Federal Ministry
Republic of Austria
Labour and Economy

FIW-Research Reports

July 2022, N° 02

Report

A snapshot of characteristics and dynamics of Austrian exporting firms

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In view of the importance of the export economy for Austria this study examines the role and characteristics of Austrian exporting firms compared with non-exporting firms. Specifically, it assesses how the share of exporting firms has developed in recent years, whether exports have become more important for firms over time and to what extent exporters have an advantage over other firms (export premium). The results show that about two third of the Austrian manufacturing firms are engaged in exporting activities and indicate that – in line with existing literature - exporting firms are larger, more productive, generate higher surpluses, invest more, and spend more on environmental protection than non-exporters. Further, the results highlight that only a small number of firms account for a large share of Austrian manufacturing exports. Finally, the results point towards a mutual positive relationship between export behaviour, productivity, and R&D expenditures.

Keywords: export premium, firm-level analysis, productivity and exporting
JEL classification: D22, F14

Commissioned by:

Federal Ministry
Republic of Austria
Labour and Economy

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The FIW - Research Centre International Economics (https://www.fiw.ac.at/) is a cooperation between the Vienna University of Economics and Business (WU), the University Vienna, the Johannes Kepler University Linz, the University of Innsbruck, WIFO, wiiw and WSR. FIW is supported by the Federal Ministry for Digital and Economic Affairs and by the Federal Ministry of Education, Science and Research.

A snapshot on the characteristics and dynamics of Austrian exporting firms

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Version: 20 June 2022

Final report within the project "Export premium: Significance and performance of Austrian exporters" for the Austrian Federal Ministry for Digital and Economic Affairs (BMDW).

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1 Introduction

1.1 Motivation

The export sector plays an important role in Austria's economy, with a ratio of gross exports to GDP of more than 50%. And even when taking into account the necessary imported intermediary inputs to produce these exports, about a third of Austrian GDP is exported in value-added terms. But despite the importance of the export economy for Austria, relatively little is known about the characteristics of Austria's exporting firms. A large body of theoretical (Melitz 2003) and empirical evidence (Bernard and Jensen 1999; Mayer and Ottaviano 2007) has suggested that exporting firms are on average larger, more productive, pay higher wages and invest more than companies that are only active in the home market. Though it may not be expected that these stylised patterns are different for Austria, it is worthwhile to get a clearer picture and document these relationships for the Austrian economy. This study therefore updates and extends a study commissioned by the Ministry of Economic Affairs in 2009, which already examined the characteristics of export enterprises (see Pöschl et al. 2009).[1] Such results have proved extremely important from an economic policy perspective and have often been cited, thus warranting an update.

In accordance with previous ones, in this study, the results have been updated considering a more recent time period, 2008-2019, based on data according to the NACE Revision 2 classification.[2] How-

[1] At the time, the difference with regard to the dimensions of turnover, employment, total wages, gross investments, labour productivity, investment intensity and wages per employee between Austrian export enterprises (differentiated by export brackets 0-5%, 5-30%, 30-50% and more than 50% due to data availability) and purely domestically active enterprises was defined as the export premium. However, due to the already lengthy time horizon since the original study was undertaken – the data used in the study ended in 2006 – its findings are now outdated in various respects (e.g. based on NACE Revision 1 industry classification, not taking into account the effects of and the period after the global financial crisis). Some of these constraints have been lifted in this study to substantiate the previous findings, which also deserved an update.

[2] A longer time series has been constructed as well, ranging over the period 2002-2019, though at a more aggregate level for the manufacturing industries because of the break in the NACE classifications and a change in the sample. For these reasons, the results presented focus on the period from 2008 onwards. The descriptive results are presented in the appendix tables and figures. It should be noted that the changes over time are rather small. In addition, we have provided results from firms in non-manufacturing industries, such as mining and quarrying (B), utilities (DtE) and construction (F). Due to the relatively low number of exporting firms in these industries, however, we have left them out from the detailed analysis.

ever, in doing so, additional indicators in which export enterprises can differ from purely domestically operating enterprises are taken into account (e.g. investment in software or environmental expenditures). Conceptually, in addition to using the export status (exporting versus non-exporting firms) we also use export shares (export intensities) rather than brackets, allowing the refinement of econometric methods to discuss potential drivers of exporting behaviour. In addition, another essential novelty of this study is the connection between Industry 4.0, research and development (R&D), ownership and export activities of Austrian firms which is examined for the first time for Austrian firms. The underlying assumption is that there is a strong correlation between innovation and R&D on the one hand and the export premium on the other, which contributes significantly to explaining the advantages of exporting firms.

1.2 Data

The data for this study were based on two sources compiled by Statistik Austria[3] : the 'Leistungs- und Strukturerhebung' (LSE),[4] which provided detailed data on the performance of firms (e.g. turnover, persons employed or investment). These LSE data included survey data (primary data) that were extended by model-based data (secondary data).[5] To obtain information on whether these firms were engaged in exporting, these data were combined with data from the 'Konjunkturerhebung',[6] which provided the share of turnover that was exported. The final sample therefore consisted of about 10,000 firms per year, as shown in Figure 1.1, which also distinguished between the broad industry groups of mining and quarrying (B), manufacturing (C), utilities (DtE) and construction (F); services firms are not included. The majority of the sampled firms were in manufacturing and construction. To highlight the role of exporting firms, we show the share of firms engaged in exporting activities in each of these industries in Figure 1.2. Manufacturing (C) is characterised by a share of exporting firms of about 70% in recent years which continuously increased from about 60% in 2002. The shares in the other broad industry groups are much smaller and relatively stable over time, with around 35% in mining (B) and a very small number of firms – less than 20% – in utilities (DtE) and around 15% in construction (F). Taken together, the sample included a bit more than 4,000 firms engaged in exporting activities, of which the large majority of almost 90% were manufacturing firms (see Figures 1.3 and 1.4). The remaining firms that were exporting were mostly in construction. Therefore, in the main part of the study, we have focused on the manufacturing (C) industry. Selected results from the other industry groups are presented in the Appendix.

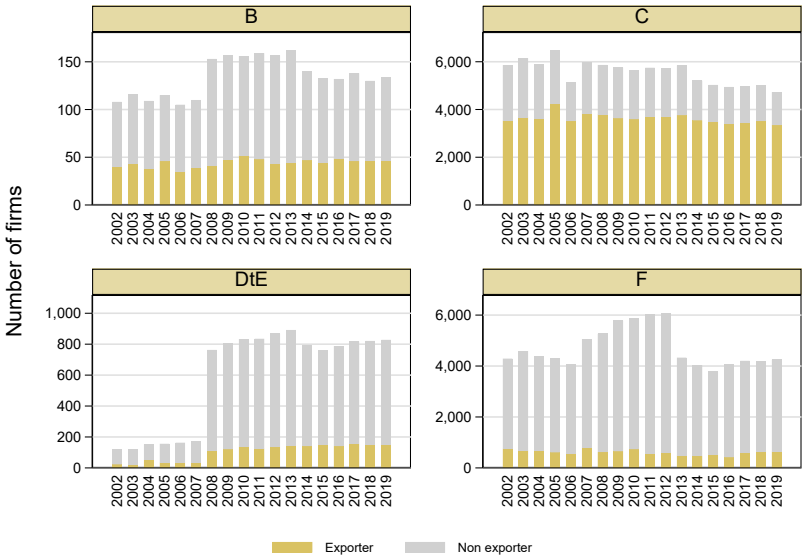
[3]We would like to thank Statistik Austria and particularly Thomas Seidl, Thomas Hodel and Lukas Gutenberger for their support in providing the data and helping with technical details. Many thanks also to Magdalene Six for running the codes.

[4]See `https://www.statistik.at/web_de/frageboegen/unternehmen/leistungs_und_strukturerhebung/index.html`

[5]These secondary data were thus estimates to provide a full sample. As these were also based on statistical methods rather than direct information, we did not use them in this study. Furthermore, the secondary data before and after 2008 when the NACE revision was implemented were not comparable.

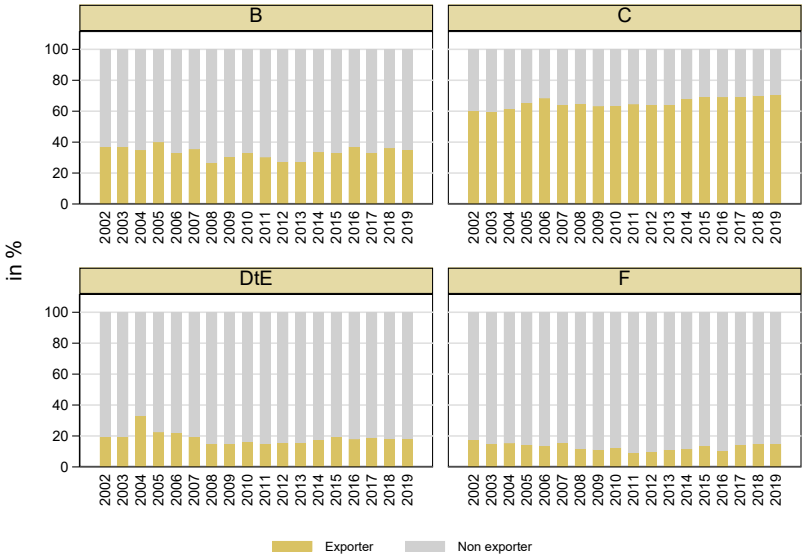
[6]`https://www.statistik.at/web_de/frageboegen/unternehmen/konjunkturerhebung_im_produzierenden_bereich/index.html`

Figure 1.1: Number of firms by exporter status



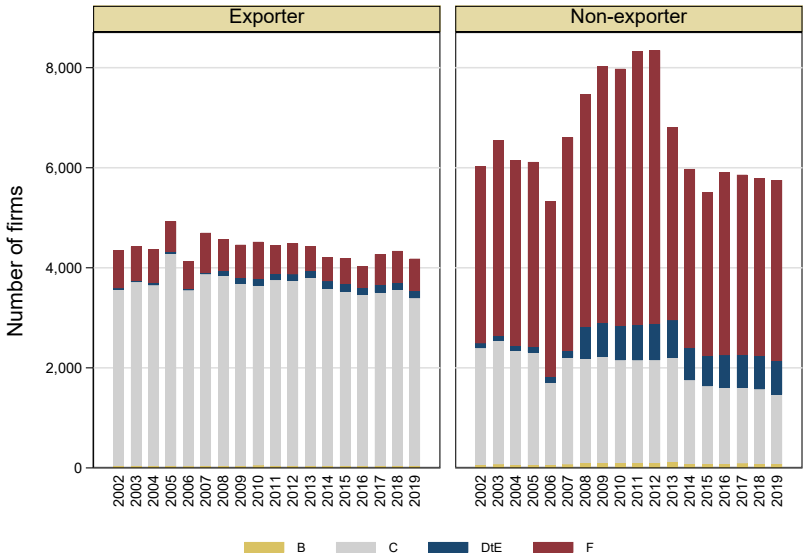
Sources: Statistik Austria and own calculations.

Figure 1.2: Share of firms by exporter status



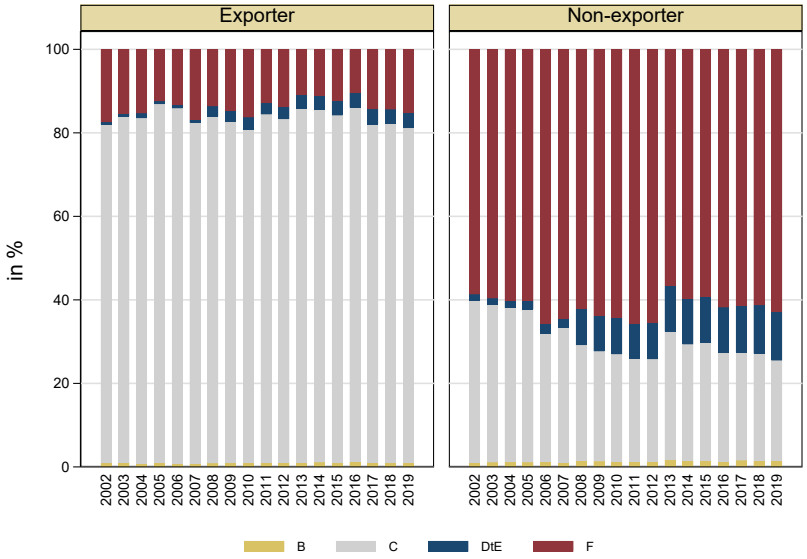
Sources: Statistik Austria and own calculations.

Figure 1.3: Number of firms by broad industry



Sources: Statistik Austria and own calculations.

Figure 1.4: Share of firms by broad industry



Sources: Statistik Austria and own calculations.

1.3 Overview of the report

To summarise, the study first provides an update for the results of the 2009 study both descriptively and econometrically and investigates the more recent developments of the characteristics of Austrian exporting firms over the longer period of 2002-2019, particularly focusing on the period of 2008-2019 due to changes in the industry classification and sampling procedures. Second, the study also extends the previous calculations from a methodological perspective. In particular, we use a continuous variable to indicate the share of exports in turnover instead of simply using the export brackets 0-5%, 5-30%, 30-50% and more than 50%. Third, some further analysis is envisaged, particularly on causality issues between export performance and productivity, or R&D activities and export performance. In the appendices, the results are also presented from firms in mining and quarrying (NACE Rev. 2 B), utilities (DtE) and construction (F). The results should provide a basis for a fact-oriented public discussion about the characteristics of Austrian export enterprises, their role in the Austrian economy and potential drivers of exporting activities.

In Section 2, we provide a short literature review focusing on the relations between R&D, digitalisation, Industry 4.0 and export behaviour. Section 3 reports the important stylised facts concerning the performance of exporting versus non-exporting firms, their importance in the economy and the dynamics with respect to switching between exporter and non-exporting as well as entries and exits from the sample. Section 4 is then devoted to the results concerning potential drivers of exporting behaviour. Finally, Section 5 provides some conclusions and policy aspects.

2 Selected literature

2.1 Firm performance and exporting behaviour

2.1.1 The new trade theory

In a seminal paper, Melitz (2003) delivered a theoretical model allowing the understanding of the relationships between exporting and the sizes and performance of firms (productivity), highlighting that more productive firms (self-)select into exporting. In this model (see also Helpman 2006), firms randomly draw their productivity level before entering. As market entry is costly, and firms also bear the risk that their productivity is too low to produce profitably at the (endogenous) market price (and some fixed costs of production), these entry costs are sunk and combined with exogenous exit rates as a steady-state situation emerges. As firms charge a constant mark-up (derived from a CES utility function) on their constant marginal costs, productivity differences directly translate into differences in prices charged. Under the assumption of 'love for variety', consumers purchase all goods but buy more of the goods with lower prices. Therefore, productive firms experience higher sales (because they charge lower prices), earn higher profits and are larger in size.

Assuming that trade involves fixed export costs (together with variable iceberg trade costs), selling to foreign markets constitutes an opportunity for additional profits but only for firms whose profit margin is large enough to cover the (fixed) trade costs, i.e. the most productive firms. Hence, the Melitz model provides an explanation that only the most productive firms – those with productivity above the export productivity cut-off – self-select into export markets. Of course, these exporting firms also serve the domestic market, but firms with a lower productivity level only serve the domestic market. Thus, one of the major implications of the Melitz model is the self-selection process of firms into exporting behaviour, which is exhibited by not all but only the most productive firms export in an open economy environment.

A reduction in trade costs implies more competition from trade, and the cut-off productivity level for staying in the market also increases, leading to the market exit of the least productive firms. The implied intra-industry reallocations of labour towards more productive firms constitute an additional source of productivity gains from international trade. The exit of the least productive firms following a decrease

in trade costs implies that international trade props up aggregate productivity. There is an additional element for gains from trade not covered in models of the classical (specialisation) and new trade (gains from variety) theories.[1]

2.1.2 Selected empirical studies

The first empirical studies dealing with firm heterogeneity and exporting activity based on firm level data emerged even before this theoretical contribution and include the seminal contributions of Clerides et al. (1998) on Colombia, Mexico and Morocco and the highly influential paper by Bernard and Jensen (1999) on the US economy. Both studies found superior performance of exporting firms when compared with non-exporting firms, particularly in terms of productivity. They also investigated the causes of this finding, in particular whether the correlation between higher productivity and export status implies a causality running from productivity to exporting or vice versa. For industrialised countries, the empirical results point towards a causality going from productivity to exporting with only limited 'learning by exporting' effects (e.g. Arnold and Hussinger 2005 for Germany).

Bernard and Jensen's (1999) paper proposed a straightforward way to estimate the extent of the export premium, i.e. the extent to which exporters are more productive, pay higher wages and have higher investment and innovation intensities or are larger in size. Despite the fact that this approach used export status as the explanatory and thus exogenous variable – which was not suggested by the results on causality – it inspired much of the following empirical work in this field and triggered many replications.

