *Innovationspotential und Hochtechnologie. Technologische Position Deutschlands im internationalen Wettbewerb*, Heidelberg: Physica.
- Madsen, Tage Koed, 1987, 'Empirical Export Performance Studies: A Review of Conceptualization and Findings', *Advances in International Marketing* 2, 177-198.
- Methner, Eckart, 1992, 'Das Erhebungsprogramm der amtlichen Statistik im Bereich des Produzierenden Gewerbes', in Rainer Ertel und Joachim Wagner (Eds.), *Produzieren in Niedersachsen. Empirische Untersuchungen mit Betriebsdaten*, Hannover: NIW.
- Miesenbock, Kurt J., 1988, 'Small Business and Exporting: A Literature Review', *International Small Business Journal* 6(2), 42-61.
- Wagner, Joachim, 1991, *Die bundesrepublikanische Industrie auf dem Weltmarkt. Ökonometrische Untersuchungen zu Bestimmungsgründen von Außenhandel und internationaler Produktion*, Berlin: Duncker & Humblot.
- Wagner, Joachim, 1992a, 'Exportserfolge niedersächsischer Betriebe. Eine empirische Untersuchung mit Betriebsdaten für das Verarbeitende Gewerbe (1978-1989)', in Rainer Ertel und Joachim Wagner (Eds.), *Produzieren in Niedersachsen. Empirische Untersuchungen mit Betriebsdaten*, Hannover: NIW.
- Wagner, Joachim, 1992b, 'Das Forschungsprojekt "Produktionsentwicklung, Beschäftigungswachstum und Exportserfolge niedersächsischer Betriebe - Empirische Untersuchungen auf der Basis von Firmendaten der amtlichen Statistik". Zielsetzungen, Datenbasis und Stand der Arbeiten im Frühjahr 1992', in Rainer Ertel und Joachim Wagner (Eds.), *Produzieren in Niedersachsen. Empirische Untersuchungen mit Betriebsdaten*, Hannover: NIW, 7-12.
- Wagner, Joachim, 1993a, 'Firm Size, Firm Growth, and Export Performance: Evidence from Longitudinal Data for German Establishments', *Jahrbücher für Nationalökonomie und Statistik* 211, 417-420.
- Wagner, Joachim, 1993b, 'Firmengröße und Exportquote', *WiSt - Wirtschaftswissenschaftliches Studium* 22, 258-261.

Copyright of Small Business Economics is the property of Kluwer Academic Publishing / Business and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.