The results from Austria provided in Pöschl et al. (2009) and this study (see Section 3) were not exceptions in this respect, as the intention is to provide comparable results for the Austrian economy. In fact, a plethora of country-specific studies on the performance of exporting firms compared with purely domestic firms have emerged. For European countries, Mayer and Ottaviano (2007) investigated several features of exporters and their roles in the respective economies. Building on firm-level data from Germany, France, the United Kingdom, Italy, Hungary, Belgium and Norway, they established a series of stylised facts concerning exporters. They also showed that a small number of exporters account for the bulk of a country's aggregate exports. For example, the top 1% of exporters in Germany and Hungary are responsible for 59% and 77% of aggregate exports, respectively. Also, only a few firms export a large fraction of their output. Comparisons of exporters with non-exporters typically revealed that firms engaged in exporting are larger in terms of output and employment, but that they are also

[1] There exists a variety of extensions and adaptations of this model now. For example, Melitz and Ottaviano (2008) allowed for variable mark-ups, implying a pro-competitive effect of trade that leads to an even stronger productivity effect. Bernard et al. (2007) discussed the model in a multi-industry setting, allowing for comparative advantages and specialisation in addition. Helpman et al. (2004) took the role of multinational firms into account. In fact, the literature based on such a model structure has mushroomed, and it is not possible to provide a detailed overview in this study.

superior to their purely domestic peers in performance measures, such as labour productivity, total factor productivity, wages and capital intensity.

Furthermore, the existing literature (e.g. Arnold and Hussinger 2005) has indicated that higher productivity is conducive to export status or intensity but not vice versa. A simple way to test this hypothesis was to use lagged variables in both regressions (see e.g. Aw et al. 2000).[2] The results from the literature suggested that for advanced countries, causality runs from higher productivity to exporting (an exception is Hansen 2010, who claimed that the effects go in both directions). A similar conclusion was also drawn in recent study by Giordano and Lopez-Garcia (2019).

2.2 Exports, R&D and digitalisation

The connection between research, development (R&D) and international expansion (including foreign direct investments, exports or licensing) has been widely researched, starting with Vernon's (1966) seminal article. The review by Juergensen et al. (2021) is the most recent of a long list of articles.

The literature has generally assumed a positive relationship between innovation and international expansion. This was based on the assumption that firms possess firm-specific advantages, such as new products, technological knowledge, well-known brands, design or management capabilities ex-ante before they enter foreign markets. Firms wish to exploit these advantages in international markets to increase the returns from their innovative activities. Therefore, international expansion is a consequence of previous innovation activities in the home country. Dunning (1973, 1981) suggested that multinational enterprises exploit these assets via international production and not via exports or licensing when ownership, location and internalisation advantages allow international investments.

Entering new foreign markets is a large investment for a firm. Firms have to finance market research, adapt their products to the local market and consumer needs, follow local regulations, invest in negotiations and contracts, build networks with local partners, bear transporting costs and tariffs, spend on additional management and administration costs, etc. Competition in foreign markets is higher, as a firm competes with local but also foreign firms. Thus, only firms with the highest productivity levels may be willing to bear all these costs and self-select into export markets (Melitz 2003; Melitz and Redding 2012). This points to a positive relationship and one-way causality, which runs from innovation to exports. Import competition, in contrast, may reduce R&D (Autor et al. 2020; Son 2021).

Other studies (Golovko and Valentini 2011; Harris and Moffat 2011; Guarascio et al. 2016) suggested a two-way causality and endogeneity between innovation and exports: innovative enterprises tend to exhibit a higher export intensity than non-innovators, but exporting also precedes a superior innovative performance. Thus, international diversification is a consequence of innovation but also a necessity to generate sufficient returns to finance future innovation activities (Juergensen et al. 2021). This seems

[2] See also Bernard and Jensen (1999) or Kunst and Marin (1989) for an early study on Austria.

to describe better the export-innovation relationship for many Austrian enterprises than the one-way causality from innovation to exports mentioned above, given that more than half of all manufacturing firms are already exporting (Pöschl et al. 2009). International expansion can also strengthen domestic innovation by learning from exporting (Golovko and Valentini 2011), reverse knowledge spillovers (Ambos and Schlegelmilch 2006) or by the concentration of the domestic headquarters on R&D and innovation (Dachs et al. 2015). Some firms ('born globals') may also be innovative and globally present from the beginning (Øyna and Alon 2018). Innovative firms do not only have a higher share of exports but also wider geographical breadth of export activities (Hauser et al. 2013). Firms that only invest in process innovations do not reveal this positive association between exports and geographical breadth.

Digitalisation can be included in this framework. Digital technologies, such as robots, can contribute to higher productivity (Graetz and Michaels 2018), so we may also assume a positive association between these technologies and exports. Moreover, digital technologies allow smooth integration with suppliers and customers and can improve the coordination between various stages of the value chain. Thus, better integration of global value chains is another channel for a positive association between digitalisation and exports (Cassetta et al. 2020). Digital technologies may also strengthen exports because they can help firms gather more information about foreign markets and customers. They give firms a better means to communicate with foreign clients and can provide better information about foreign markets. Thus, digitalisation may allow enterprises to enter international markets more rapidly (Lee et al. 2019). Lerch und Jäger (2021) investigated both effects for Germany. They confirmed that manufacturing firms that utilise more Industry 4.0 technologies also have higher productivity, which is a precondition and a result of exports. Moreover, providing digital services is associated with higher export intensity. It is, however, difficult to determine cause and effect in this relationship.

3 Exporting firms in manufacturing

In this chapter, we report some selected common indicators, providing a snapshot of the importance and characteristics of Austria's exporting and non-exporting firms. This has been done in a descriptive way and in some cases – for the size and performance premium – using simple econometrics by following the standard literature.

1. Export participation concerns the number and share of exporting versus non-exporting firms in an industry.

2. Export intensity indicators show the share of exports in turnover. Specifically, we showed the share of firms in so-called export brackets of five percentage points.

3. Export concentration measures what percentage share of total exports is accounted for by the 5%, 10% or 25% of the largest firms in terms of exports.

4. Size premium: A number of size measures (e.g. turnover, employment, labour costs, and investment) were presented that indicate the size of exporting firms compared with non-exporting firms. Furthermore, we showed the importance of exporting versus non-exporting firms with respect to some variables.

5. Performance premium: These were indicators, as turnover, labour costs or investment per hour worked are shown in a descriptive manner with corresponding econometric results.[1]

6. Finally, we calculated turnover measures, i.e. the number of firms transiting between exporting and non-exporting status and entry and exit dynamics distinguishing exporting and non-exporting firms.

With respect to the size and performance premium, we provided econometric results by following the seminal paper by Bernard and Jensen (1999), which has been followed by many studies (see Section 2 for an overview of the literature). We presented these important stylised facts for the manufacturing industry (NACE Revision 2 Section C) for the years 2002-2019.[2]

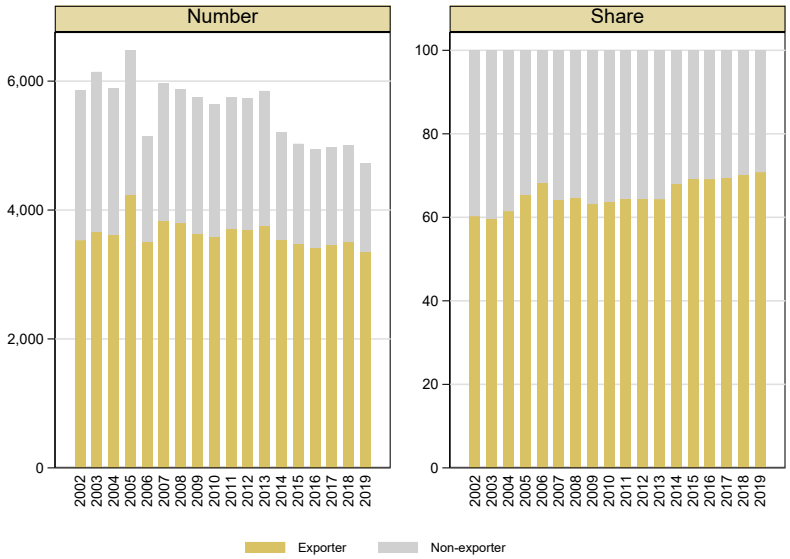
[1] The results in terms of persons employed are similar.

[2] For the period of 2002-2007, this broadly corresponded to NACE Revision 1 Section D, which was combined in this

3.1 Export participation

Export participation refers to the number of firms engaged in exporting behaviour, which is shown in Figure 3.1. Over time, around 5,000 firms have been surveyed, of which about 3,500 firms are exporters on average. The share of exporting firms has been increasing over time, from about 60%, as can be seen from the right panel. Nowadays, according to these figures, more than 70% of the manufacturing firms in Austria are engaged in exporting activities.[3] Thus, export participation increased by about 10 percentage points over the period 2002-2018.

Figure 3.1: Number of firms by exporter status



Sources: Statistik Austria and own calculations.

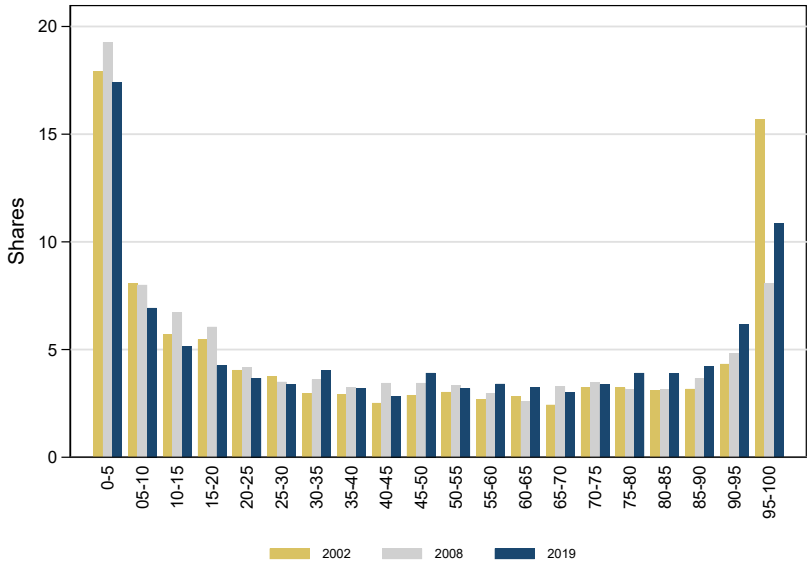
3.2 Export intensity and concentration

Having looked at the extent to which the firms were engaged in exporting activities at all, the next question concerned the share of exports in their total turnovers. Figure 3.2 shows the number of firms by export brackets of 5 percentage points for the years 2002, 2008 and 2019, considering exporting firms only. The results pointed towards a U-shaped relationship. In 2019, around 17% of the exporting firms exported less than 5% of their turnover, and around 7% of the firms between 5 and 10%. Around 3-4% of

data set. The same set of results (averages of 2002-2019) are provided in the Appendix for the four broad industry groups B, DtE and F. For the manufacturing industry C, the details at the industry level are presented in the Appendix.

[3]These figures were based on the surveyed firms. When taking the number and performance of the smaller non-surveyed firms into account (secondary sample), the share of exporting firms amounted to about 50 to 55% on average.

Figure 3.2: Share of exporting firms by export brackets



Sources: Statistik Austria and own calculations.

the firms had export shares ranging from 15-20% to 85-90%. Interestingly, around 6% of all the exporting firms reported export shares between 90 and 95%, and around 11% had export shares above 95%. The figures indicate that export intensities gradually increased over time. Taking the means of the export brackets (e.g. export share of 7.5% for bracket 5-10%), weighting these by the share of firms in these brackets, and calculating the weighted average results in an average export intensity of 40% in 2008 and 45% in 2018 and thus increased by about 5 percentage points over these ten years.[4]

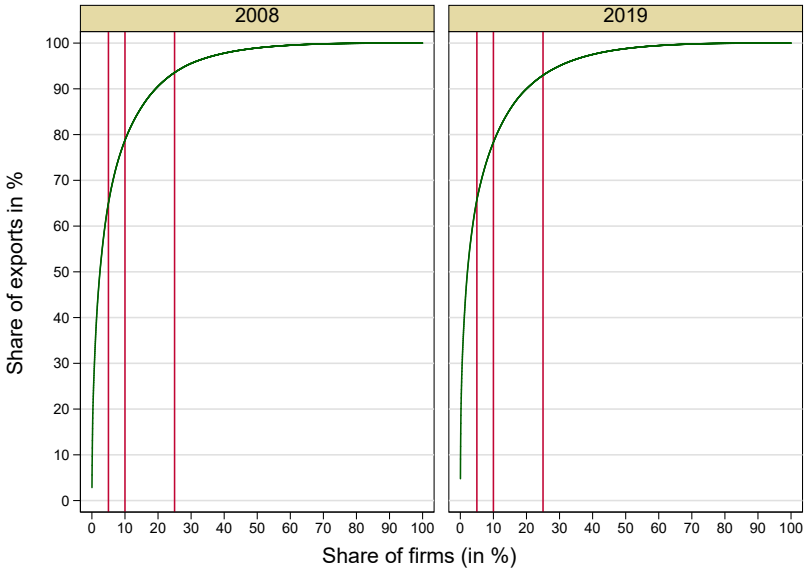
A related question is how exports were concentrated across the exporting firms. Figure 3.3 shows this relationship for the period of 2002-2019, indicating the share of the exporting firms on the horizontal axes (ranked by their export values) and the share of their exports (in total exports). The figure indicates that in 2019, the top 5% of the firms accounted for about 65% of all manufacturing exports, the top 10% for almost 80% and the top 25% for more than 90%. These figures were broadly in line with the theoretical and empirical literature, suggesting that exports were mostly driven by the larger firms. This distribution was also fairly stable over time.

Figure 3.4 shows the respective evolutions of the shares of the top exporters over time, confirming the stability of these distributions.[5] To put things in perspective, with regard to the number of firms, the results suggested that slightly fewer than 900 firms (of 3,500) accounted for 90% of Austrian manufacturing exports, and fewer than 200 firms for two-thirds of these exports.

[4]The outlier in 2002 for the export bracket 95-100% was due to a different sampling in the period 2002-2007. Therefore also the average export intensity in this period has already been at a level of around 45% on average.

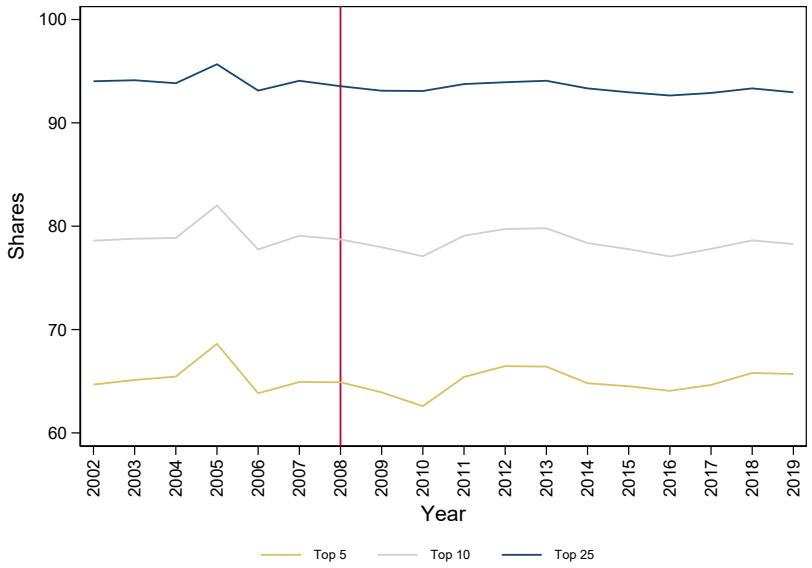
[5]The line in 2008 indicates the change in the sample.

Figure 3.3: Cumulative distribution



Sources: Statistik Austria and own calculations.

Figure 3.4: Top shares

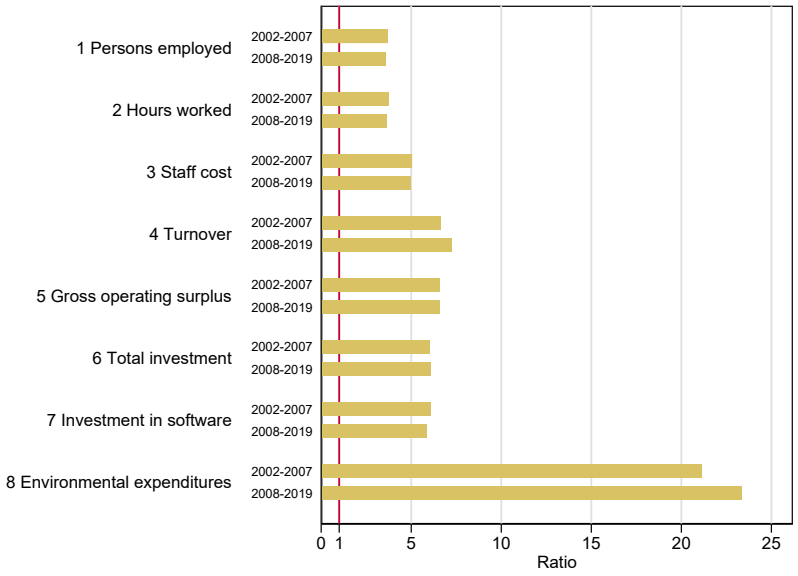


Sources: Statistik Austria and own calculations.

3.3 Size premium

The next question referred to the importance of the exporting firms in industry performance. According to the literature, a stylised fact is that exporting firms on average are larger, which has also driven the results presented before. This was confirmed when considering various performance variables divided by the number of exporting and non-exporting firms, respectively, which was an indicator of size.

Figure 3.5: Size ratios (annual averages over periods)



Sources: Statistik Austria and own calculations.

Figure 3.5 shows the size ratios (i.e. average size of exporting to average size of non-exporting firms) for eight performance variables.[6] For all indicators, the exporting firms were larger by a factor between 4 and 7 and particularly larger concerning environmental expenditures.[7] This pattern was relatively stable over time as well as, which can be seen from comparing the period 2002-2007 with 2008-2019.[8] To get a more concise measure of this size premium (i.e. the extent to which exporting firms were larger on average), an OLS regression was applied that regressed a measure of export behaviour on the performance

[6] In this study we consider staff costs which include in addition to wages and salaries also other (collectively agreed, contractual or voluntary) social expenses, and social security contributions. Results when considering wages and salaries only (as in Pöschl et al., 2009) are similar.

[7] The results at the industry level are presented in Table B.8 in the Appendix of this chapter. Table B.8 shows that these high figures were mostly driven by the leather industry (NACE Revision 2 15) and the pharmaceutical industry (NACE Revision 2 21).

[8] Due to the different samplings and some outliers in the first period, we used the median of these indicators in this period. When using medians for both periods, the same conclusions arose.

indicators. Formally, this regression is written as

$$\ln Y_{it} = \alpha_0 + \beta \text{ EXP}_{it} + \text{Industry dummies} + \varepsilon_{it}$$

where EXP can be the export status (0 = not exporting, 1 = exporting) or export intensity (share of exports in turnover). The results of these estimations are presented in Table 3.1.[9] The upper part shows the specification using export status (0/1), with the small table below indicating the implicit size premium.[10] The results confirmed the patterns discussed above: the exporters compared with the non-exporters were almost twice as large with respect to persons employed and hours worked, more than twice as large for the other variables, even three times as large in terms of total investments and 2.5 times as large for software investments. These indicated another stylised fact: that exporting firms are not only larger but also more capital-intensive. Generally, these results were in line with other existing literature.[11] The lower part of this table presents the results when using export intensity (share of export turnover in total turnover) as the independent variable. These results basically confirmed the previous results that the exporters were larger in all these dimensions. For example, a one percentage point higher export share implied that the number of persons employed was 1.4% larger; an analogous interpretation held for the other variables.

Table C.1 in the Appendix to this chapter shows the results of a panel estimation with firm-specific fixed effects:

$$\ln Y_{it} = \alpha_0 + \beta \text{ EXP}_{it} + \mu_i + \varepsilon_{it}$$

The upper panel uses export intensity (0/1) as the dependent variable. As most of the variation was explained by the between-effects (i.e. the cross-section dimension), the results indicated that the exporters were about 4-5% larger (and had 11% larger investments) when controlling for unobserved firm characteristics. The lower panel presents the results when using export share as the independent variable. Again, it was confirmed that a larger export share increased the firm sizes. For example, a one percentage point increase in export shares increased the number of persons employed (INSGES) by 0.3%. Even larger coefficients were found for staff costs, turnover and gross operating surplus. Thus, even when controlling for unobserved firm-specific effects, the general conclusion that the exporting firms were larger with respect to various performance variables held. Finally, these general patterns were also found when using the longer time period, with the results being presented in the Appendix.

These size differences, i.e. the fact that the exporting firms were larger on average, implied that these were also more relevant when considering their contribution to the various performance measures. Figure 3.6 indicates that the exporting firms contributed 90% and more to the economic performance variables

[9] The results for the longer period are presented in the Appendix.

[10] This was calculated as $\exp(\beta)$.

[11] Compared with the ratios of averages (per firm), these size premia were lower. The reason for this was that the means were upward-biased, given the skewed size distributions.

Table 3.1: Size premium: OLS (2008-2019)

	(1) Persons employed	(2) Hours worked	(3) Staff costs	(4) Turn-over	(5) GOS	(6) Total	(7) Investment Software	(8) Environmental
EXPstatus	0.629***	0.647***	0.812***	0.990***	0.968***	1.131***	0.881***	1.228***
	(0.010)	(0.010)	(0.011)	(0.011)	(0.015)	(0.017)	(0.026)	(0.028)
Constant	4.192***	10.991	10.433***	11.659***	5.529	4.008	4.018***	4.070***
	(0.178)	(15,266.042)	(0.586)	(0.207)	(15,465.762)	(12,410.257)	(0.332)	(0.798)
Observations	64,184	64,077	64,101	64,482	55,507	61,988	25,391	21,802
R-squared	0.237	0.235	0.282	0.295	0.240	0.198	0.132	0.288
r2_a	0.237	0.235	0.281	0.295	0.240	0.198	0.132	0.287
F	832.1	788.6	1047	1123	700.8	612.2	161.3	366.5

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

	Persons employed	Hours worked	Staff costs	Turn-over	GOS	Investment Total	Software	Environmental
Implied size premium	1.876	1.910	2.252	2.691	2.633	3.099	2.413	3.414

	(1) Persons employed	(2) Hours worked	(3) Staff costs	(4) Turn-over	(5) GOS	(6) Total	(7) Investment Software	(8) Environmental
EXPint	1.396***	1.416***	1.729***	2.088***	2.146***	2.190***	1.598***	2.068***
	(0.014)	(0.014)	(0.015)	(0.016)	(0.021)	(0.024)	(0.032)	(0.034)
Constant	4.453***	13.311***	6.922	7.642	8.624***	3.836	4.558***	9.460***
	(0.170)	(0.516)	(6,707.834)	(11,334.485)	(0.236)	(15,882.437)	(0.323)	(0.411)
Observations	63,770	63,681	63,694	64,056	55,158	61,605	25,243	21,760
R-squared	0.301	0.296	0.350	0.381	0.312	0.240	0.176	0.337
r2_a	0.301	0.296	0.349	0.381	0.312	0.239	0.175	0.336
F	1145	1116	1369	1575	1044	776.3	223.8	460.7

Standard errors in parentheses

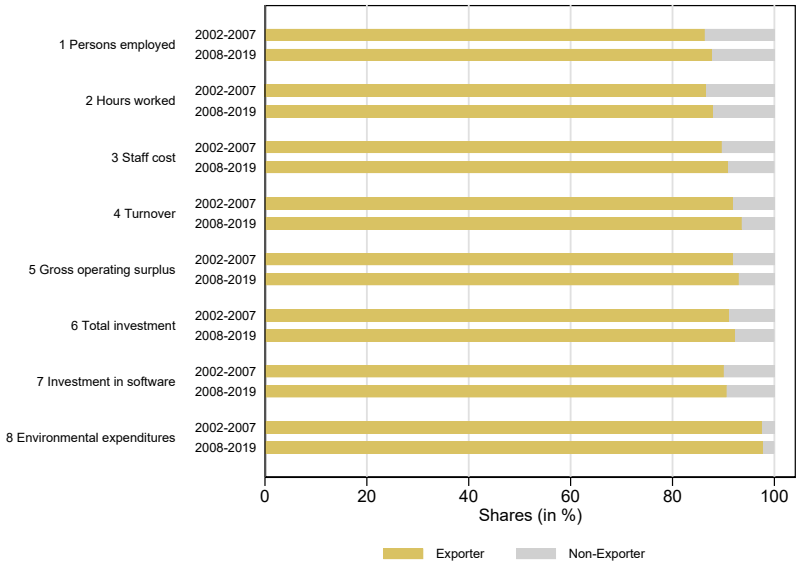
*** p<0.01, ** p<0.05, * p<0.1

considered, even though the share of the exporting firms was only about two-thirds, as shown above. Again, these shares were remarkably stable over time.

3.4 Performance premium

Another result from the literature was that the exporting firms performed better in terms of productivity (measured as output or turnover per capita or hour worked, for example), wages or investment (per capita or hour worked), known as 'performance premium'. These performance measures per hour worked are presented in Figure 3.7, which indicate that this was indeed the case for this Austrian sample. As shown

Figure 3.6: Importance in size measures (annual averages over periods)



Sources: Statistik Austria and own calculations.

here, the exporting firms outperformed the non-exporting firms by a factor of about 1.2 to 1.5 and even more for investment in software and environmental expenditures. Similar to before, these ratios were fairly stable over time. Analogous to the size premium, this performance premium can also be tested econometrically using the OLS specification

$$\ln Y_{it} = \alpha_0 + \beta \text{ EXP}_{it} + \text{Industry dummies} + \varepsilon_{it}$$

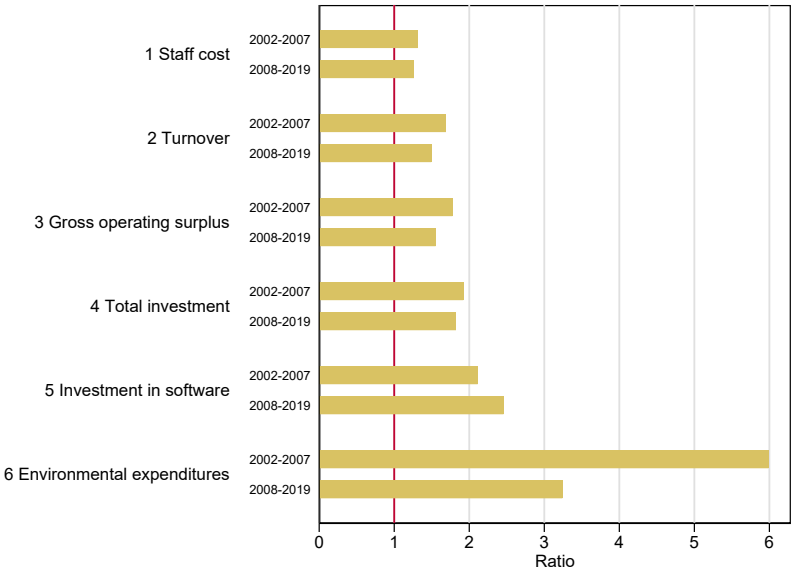
where EXP can be the export status (0/1) or the export intensity (share of exports in turnover). Here, Y_{it} denotes the performance variable (in hours worked) of firm i at time t. The results are presented in Table 3.2. In confirmation of the descriptive results, these estimations showed that the exporting firms performed better in terms of staff costs per hour worked by a factor of 1.2, turnover and gross operating surplus by a factor of around 1.4 and investments (see upper panel of this table). These results were also confirmed by using export intensity (the share of exports in total turnover as a dependent variable), which showed a positive relation between export intensity and performance.[12] Generally, these results confirmed the existing literature findings that exporting firms perform better in terms of productivity and therefore also size, which results in a skewed distribution indicating that a relatively small number of firms account for a large bulk of manufacturing exports.

[12] When using a panel FE specification,

$$\ln Y_{it} = \alpha_0 + \beta \text{ EXP}_{it} + \mu_i + \varepsilon_{it}$$

again confirmed this relationship (see Table C.2 in the Appendix to this chapter).

Figure 3.7: Performance ratios per hour worked (annual averages over periods)



Sources: Statistik Austria and own calculations.

3.5 Entry, exit and status transitions

Finally, we considered the dynamics of the firms with respect to entry, exit and changes in their status between exporting and non-exporting. Figure 3.8 presents these dynamics for the number of firms (upper panel) and in terms of Markov transition rates (lower panel). The results indicated, first, that there were only a few dynamics between the exporting and non-exporting status of the firms. Only a small percentage of the active firms switched from non-exporting to exporting or vice versa. Second, a small share of the firms exited the market, with the share of exiting firms being larger for the non-exporting firms (on average, 15%) than for the exporting firms (on average, less than 10%). Third, entry (expressed in the percentage of the existing firms in this year) amounted to around 4% (on average), with also a large share starting immediately as exporters. These shares were rather stable over time as well.

Table 3.2: Performance (hours worked) premium: OLS (2008-2019)

	(1)	(2)	(3)	(4)	(5)	(6)
	Staff	Turn-			Investment	
	costs	over	GOS	Total	Software	Environment
EXPstatus	0.165***	0.343***	0.311***	0.487***	0.080***	0.390***
	(0.003)	(0.006)	(0.011)	(0.013)	(0.022)	(0.019)
Constant	-3.757	-1.752	-3.308***	-4.502***	-9.608***	-4.625***
	(4,053.192)	(9,450.754)	(0.193)	(0.243)	(0.783)	(0.294)
Observations	64,077	64,077	55,181	61,786	25,370	21,782
R-squared	0.298	0.156	0.070	0.073	0.025	0.233
r2_a	0.297	0.156	0.0695	0.0724	0.0245	0.232
F	1086	475.2	172.6	201.9	27.51	274.9

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

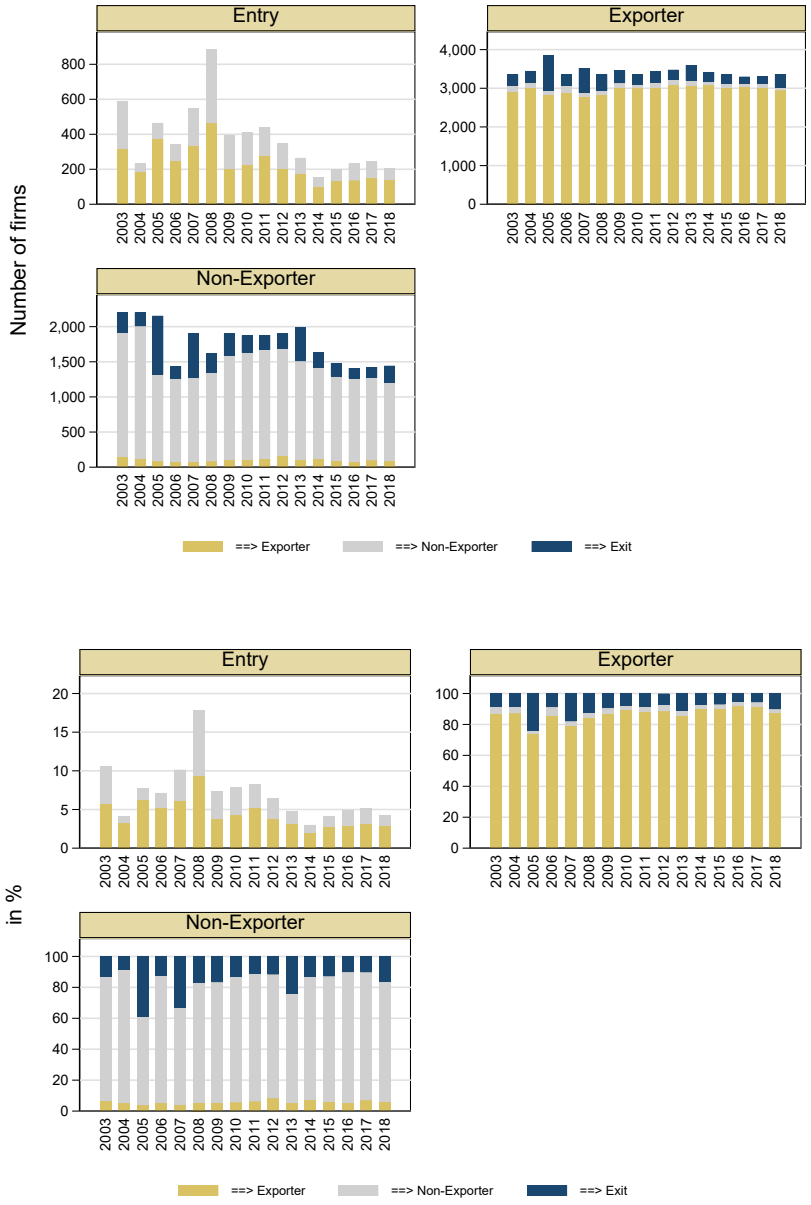
	Staff	Turn-			Investment	
	costs	over	GOS	Total	Software	Environmental
Implied performance premium	1.179	1.409	1.365	1.627	1.083	1.477

	(1)	(2)	(3)	(4)	(5)	(6)
	Staff	Turn-			Investment	
	costs	over	GOS	Total	Software	Environment
EXPint	0.313***	0.671***	0.698***	0.768***	0.140***	0.521***
	(0.004)	(0.009)	(0.017)	(0.020)	(0.028)	(0.024)
Constant	-3.020***	-1.902***	-5.638	-4.260***	-8.953	-9.082***
	(0.139)	(0.325)	(16,826.981)	(0.242)	(21,682.659)	(0.548)
Observations	63,681	63,681	54,854	61,416	25,226	21,740
R-squared	0.329	0.189	0.086	0.076	0.026	0.234
r2_a	0.329	0.188	0.0856	0.0753	0.0250	0.234
F	1302	616.3	206.4	209.3	26.83	277.0

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Figure 3.8: Entry, exit and status transitions (annual averages 2008-2019)



Sources: Statistik Austria and own calculations.

4 Drivers of exporting behaviour

4.1 Productivity and exporting

The above results concerning size and performance premium suggest that exporting firms are generally larger and more productive than non-exporting firms. However, there is a debate on the causality between performance and exporting behaviour. Existing literature (e.g. Arnold and Hussinger 2005) has indicated that higher productivity is conducive to export status or intensity but not vice versa. On the other hand, Hansen (2010) claimed that the effects go in both directions, with a similar conclusion being drawn in a more recent study by Giordano and Lopez-Garcia (2019). A simple way to test this hypothesis was to use lagged variables in both regressions (Aw et al. 2000); thus, to estimate the panel equation:

$$\begin{aligned} \ln Y_{it} &= \alpha + \beta \ \mathrm{EXP}_{i,t-3} + \mu_i + \varepsilon_{it} \\ \mathrm{EXP}_{i,t} &= \alpha + \gamma \ \ln Y_{i,t-3} + \mu_i + \varepsilon_{it} \end{aligned}$$

where EXP denotes the export intensity (share of exports in turnover). Thus, the idea is that lagged exporting status impacts positively on performance (if $\beta > 0$) but also that better lagged performance is positively related to export intensity ($\gamma > 0$).[1] Table 4.1 presents the results of these estimations. Indeed, the results showed that higher productivity (which was correlated with higher staff costs per hour worked, as more productive firms paid higher wages) was conducive to a higher share in exports. However, we also found a small but significant effect of higher environmental expenditures on the export share. Conversely, the results also pointed towards significant positive effects in the other direction: there was some evidence that a higher export intensity in $t-3$ was positively related to a higher turnover per hour worked (and again staff costs) as well as environmental expenditures.[2] These results were also confirmed when using the longer time period, as reported in Appendix Table C.7. These results – though such regressions are plagued by endogeneity issues – suggested that exporting and productivity are mutually positively related.

[1] The restricted access to data did not allow us to use more sophisticated analysis, e.g. propensity score matching.

[2] The negative significant relationship to software expenditures was hard to explain, however.

Table 4.1: Productivity and exporting (2008-2019)

VARIABLES	(1) EXPint	(2) EXPint	(3) EXPint	(4) EXPint	(5) EXPint	(6) EXPint
Staff costs$_{t-3}$	0.019***					
	(0.002)					
Turnover$_{t-3}$		0.009***				
		(0.002)				
GOS$_{t-3}$			-0.001			
			(0.001)			
Total investment$_{t-3}$				0.000		
				(0.000)		
Software investment$_{t-3}$					0.001	
					(0.001)	
Environmental$_{t-3}$						-0.004***
						(0.001)
Constant	0.374***	0.325***	0.300***	0.310***	0.404***	0.367***
	(0.009)	(0.004)	(0.002)	(0.002)	(0.005)	(0.010)
Observations	40,356	40,356	35,149	39,128	16,847	14,329
Number of i	6,293	6,293	6,127	6,214	4,270	3,028
r2_o	0.163	0.0931	0.0448	0.0275	0.00381	0.00922
F	63.49	25.67	1.126	0.163	0.803	9.862

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

	(1) Staff costs	(2) Turn-over	(3) GOS	(4) Total	(5) Investment Software	(6) Environmental
EXPint$_{t-3}$	0.130***	0.135***	0.069	0.093	-0.297**	0.152***
	(0.010)	(0.013)	(0.055)	(0.069)	(0.125)	(0.059)
Constant	-3.613***	-2.255***	-4.612***	-6.053***	-8.889***	-8.486***
	(0.003)	(0.004)	(0.017)	(0.021)	(0.049)	(0.023)
Observations	40,167	40,167	34,851	39,010	16,658	14,593
Number of i	6,267	6,267	6,042	6,177	4,208	2,941
r2_o	0.179	0.103	0.0451	0.0364	0.00354	0.0108
F	185.0	100.6	1.558	1.790	5.668	6.690

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: All performance variables are expressed in per hour worked.

4.2 R&D and exporting

4.2.1 Descriptives

The analysis of the relationship between R&D and exporting was based on a matched sample that included data from the Konjunkturstatistik (information on exports), R&D data (F&E-Erhebung) and Struktur- und Leistungserhebung (all other firm characteristics) – all by Statistik Austria. These three surveys followed different approaches for sampling, so not all firms were included in all three surveys. The Struktur- und Leistungserhebung was the most comprehensive of the three surveys, and the other two overlapped in different degrees, as seen in Table 4.2.

Table 4.2: Number of firms (total sample)

		2017		2019	
		Export status		Export status	
		No	Yes	No	Yes
R&D	No	1465	2365	1333	2237
	Yes	48	1095	47	1110

Sources: Statistik Austria and own calculations.

The starting point for putting together the database were all firms of the Struktur- und Leistungserhebung. Statistik Austria then added data from the Konjunkturstatistik and the F&E-Erhebung. The firms were linked through their enterprise register identification code (Firmenbuchnummer). There were 1,110 firms in the sample for 2019 and 1,095 firms for 2017 for which data on R&D and exports were available, and 2,365 and 2,237 firms for those with information on exports only and not R&D. Since Statistik Austria assumed that their R&D survey caught all the R&D active firms in Austria, we considered these firms as not R&D active. On the other hand, there was only a small minority (48 and 47 firms) in which we had information on R&D but not on exports. Moreover, a large number of firms had neither R&D nor exports. Most of them were in utilities, mining and construction; the majority of the manufacturing firms had either R&D or exports.

We first looked at the differences between sectors in R&D and export activities. The table below classifies sectors according to their technology intensity (Eurostat, 2016). The results indicated large differences between sectors in terms of R&D and exports. R&D activities (INTFUE) as well as exporting (EXPstat) were the most frequent among high-technology and medium-high technology firms. The values of both indicators decreased when we moved to sectors with lower technology intensity. For example, the difference in the share of R&D active firms between high-technology and medium-high technology firms was more than 20 percentage points. The values further decreased outside manufacturing (not included in the table) and reached the lowest in construction where only 15% of all the firms exported and one percent were R&D active. Construction firms, however, encompassed a large share of the sample.

A similar distribution could be seen for the intensity of R&D and exporting, measured by the share

of R&D expenditures (INTFUE) or exports (UMSAUSA) on turnover. Both indicators decreased with falling technology intensity and again reached their lowest value in construction. Moreover, the table also presents information on foreign ownership for 2019, which was also highest in high-technology sectors. Due to the low number of exporting and R&D active firms in mining, construction and utilities, the following analysis focused on the manufacturing industries. The sectors outside manufacturing were only considered when their results deviated considerably from those for manufacturing.

Table 4.3: Descriptives by broad sectors: Total sample

Year	Sector	Number	Export status EXPstat	Foreign owned FOROWN	Export share UMSAUSA	Persons employed INSGES	Turn-over UMSATZ	R&D share INTFUE	R&D intensity FUEINT
2017	High tech	151	0.95	.	0.68	233.6	75361.6	0.75	0.11
2019	High tech	148	0.97	0.39	0.70	257.0	87704.5	0.78	0.13
2017	Medium-high tech	836	0.94	.	0.61	211.9	80214.9	0.54	0.04
2019	Medium-high tech	852	0.94	0.31	0.61	228.9	88976.2	0.55	0.05
2017	Medium-low tech	2,065	0.67	.	0.24	90.4	27607.4	0.17	0.01
2019	Medium-low tech	1,812	0.68	0.15	0.26	104.4	34246.3	0.20	0.01
2017	Low tech	1,921	0.60	.	0.22	78.5	23490.5	0.11	0.00
2019	Low tech	1,915	0.61	0.10	0.23	80.1	24360.1	0.11	0.00

Sources: Statistik Austria and own calculations.

In the next step, we looked at the differences between firms of various sizes. Similar to the sectoral perspective, there were also large differences in export and R&D activities between firms of different sizes. The table below shows mean values for six groups of firms:

1. firms with between 0 and 49 employees (sizeclass 0),
2. between 50 and 99 employees (sizeclass 50),
3. between 100 and 249 employees (sizeclass 100),
4. between 250 to 499 employees (sizeclass 250),
5. between 500 to 1,499 employees (sizeclass 500) and
6. with 1,500 or more employees (sizeclass 1,500).

The first three size classes included small and medium-sized firms according to the EU definitions. The data showed that the majority, even among the smallest firms in sizeclass 0, exported (the share was 59%, see EXPstat in the table). The share of exports on turnover (UMSAUSA) rose with increasing firm size. R&D was less frequent than exporting: the share of R&D active firms (INTFUE) in sizeclass 0 was only around 8%, but increased to 26% and 28% in sizeclass 50 and to more than 50% in sizeclass 100. The vast majority of the firms with more than 249 employees were R&D active. The share of R&D expenditures on turnover (or R&D intensity, FUEINT in the table) also rose with increasing firm size. Finally, the share of foreign-owned firms (FOROWN) also rose with increasing firm size.

Table 4.4: Descriptives by size classes: Manufacturing

Year	Sizeclass	Number	Export status EXPstat	Foreign owned FOROWN	Export share UMSAUSA	Persons employed INSGES	Turn-over UMSATZ	R&D share INTFUE	R&D intensity FUEINT
2017	0	3,068	0.59	.	0.19	24.9	4,811.9	0.08	0.01
2019	0	2,787	0.60	0.08	0.19	25.9	5,190.0	0.08	0.01
2017	50	764	0.78	.	0.37	69.8	16,266.7	0.26	0.02
2019	50	762	0.79	0.19	0.38	69.1	15,668.3	0.28	0.02
2017	100	673	0.90	.	0.53	158.2	55,193.7	0.52	0.02
2019	100	679	0.89	0.31	0.53	156.1	52,130.1	0.52	0.02
2017	250	279	0.95	.	0.62	347.1	119,852.8	0.70	0.03
2019	250	293	0.94	0.39	0.61	349.1	129,987.5	0.69	0.03
2017	500	160	0.96	.	0.70	794.1	301,144.2	0.85	0.04
2019	500	175	0.95	0.42	0.70	810.2	327,867.1	0.79	0.04
2017	1,500	29	0.93	.	0.75	3,093.2	1.2e+06	0.97	0.06
2019	1,500	31	0.97	0.52	0.78	3,251.5	1.3e+06	0.97	0.06

Sources: Statistik Austria and own calculations.

These results already pointed to a strong relationship between R&D and exports but also between the size and the sector of the firm on the one hand and R&D and exports on the other hand. To disentangle these relationships, we employed multivariate analysis in the following chapter.

4.2.2 Econometrics

This chapter tests the relationship between exports and R&D by controlling for the size and sector of the firm. Descriptive statistics have indicated that both factors are positively related to exports. We employed various regressions with the propensity to export or export intensity as the dependent variable. The results of the regressions were coefficients for the independent variables, which could be interpreted as the direction and size of a change of the dependent variable when the independent variable increased or decreased by one unit.

The first regression in the table below related the likelihood to export (EXPstat) to the size of the firm, measured by the logarithm of the number of employees (LINSGES), to R&D activity (INTFUE), to R&D intensity (FUEINT) and to foreign ownership (FOROWN). The table includes five different regressions in columns (1)-(5). The first four regressions were estimated with all the data for 2017 and 2019; the last regression (column 5) only included data for 2019 because we did not have ownership data for 2017. In addition, sectoral dummies at the level of NACE 2 digits were included in estimation (3)-(5) but not reported.

The results indicated a significant and positive association between the likelihood to export and firm size as well as with R&D activities. The coefficient for INTFUE in columns (1) and (3) showed that the likelihood that a firm exported increased by 26% or 19% if this firm was also R&D active. Moreover, the results also revealed a positive relationship between the likelihood to export and R&D intensity (FUEINT) in columns (2) and (4). From column (2), we can see that the likelihood to export increased by 0.67% if R&D intensity increased by 1%. Thus, the higher the share of R&D expenditure on

turnover, the higher the likelihood of exporting. The positive association between R&D and exports also appeared when we controlled for the sectors in columns (3)-(5). This meant that the sector as well as the firm size contributed to the positive relationship between exports and R&D we saw in the descriptive statistics. Column (5) also includes the foreign ownership variable, which are shown to also be positive and significant. This indicates that R&D active foreign-owned firms with the same size and sectoral affiliation had a 16% higher likelihood to export compared with domestically owned firms.

Table 4.5: Probit estimations for manufacturing firms

	(1)	(2)	(3)	(4)	(5)
	EXPstat	EXPstat	EXPstat	EXPstat	EXPstat
LINSGES	0.093***	0.139***	0.089***	0.118***	0.072***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.007)
INTFUE	0.262***		0.188***		0.178***
	(0.009)		(0.011)		(0.015)
FUEINT		0.670***		0.153*	
		(0.091)		(0.080)	
FOROWN					0.163***
					(0.014)
Sector dummies	No	No	Yes	Yes	Yes
Observations	9,639	9,639	9,639	9,639	4,696
chi2	1559	1152	2637	2455	1382
r2_p	0.133	0.0986	0.226	0.210	0.245

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

A second set of regressions in Table 4.6 tested the association between export intensity and R&D and related the same set of dependent variables to the share of exports on turnover (UMSAUSA). We assumed that R&D active firms and firms with higher R&D intensity generate more of their turnover from exports. The results confirmed this assumption. We saw a positive and significant relationship between export intensity and firm size as well as between export intensity, R&D activities and foreign ownership. The coefficient for R&D intensity was also significant in all regressions. These results in column 4 indicated that an increase in R&D intensity by 10% resulted in an increase in export intensity by 4%.

A central question in the analysis of exports and R&D related to the directionality of the relationship between the two variables. Recent contributions to this discussion have assumed a two-way relationship from R&D to exports and also the other way around. On the one hand, R&D helps firms create products that succeed on export markets and increase their competitiveness; on the other hand, the competition in international markets puts pressure on firms to carry out R&D in order to stay competitive in these markets. To test the association between R&D and exports, we introduced lagged independent variables in the regressions. We estimated two versions of the regressions: one version regressed R&D activities in 2017 on exports in 2019 and the other one regressed exports in 2017 on R&D activities in 2019. The

Table 4.6: Exports, R&D and ownership I

	(1)	(2)	(3)	(4)	(5)
VARIABLES	UMSAUSA	UMSAUSA	UMSAUSA	UMSAUSA	UMSAUSA
LINSGES	0.080***	0.136***	0.069***	0.101***	0.054***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)
INTFUE	0.317***		0.209***		0.211***
	(0.008)		(0.008)		(0.011)
FUEINT		0.844***		0.412***	
		(0.045)		(0.042)	
FOROWN					0.191***
					(0.011)
Constant	-0.070***	-0.221***	-0.276**	-0.326***	0.305***
	(0.011)	(0.011)	(0.120)	(0.124)	(0.060)
Sector dummies	No	No	Yes	Yes	Yes
Observations	9,589	9,589	9,589	9,589	4,665
R-squared	0.322	0.247	0.440	0.408	0.479
r2_a	0.322	0.247	0.439	0.407	0.476
F	2276	1572	313.1	275.1	170.5

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

results are reported in Tables 4.7 and 4.8. The results were significant and positive in both directions and very similar to those with unlagged independent variables in the tables above. These pointed to a very stable two-way relationship between exporting and R&D. The exporting firms did not need to perform R&D in order to stay competitive, and R&D was a highly significant predictor of later exports.

Altogether, the descriptive as well as the econometric results indicated a positive and significant association between exports and R&D. R&D can help firms enter and stay competitive in export markets, and exports are preconditions that increase the benefits from R&D. This is the reason why very few R&D active firms do not export. Exporting firms with no R&D activities were more frequent in the sample; in particular, among smaller firms.

4.3 Digital production technologies and exporting

In Section 2, we argued that a positive association exists between digital production technologies (also known as Industry 4.0) and exports. Digital technologies can increase the productivity of firms, which, in turn, allows firms to compete in export markets. However, it may also be true that competition in export markets forces firms to introduce these technologies. Pressure may also come from the requirements of industrial customers abroad to introduce digital technologies. We tested the association between digital production technologies and exports for Austrian firms with a data set from the European Manufacturing Survey (EMS). EMS is a firm-level survey that targets manufacturing firms with 20 or more employees

Table 4.7: Exports, R&D and ownership II

	(1)	(2)	(3)	(4)
VARIABLES	UMSAUSA	UMSAUSA	UMSAUSA	UMSAUSA
LagLINSGES	0.082***	0.136***	0.070***	0.102***
	(0.005)	(0.004)	(0.004)	(0.004)
LagINTFUE	0.307***		0.197***	
	(0.012)		(0.012)	
LagFUEINT		1.090***		0.476***
		(0.083)		(0.079)
Constant	-0.070***	-0.220***	0.218***	0.155**
	(0.017)	(0.017)	(0.065)	(0.066)
Sector dummies	No	No	Yes	Yes
Observations	4,280	4,280	4,280	4,280
R-squared	0.317	0.249	0.440	0.411
r2_a	0.316	0.249	0.437	0.408
F	991.4	710.5	139.6	123.9

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 4.8: Exports, R&D and ownership III

	(1)	(2)
VARIABLES	INTFUE	INTFUE
LagUMSAUSA	0.391***	0.260***
	(0.019)	(0.021)
LagLINSGES	0.148***	0.147***
	(0.007)	(0.007)
Sector dummies	No	Yes
Observations	4,269	4,269
chi2	1725	2063
r2_p	0.356	0.425

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

and investigates product, process, service, and organisational innovations (Zahradnik et al. 2019). The data for the most recent survey (EMS 2018) were collected in late spring of 2018 and related to the year 2017.

EMS gives detailed information on the implementation of 20 different digital technologies coded as binary variables. These variables are one if the firm uses a certain technology and zero otherwise. We utilised this information by aggregating technologies into four groups: Industry 4.0, digital products, robots and additive manufacturing. Industry 4.0 includes all technologies that digitally connect various stages of production; this variable was constructed following the approach of Lerch et al. (2017). Digital

products are those technologies that can be included in products, such as sensors or RFID tags. Robots refer to handling robots as well as production robots. Finally, additive manufacturing includes rapid prototyping as well as additive manufacturing for mass production. We calculated an index that increased with a rising number of technologies used by the firm for Industry 4.0 and digital products. The variables for robots and additive manufacturing represented the share of firms that utilised these technologies.

EMS 2018 included 259 observations for Austrian manufacturing firms with 20 or more employees. We arranged these firms according to their export intensity (exports as a share of turnover) into five groups: no exports, export intensity less than 10%, between 10 and 50%, 50-75% and more than 75%. Table 4.9 depicts the number of firms and mean values for the different variables for each of these five groups.

Table 4.9: Export intensity and the use of digital technologies in manufacturing enterprises, 2017.

Export intensity	Number of firms	Number of employees	Innovation (Y/N)	Industry 4.0 index	Digital products index	Robots index	3D printing index
0	33	85	33%	1.00	0.39	0.15	0.12
< 10%	27	76	44%	1.33	0.48	0.37	0.07
10-50%	71	97	53%	1.77	0.58	0.28	0.20
50-75%	52	117	65%	1.90	0.54	0.42	0.19
>75%	76	297	69%	2.22	0.82	0.51	0.32
Total	259	156	57%	1.79	0.61	0.37	0.21

Sources: EMS and own calculations.

The firms with no exports or less than 10% on their turnover were a minority in the sample. Export intensity increased with firm size measured by the number of employees in the sample, which was consistent with the results from the whole manufacturing sector presented in Chapter 4. The fourth column of the table shows the share of innovative firms in each of the five groups. We can see that the share of innovative firms rose with increasing export intensity, which was consistent with the literature but also with the findings on R&D from the previous section. R&D was the most important part of innovation activities for many of the manufacturing firms.

The last four columns of the table provide the mean values for each of the four technology groups. An index value of one for Industry 4.0 and digital products meant that the enterprises in a particular group employed at least one of those technologies. The index values, however, were not immediately comparable because the number of technologies differed between each group. The values for robots and 3D printing indicated the share of firms that used any of these technologies rather than the number of technologies employed.

The Industry 4.0 index took a value of one for the non-exporting firms, which meant that these firms had a least one of these technologies. In fact, the share of firms with no Industry 4.0 technology was only 23% of the sample. Around half of all the non-exporting firms used no Industry 4.0 technology compared with 13% for firms with an export intensity of more than 75%. The Industry 4.0 index increased steadily with rising export intensity, which meant that firms with a higher share of exports on turnover tended to

use more Industry 4.0 technologies. This was also true for digital products, robots and 3D printing. The non-exporting firms, with one exception, always employed fewer of these technologies than the next group with an export intensity of below 10%. Both findings were a strong indication that digital technologies are indeed positively related to exports.

In the next step, we tested the relationship between exports and digitalisation in a regression. The equation relates the export status (columns 1 and 2) or the share of turnover on exports (columns 3 and 4) to firm size, the four technology groups, the share of employees with tertiary and secondary education, sectoral variables and a variable that indicates if the firm supplies to other firms or to consumers. The results of these regressions can be found in Table 4.10.

Table 4.10: Exports and digital technologies: regression results

	(1)	(2)	(3)	(4)
VARIABLES	EXPstat	EXPstat	EXPint	EXPint
lemp	0.033**	0.024*	10.189***	9.721***
	-0.014	-0.014	-2.027	-2.266
innov	0.024	0.019	7.043	6.658
	-0.026	-0.022	-4.369	-4.425
prodindex		0.038*		3.412
		-0.021		-3.65
digindex		-0.003		-0.552
		-0.014		-3.30
robot		0.002		1.278
		-0.022		-4.801
adm		-0.027		1.366
		-0.039		-5.457
tert	0.128	0.096	85.706***	82.853***
	-0.209	-0.175	-25.827	-26.489
up_sec	0.099	0.04	2.995	0.515
	-0.114	-0.103	-18.607	-19.549
supp	0.05	0.04	18.630***	19.128***
	-0.03	-0.028	-4.555	-4.639
hitech			-5.209	-7.886
			-9.824	-10.235
mhitech			2.003	0.096
			-6.126	-6.496
mlowtech			0.96	0.321
			-5.093	-5.206
Observations	208	208	208	208
R-squared			0.285	0.289
chi2	16.01	20.92	.	.
r2_p	0.165	0.215	.	.
r2	.	.	0.285	0.289

Source: EMS, own calculations

Columns (1) and (3) include the results of the regressions without digital technologies, while columns (2) and (4) present the results with these variables. Unfortunately, the results failed to establish a significant association between exports and the four technology groups. The inclusion of the variables for digital technologies added only little to the overall explanatory power of the regression, and the coefficients were not significantly different from zero. Significant coefficients could only be found for exports and firm size on the one hand and for exports and the share of employees with tertiary education on the other

hand. This may indicate that the positive relationship we saw in the descriptive statistics was due to the correlation of digital technologies and firm size. However, a larger sample may yield significant results. To sum up, the firms with a high share of exports on turnover also employed more digital technologies, but it seemed that this positive relationship was due to firm size rather than digital technologies as such.

5 Summary and conclusions

Austria's economic performance depends to a large extent on exports. More than half of Austria's GDP is generated by exports and, even if the necessary imported inputs are deducted, one third of domestic value added still stems from exporting activities. Despite this great importance, we know little about domestic exporters. This study therefore investigated the characteristics of exporting firms in Austria using a large untapped firm-level database.[1] Specifically, we examined how the share of exporting firms has developed in recent years, whether exports have become more important for firms over time and to what extent exporters have an advantage over other firms (export premium).

Summarising the main results, overall, the share of exporting firms in the total number of firms is about 66% in the Austrian manufacturing sector (NACE Revision 2 C). This share has risen slightly over time since 2002 when it was about 60%. The export intensity, which is the share of export turnover in total turnover, has also increased slightly over time. Correspondingly, there are clear differences between exporting firms with regard to their importance in Austrian manufacturing exports. While about a quarter of the firms generate less than 10% of their turnover in export markets, about 15% of all exporting firms have export shares of 90 or more percent. The number of these highly export-oriented firms increased significantly between 2008 and 2019. The increase in the export participation and the increase in export intensities have also been the most important and significant trends over time pointing towards a further internationalisation and improved performance in foreign markets of the Austrian manufacturing industry.

The transitions between the export and non-export status of enterprises are rather low. About 90-95% of exporting firms continue to export in the next year, and only a few non-exporting firms or about 5% switch to export activity. Non-exporters are also more likely to exit. The share of entering firms that export immediately accounts for about two-thirds of all firm entries. In line with the literature, the results also strongly confirmed that exporting firms are larger, generate more surpluses, invest more and spend more on environmental protection than non-exporters. The results showed that exporting firms are larger than non-exporting firms by a factor of 2-3, depending on the performance variable considered. Correspondingly, a relatively small proportion of firms contribute to a large share of exports: for example,

[1] A previous study based on this data was published more than ten years ago (see Pöschl et al. 2009).

the top 5% of firms account for about 65% of all manufacturing exports in 2019, those in the top 10% account for almost 80% and those in the top 25 % account for more than 90%. Firm performance in terms of per hours worked of these variables is higher for exporters by a factor of 1.2 to 1.6. For these indicators no significant trends over time can be observed, however. Nonetheless, the increases in export participation also imply slight increases of the exporting firms with respect to their overall shares of about 85-90% in output, investment, or employment in the Austrian manufacturing industry.

The results further indicated a reciprocal positive relationship between export behaviour and productivity: higher productivity in the past is associated with significantly higher export intensity. Conversely, higher export intensities in the past cause higher productivity. Along these lines, when the drivers of exporting behaviour were examined, the results also indicated strong relationships between firm performance and particularly R&D expenditures. We found that only a few R&D active firms do not export. Exporters conduct research and development (R&D) significantly more often and invest more in digitalisation than non-exporters. The more invested in R&D they are, the higher their export share of turnover. However, the regression results did not show a significant relation between exporting and proxies for Industry 4.0. The causality between exports and R&D runs in both directions, i.e. exports create incentives and pressure to develop new products just as R&D provides the basis for new products that can be marketed internationally. In terms of economic policy, these results imply that measures to promote firm productivity may lead to better export performance and, conversely, measures to promote export activity may impact positively on better firm performance. In particular, the close links between R&D and exports are very important in terms of economic policy because they show a way to increase export intensity via the promotion of R&D and innovation. If, as in the past, the number of R&D performing firms in Austria can be increased, the share of exporters will also continue to rise. The relationship between productivity and exports is similar. Measures that increase productivity, such as the investment premium, should also increase the export activity of Austrian firms in the long run. In the best case, exports and productivity reinforce each other over time, as suggested by the results, indicating that exports are related to a number of highly desirable characteristics of firms, like higher productivity or R&D activities with mutual relationships. From a policy perspective, this means that measures to promote productivity upgrading, investments (like the 'Investitionsprämie') or R&D (like the 'Forschungsprämie') should consequently provide positive knock-on effects on exporting performance.

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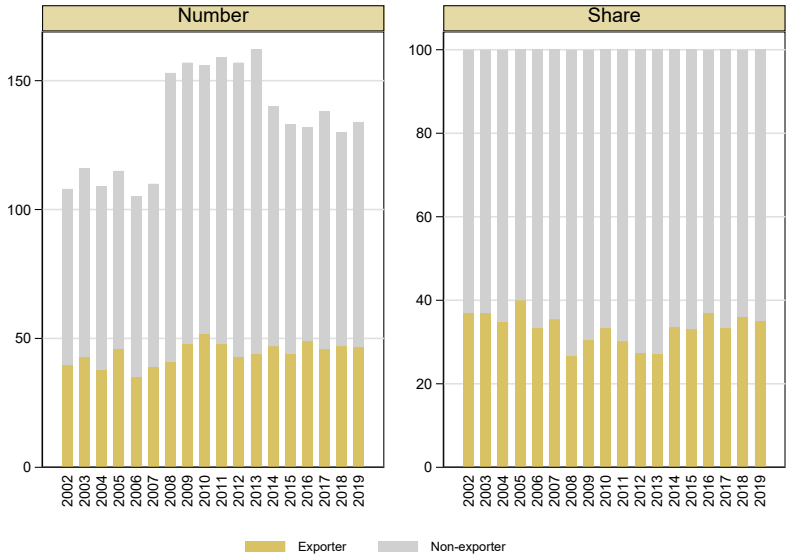
A Selected descriptive results for other industries

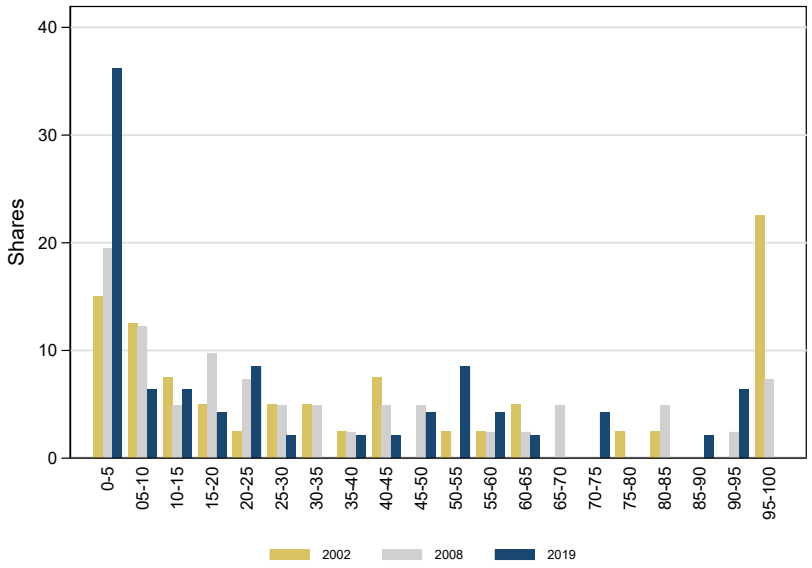
A.1 Mining and quarrying B (2002-2019)

Figure A.1: Number of firms by exporter status



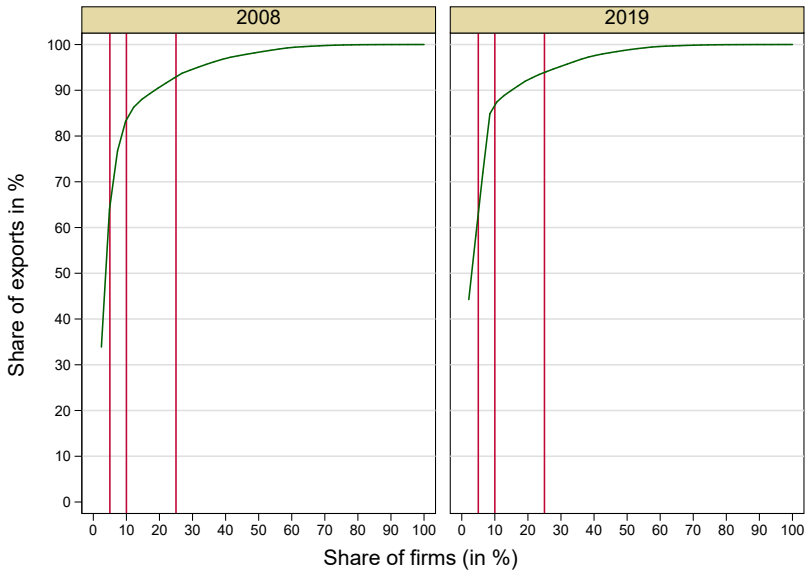
Source: Statistik Austria; own calculations.

Figure A.2: Share of exporting firms by export brackets



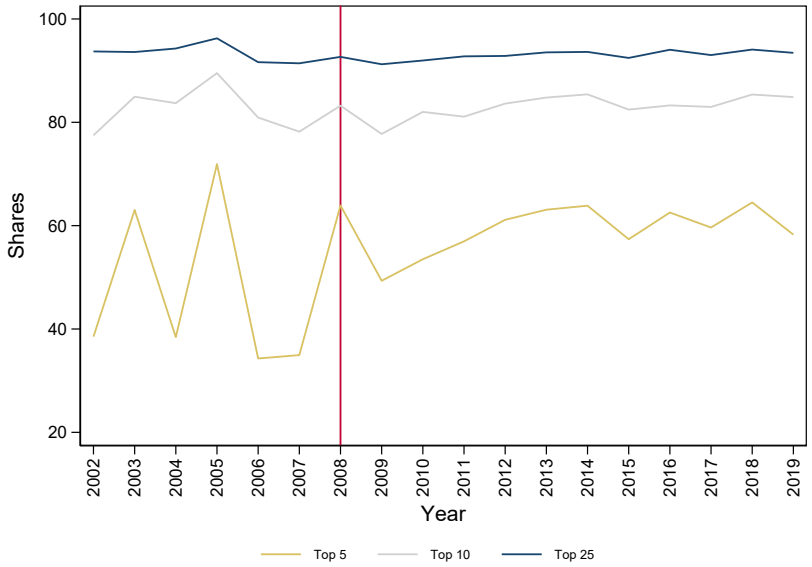
Source: Statistik Austria; own calculations.

Figure A.3: Cumulative distribution



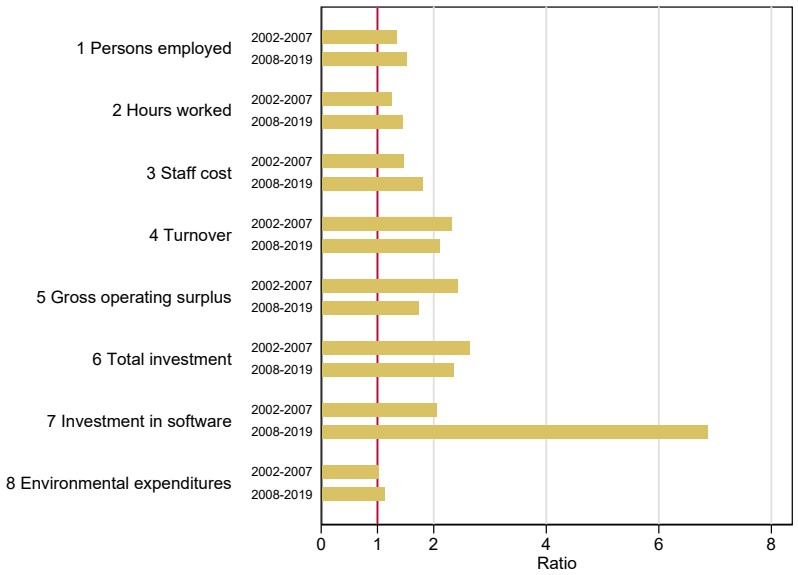
Source: Statistik Austria; own calculations.

Figure A.4: Top shares (number of firms)



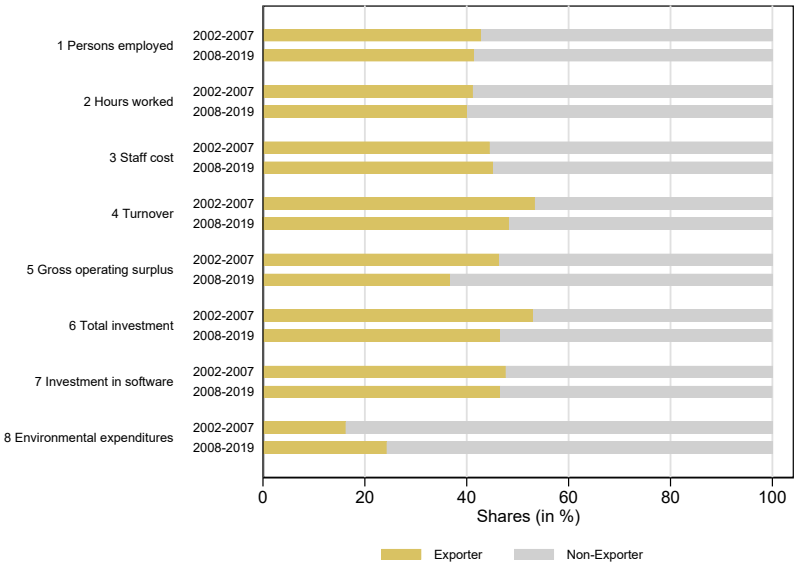
Source: Statistik Austria; own calculations.

Figure A.5: Size ratios (average 2002-2019)



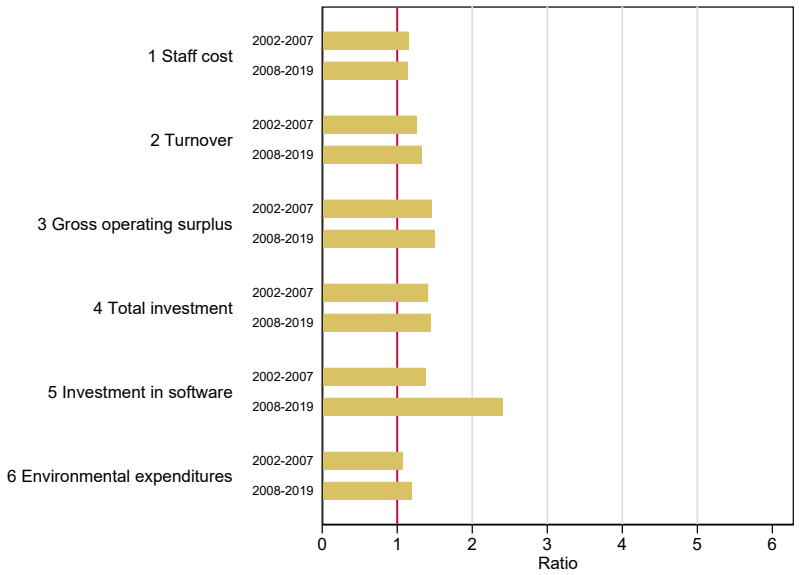
Source: Statistik Austria; own calculations.

Figure A.6: Shares (average 2002-2019)



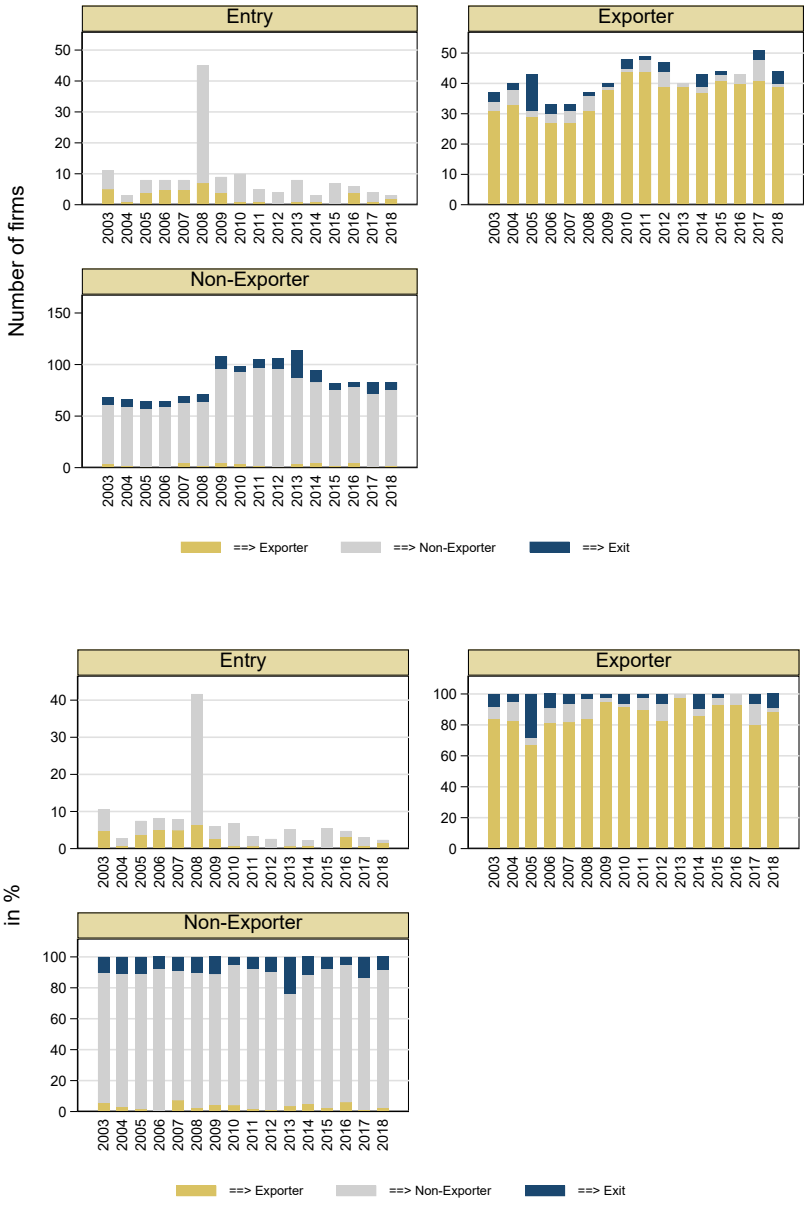
Source: Statistik Austria; own calculations.

Figure A.7: Performance ratios (per hour worked)



Source: Statistik Austria; own calculations.

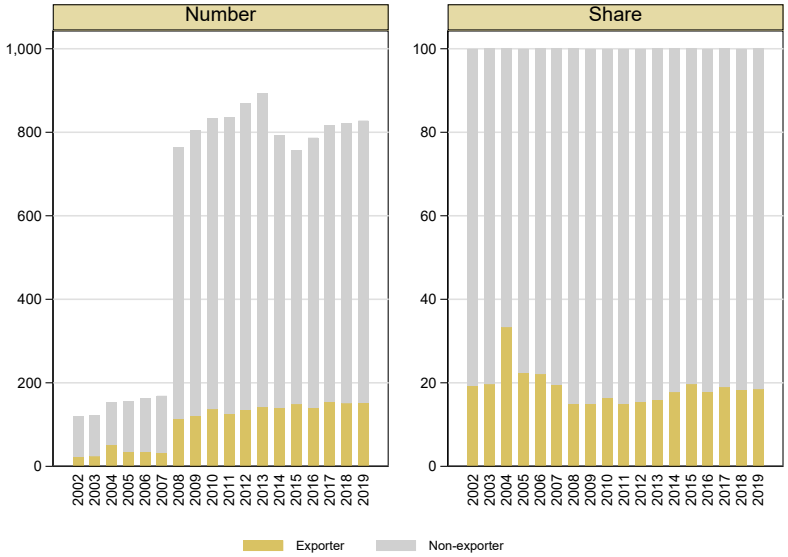
Figure A.8: Entry, exit and status transitions



Source: Statistik Austria; own calculations.

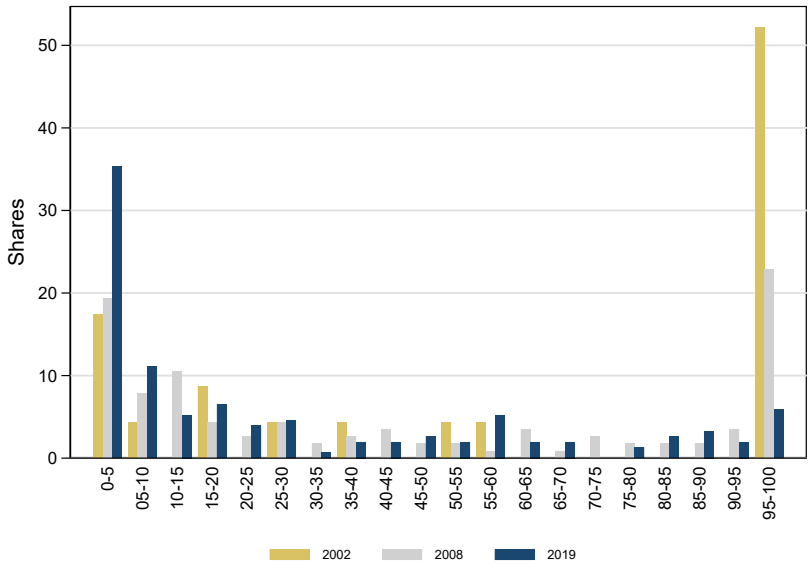
A.2 Utilities DtE (2002-2019)

Figure A.9: Number of firms by exporter status



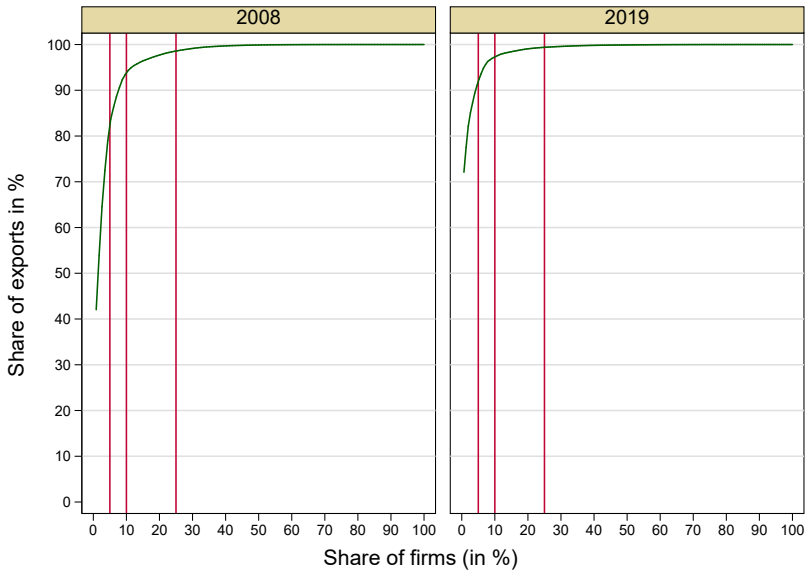
Source: Statistik Austria; own calculations.

Figure A.10: Share of exporting firms by export brackets



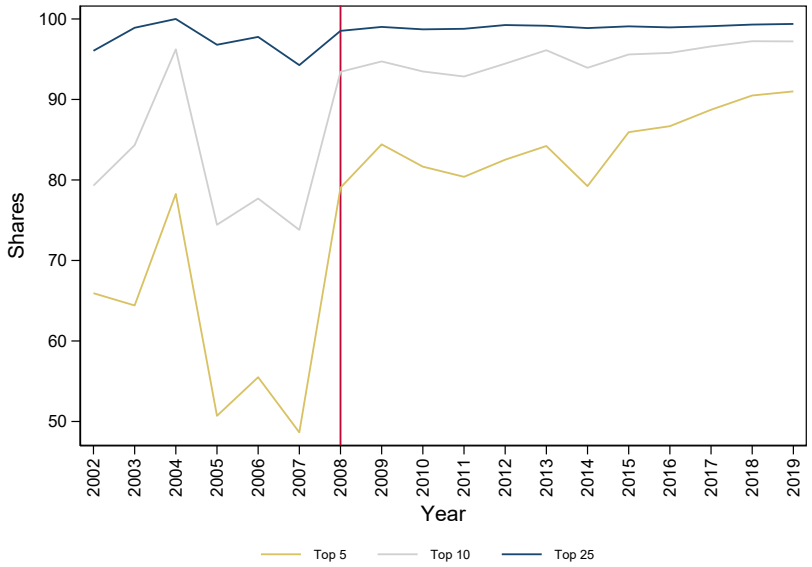
Source: Statistik Austria; own calculations.

Figure A.11: Cumulative distribution



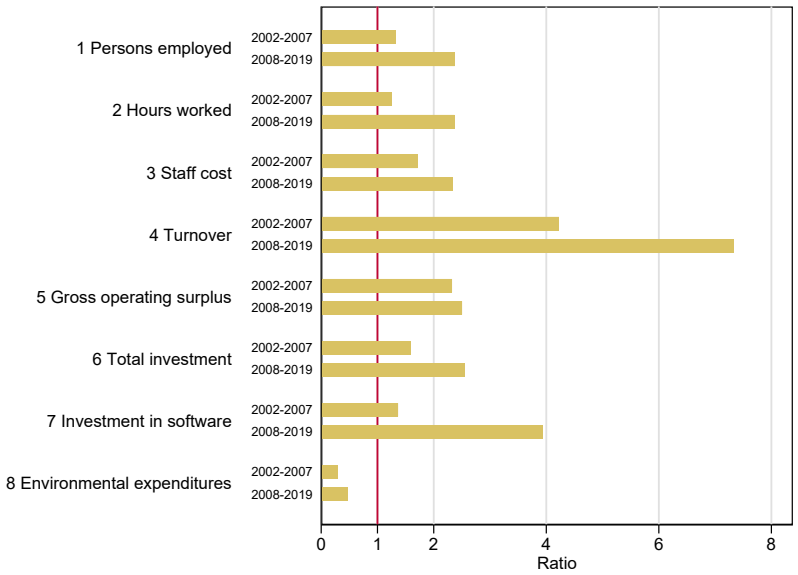
Source: Statistik Austria; own calculations.

Figure A.12: Top shares (number of firms)



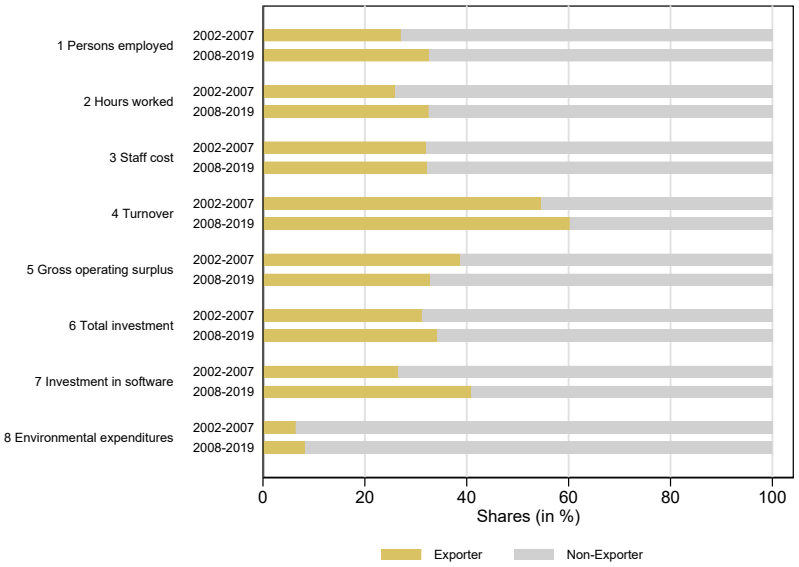
Source: Statistik Austria; own calculations.

Figure A.13: Size ratios (average 2002-2019)



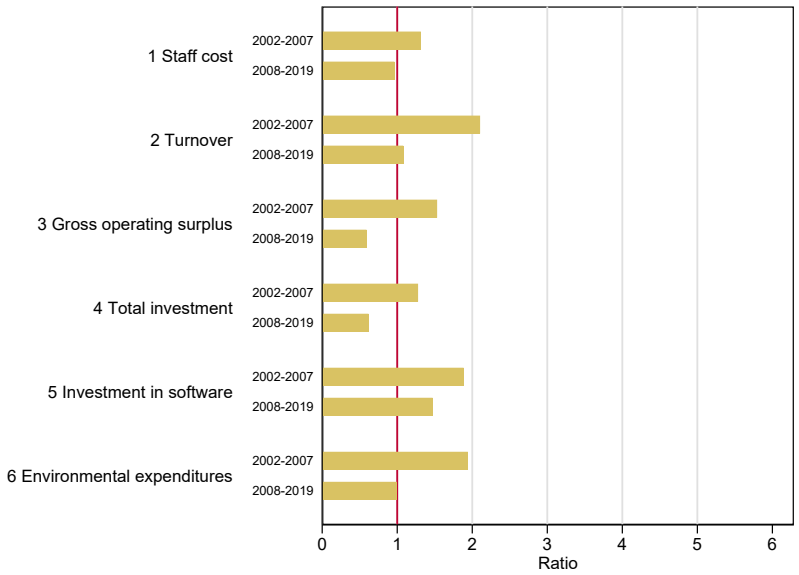
Source: Statistik Austria; own calculations.

Figure A.14: Shares (average 2002-2019)



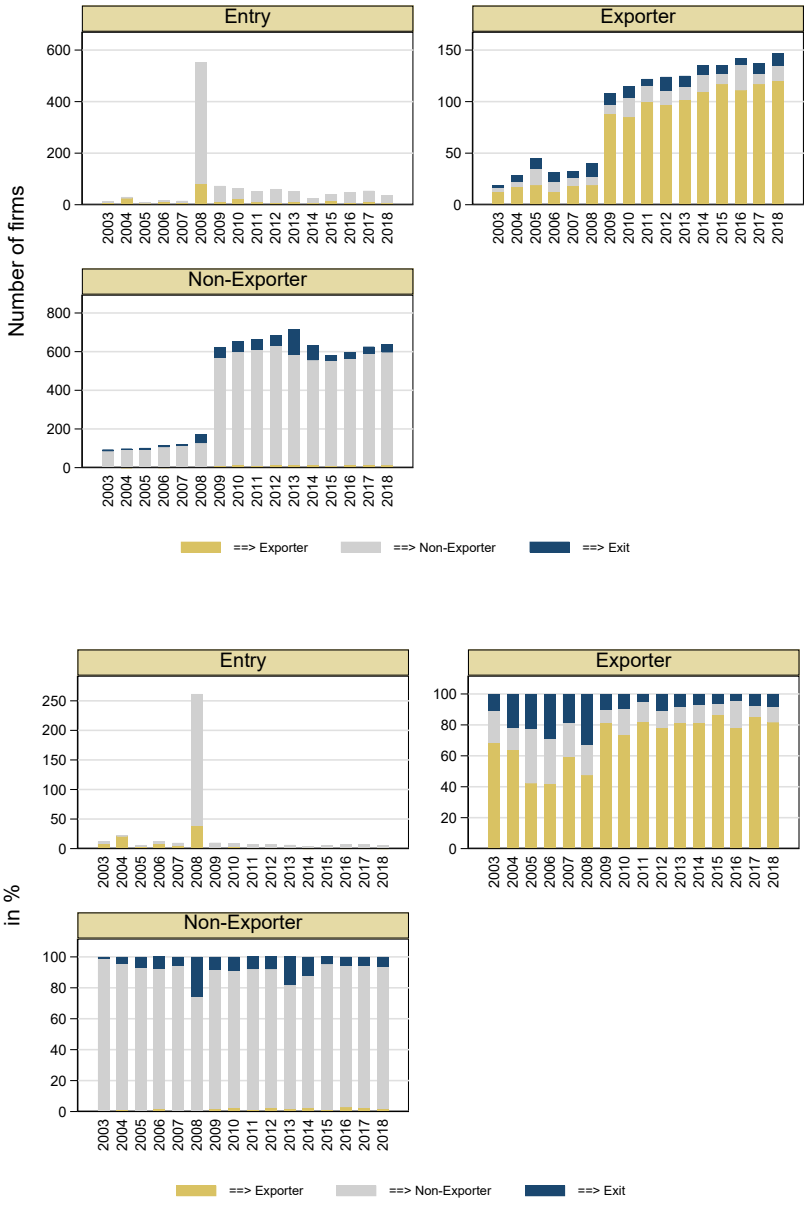
Source: Statistik Austria; own calculations.

Figure A.15: Performance ratios (per hour worked)



Source: Statistik Austria; own calculations.

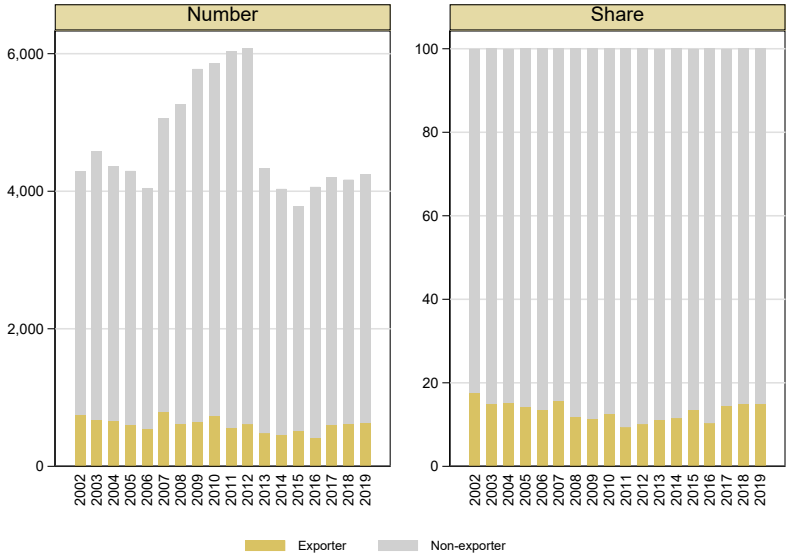
Figure A.16: Entry, exit and status transitions



Source: Statistik Austria; own calculations.

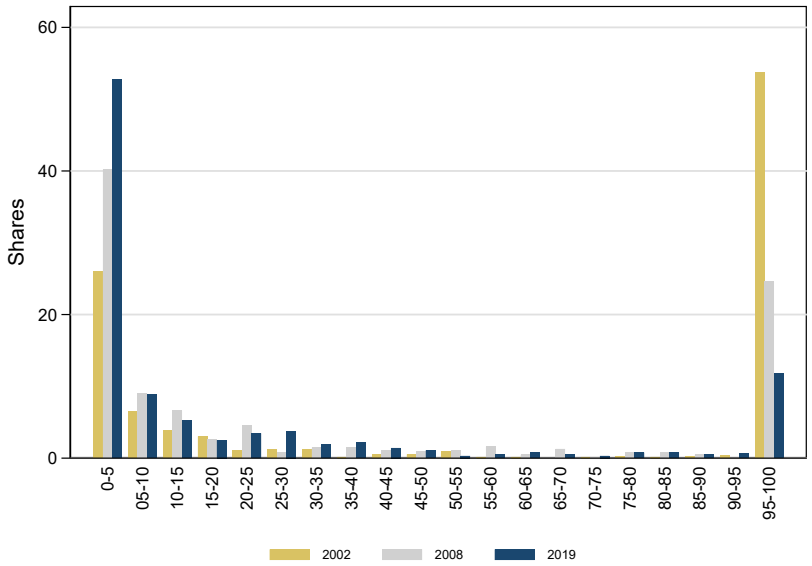
A.3 Construction F (2002-2019)

Figure A.17: Number of firms by exporter status



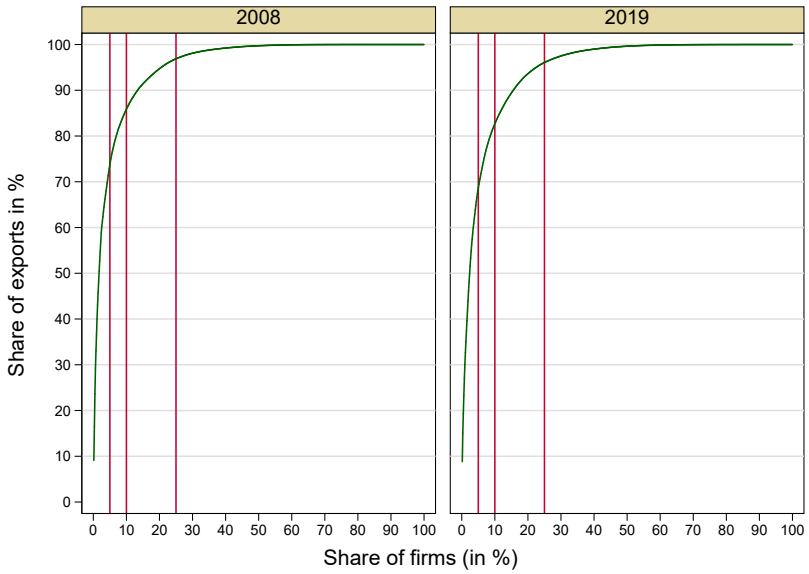
Source: Statistik Austria; own calculations.

Figure A.18: Share of exporting firms by export brackets



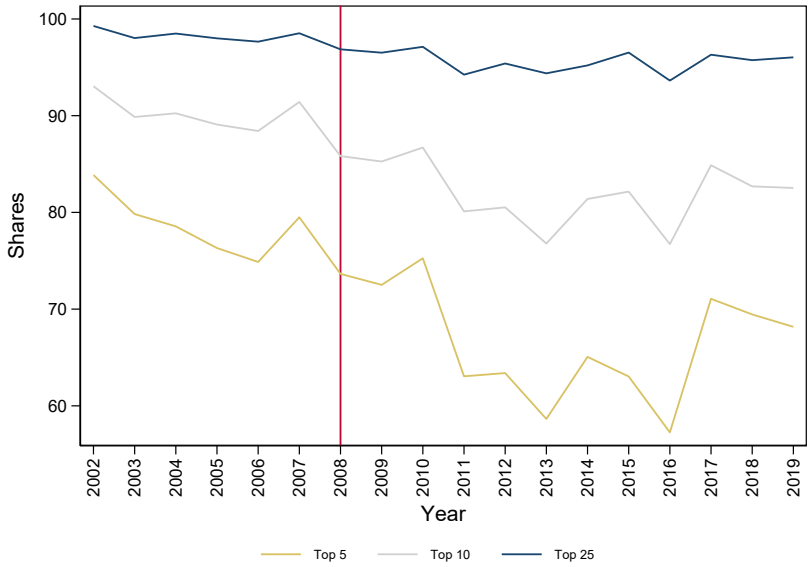
Source: Statistik Austria; own calculations.

Figure A.19: Cumulative distribution



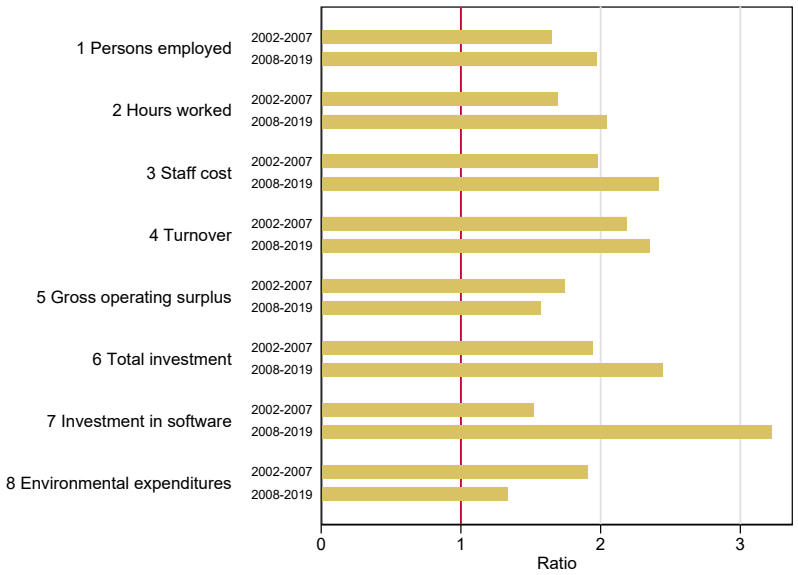
Source: Statistik Austria; own calculations.

Figure A.20: Top shares (number of firms)



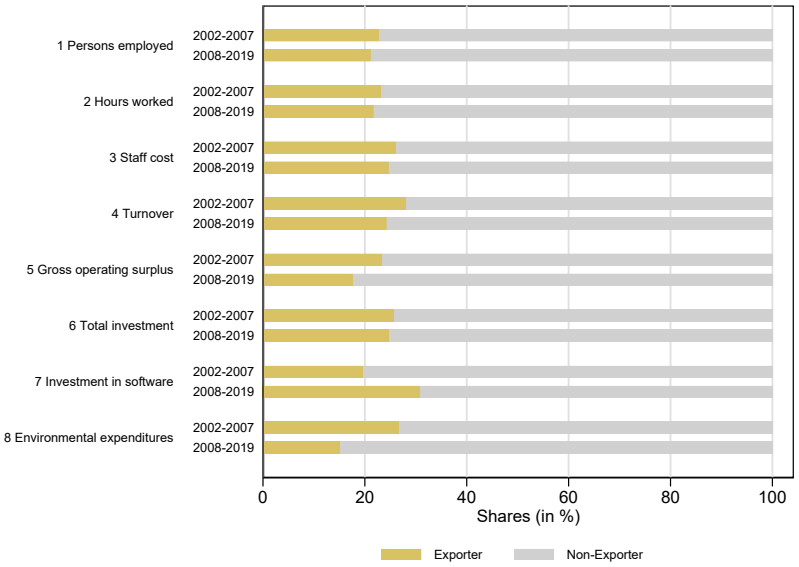
Source: Statistik Austria; own calculations.

Figure A.21: Size ratios (average 2002-2019)



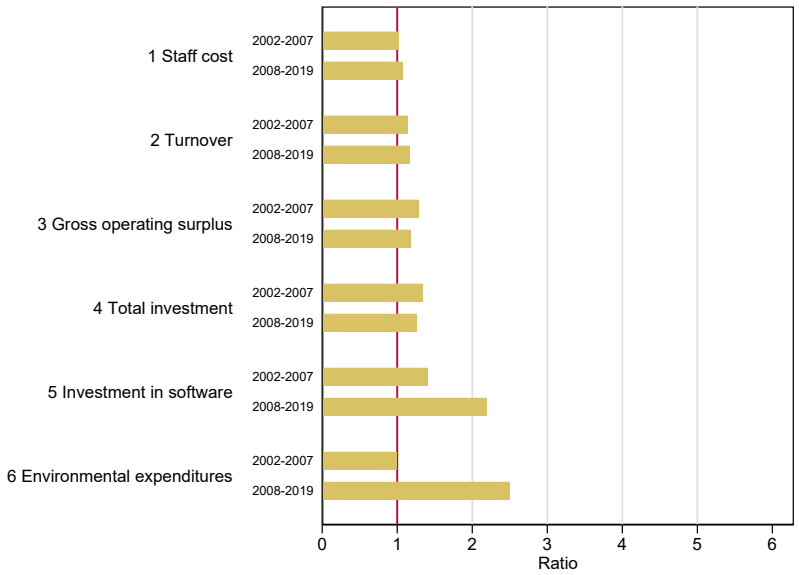
Source: Statistik Austria; own calculations.

Figure A.22: Shares (average 2002-2019)



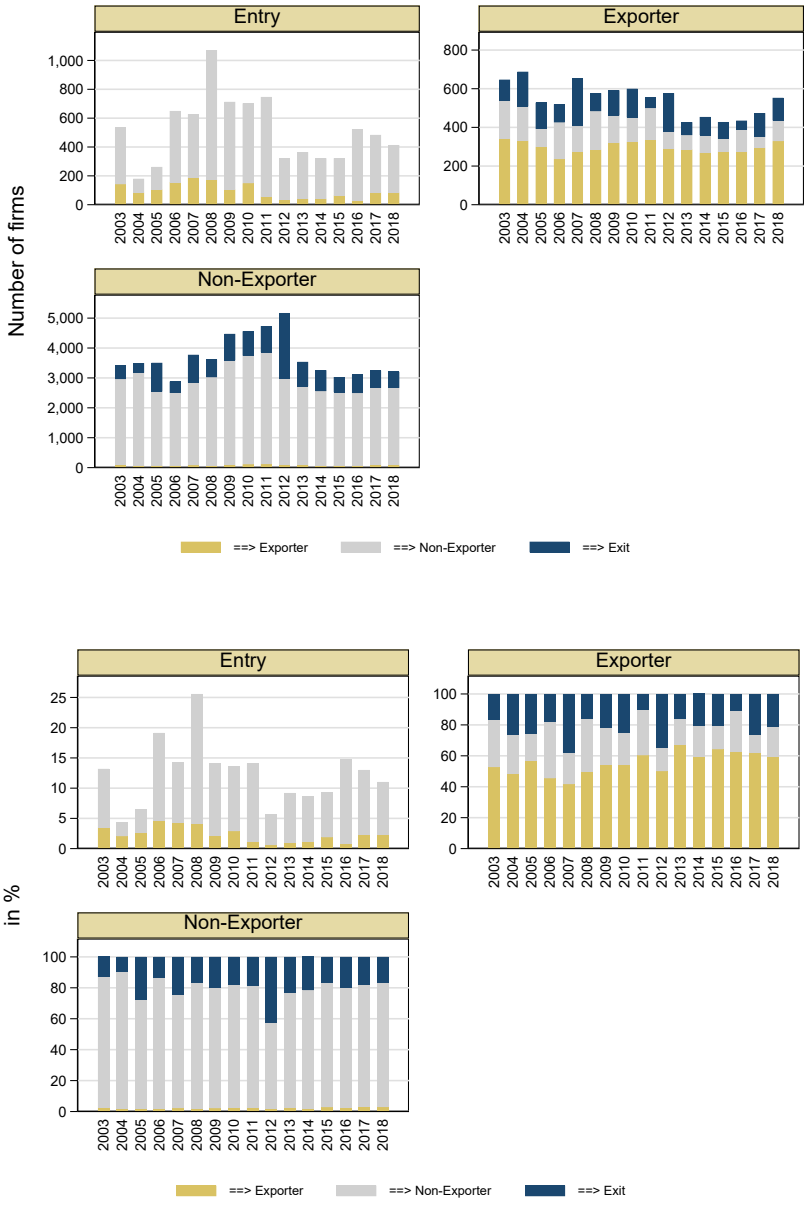
Source: Statistik Austria; own calculations.

Figure A.23: Performance ratios (per hour worked)



Source: Statistik Austria; own calculations.

Figure A.24: Entry, exit and status transitions



Source: Statistik Austria; own calculations.

B Selected results by detailed manufacturing industries

B.1 Manufacturing by NACE* (2002-2019)

Table B.1: Export participation (average 2002-2019)

		Number			Shares			Export
NACE		Total	Exporter	Non-exp.	Total	Exporter	Non-exp.	part.
C10tC12	Food, beverages, tobacco	953.4	379.1	574.3	17.1	10.4	29.9	40.6
C13tC15	Textiles, apparel, leather	214.1	191.6	22.4	3.8	5.3	1.2	89.9
C16	Wood and wood products	518.4	326.2	192.3	9.4	9.0	10.0	63.1
C17	Paper and paper products	82.1	77.2	4.8	1.5	2.1	0.3	94.1
C18	Printing	282.8	199.1	83.7	5.0	5.5	4.4	71.0
C20tC21	Chemicals and pharmaceuticals	133.6	126.2	7.4	2.4	3.5	0.4	94.6
C22	Rubber and plastics	219.3	197.7	21.7	4.0	5.4	1.1	90.1
C23	Mineral products	386.2	161.9	224.3	7.0	4.5	11.7	42.5
C24	Basic metals	90.4	88.9	1.5	1.6	2.4	0.1	98.4
C25	Fabricated metals	989.9	615.2	374.8	17.8	16.9	19.5	62.4
C26tC28	Electrical, electronic, machinery	742.7	686.4	56.3	13.5	18.9	2.9	92.4
C29tC30	Transport equipment	118.1	107.1	10.9	2.1	3.0	0.6	90.8
C31tC33	Other	818.8	472.9	345.9	14.7	13.0	18.0	58.2

Source: Statistik Austria; own calculations.

Table B.2: Export intensity

		2002			2008			2019	
NACE	Description	Top05	Top10	Top25	Top05	Top10	Top25	Top05	Top10	Top25
C10tC12	Food, beverages, tobacco	52.7	70.7	91.7	67.2	79.7	94.1	63.0	75.6	92.9
C13tC15	Textiles, apparel, leather	55.7	72.1	89.7	51.6	71.4	86.9	43.2	62.1	86.6
C16	Wood and wood products	60.5	77.4	93.2	61.3	76.4	92.9	57.2	75.3	92.2
C17	Paper and paper products	36.4	55.5	85.5	34.3	52.9	81.5	26.0	45.9	76.2
C18	Printing	80.9	88.3	96.1	85.2	92.2	97.5	70.0	79.4	93.1
C20tC21	Chemicals and pharmaceuticals	52.0	68.3	86.7	61.9	76.4	91.3	68.6	78.1	91.4
C22	Rubber and plastics	42.8	64.9	86.4	44.5	64.3	85.5	48.3	66.6	86.7
C23	Mineral products	65.7	77.4	93.0	61.6	76.7	91.8	53.8	71.7	91.0
C24	Basic metals	34.3	48.7	76.3	31.2	51.6	78.1	36.6	53.0	78.7
C25	Fabricated metals	57.7	73.3	92.8	63.6	77.3	93.7	63.3	75.6	90.9
C26tC28	Electrical, electronic, machinery	52.6	68.4	88.4	49.6	65.4	86.1	52.6	69.1	87.0
C29tC30	Transport equipment	55.9	75.1	93.6	62.0	77.4	92.0	61.7	76.9	91.1
C31tC33	Other	53.4	72.7	92.6	70.2	82.6	94.6	64.3	80.7	93.7

Source: Statistik Austria; own calculations.

Table B.3: Size ratios by industry (annual averages 2002-2019)

NACE	Description	Persons employed	Hours worked	Staff costs	Turn-over
C10tC12	Food, beverages, tobacco	2.8	3.0	4.4	8.9
C13tC15	Textiles, apparel, leather	2.8	3.0	3.5	3.5
C16	Wood and wood products	2.7	2.8	3.5	5.3
C17	Paper and paper products	2.4	2.4	3.1	3.2
C18	Printing	1.9	1.8	1.8	2.6
C20tC21	Chemicals and pharmaceuticals	1.6	1.6	1.8	4.3
C22	Rubber and plastics	1.7	1.6	2.0	2.3
C23	Mineral products	3.8	3.5	4.2	3.2
C24	Basic metals	9.8	9.4	12.6	25.2
C25	Fabricated metals	2.5	2.5	3.0	3.6
C26tC28	Electrical, electronic, machinery	3.3	3.2	4.1	5.6
C29tC30	Transport equipment	2.2	2.1	2.0	2.2
C31tC33	Other	2.9	2.9	3.9	5.3

			Investment		
NACE	Description	GOS	Total	Software	Environmenat
C10tC12	Food, beverages, tobacco	8.2	6.9	16.1	27.2
C13tC15	Textiles, apparel, leather	9.5	5.1	10.1	22.0
C16	Wood and wood products	5.0	5.2	5.9	9.5
C17	Paper and paper products	7.6	6.1	18.0	18.0
C18	Printing	3.3	2.5	4.6	4.6
C20tC21	Chemicals and pharmaceuticals	6.9	8.1	17.2	44.3
C22	Rubber and plastics	1.5	1.3	2.7	1.4
C23	Mineral products	3.4	4.0	4.7	10.6
C24	Basic metals	31.1	26.9	20.0	364.4
C25	Fabricated metals	3.6	4.6	5.6	4.6
C26tC28	Electrical, electronic, machinery	5.2	4.9	4.8	16.6
C29tC30	Transport equipment	2.8	4.8	6.1	20.1
C31tC33	Other	4.9	4.5	6.2	9.8

Source: Statistik Austria; own calculations.

Table B.4: Importance measures (annual averages 2002-2019)

NACE	Description	Firms	Persons employed	Hours worked	Staff costs	Turn-over
C10tC12	Food, beverages, tobacco	40.6	64.8	66.6	74.4	85.4
C13tC15	Textiles, apparel, leather	89.9	96.1	96.4	96.9	96.6
C16	Wood and wood products	63.1	82.4	82.7	85.6	89.9
C17	Paper and paper products	94.1	96.7	96.7	97.0	96.6
C18	Printing	71.0	82.1	81.8	81.6	86.1
C20tC21	Chemicals and pharmaceuticals	94.6	96.4	96.4	96.2	98.5
C22	Rubber and plastics	90.1	93.8	93.6	94.9	95.4
C23	Mineral products	42.5	73.1	71.6	75.1	69.8
C24	Basic metals	98.4	100.0	100.0	100.0	100.0
C25	Fabricated metals	62.4	80.4	80.8	83.4	85.3
C26tC28	Electrical, electronic, machinery	92.4	97.4	97.3	97.8	98.4
C29tC30	Transport equipment	90.8	95.2	95.1	95.0	94.0
C31tC33	Other	58.2	79.6	79.8	83.7	87.3

					Investment	
NACE	Description	Firms	GOS	ISACH	SOFTW	UTAB01
C10tC12	Food, beverages, tobacco	40.6	83.5	81.8	87.9	93.0
C13tC15	Textiles, apparel, leather	89.9	97.6	97.2	96.8	98.5
C16	Wood and wood products	63.1	89.0	89.0	88.7	92.6
C17	Paper and paper products	94.1	97.8	96.7	92.9	97.9
C18	Printing	71.0	88.4	84.2	90.1	89.3
C20tC21	Chemicals and pharmaceuticals	94.6	97.2	96.0	97.3	98.9
C22	Rubber and plastics	90.1	92.7	91.1	93.5	92.8
C23	Mineral products	42.5	70.6	73.9	73.2	84.6
C24	Basic metals	98.4	100.0	100.0	100.0	100.0
C25	Fabricated metals	62.4	85.0	87.5	87.6	87.3
C26tC28	Electrical, electronic, machinery	92.4	98.0	98.0	98.1	98.9
C29tC30	Transport equipment	90.8	95.1	96.2	84.2	97.9
C31tC33	Other	58.2	85.3	85.5	87.9	89.3

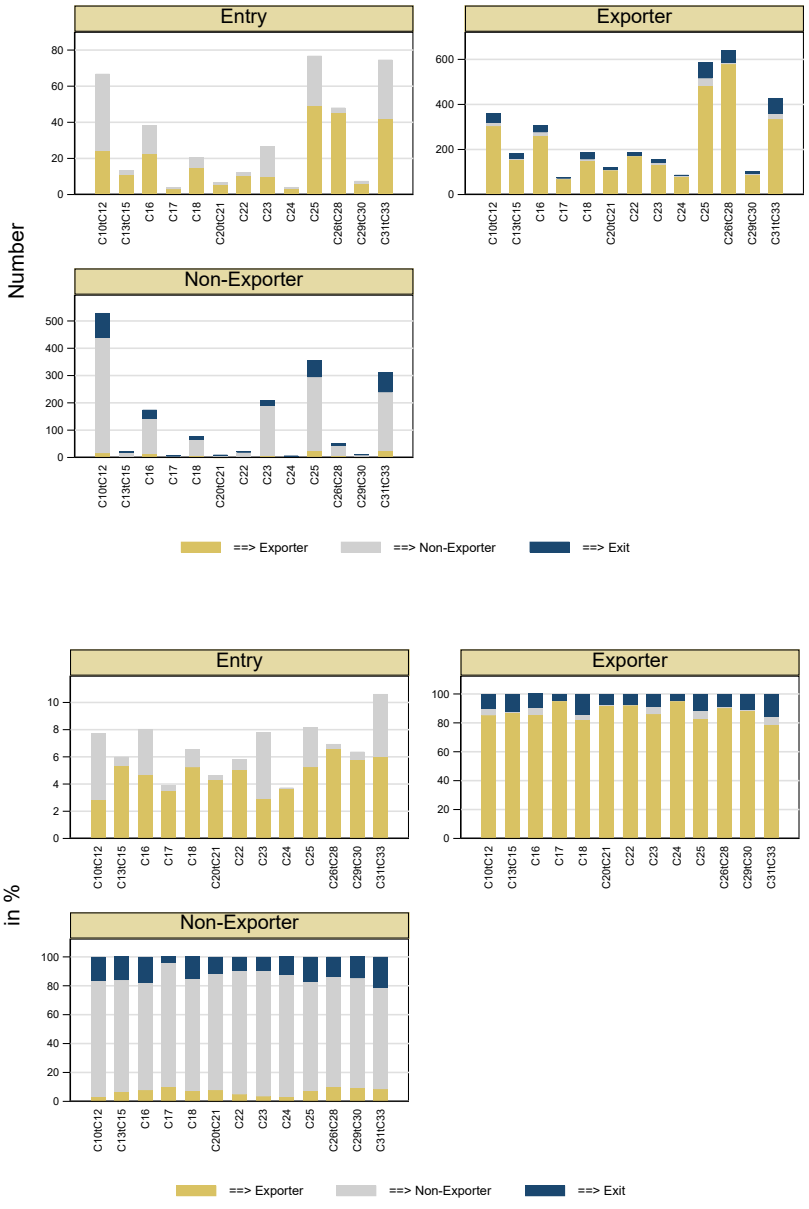
Source: Statistik Austria; own calculations.

Table B.5: Relative performance measures

NACE	Description	Staff costs	Turn-over	GOS	Investment Total	Investment Software	Investment Environment
C10tC12	Food, beverages, tobacco	1.4	2.8	2.7	2.4	5.7	6.4
C13tC15	Textiles, apparel, leather	1.2	1.4	2.3	1.7	4.3	4.1
C16	Wood and wood products	1.2	1.7	1.5	2.1	1.4	2.0
C17	Paper and paper products	1.1	1.9	3.5	1.7	5.6	4.2
C18	Printing	1.0	1.1	1.2	1.5	1.7	1.4
C20tC21	Chemicals and pharmaceuticals	1.2	3.7	3.8	3.7	19.2	38.9
C22	Rubber and plastics	1.1	1.2	1.4	1.8	1.3	1.3
C23	Mineral products	1.1	0.7	0.8	1.1	1.6	2.7
C24	Basic metals	1.2	2.4	2.5	1.8	1.9	6.6
C25	Fabricated metals	1.1	1.3	1.4	1.6	1.9	3.0
C26tC28	Electrical, electronic, machinery	1.1	1.3	1.3	1.5	1.7	2.5
C29tC30	Transport equipment	1.1	1.4	1.1	2.2	4.0	2.8
C31tC33	Other	1.2	1.4	1.4	1.4	2.7	1.9

Source: Statistik Austria; own calculations.

Figure B.1: Markow transitions (averages 2002-2018)



Source: Statistik Austria; own calculations.

B.2 Manufacturing by NACE Rev. 2 (2008-2019)

Table B.6: Export participation (annual averages 2008-2019)

		Number			Shares			Export
NACE		Total	Exporter	Non-exp.	Total	Exporter	Non-exp.	part.
10	Food	813.1	334.9	478.2	15.1	9.4	26.7	41.4
11	Beverages	66.0	49.3	16.7	1.2	1.4	0.9	74.7
12	Tobacco	0.3	1.0	0.0	0.0	0.0	0.0	100.0
13	Textiles	115.9	108.8	7.2	2.2	3.0	0.4	94.0
14	Wearing apparel	55.2	47.7	7.5	1.0	1.3	0.4	86.4
15	Leather	23.2	20.3	2.8	0.4	0.6	0.2	88.1
16	Wood	510.8	330.0	180.8	9.5	9.2	10.1	64.8
17	Paper	82.3	78.9	3.4	1.5	2.2	0.2	95.8
18	Printing	214.4	152.9	61.5	4.0	4.3	3.4	71.8
19	Coke	2.9	1.8	1.2	0.1	0.0	0.1	60.4
20	Chemicals	103.1	98.8	4.3	1.9	2.8	0.2	95.9
21	Pharmaceuticals	32.5	29.7	2.8	0.6	0.8	0.2	91.4
22	Rubber and plastics	219.5	197.2	22.3	4.1	5.5	1.2	89.8
23	Non-metallic	411.4	157.8	253.7	7.7	4.4	14.1	38.5
24	Basic metals	88.7	87.5	1.2	1.7	2.4	0.1	98.7
25	Fabricated metas	997.1	625.4	371.7	18.5	17.5	20.7	63.2
26	Computer etc.	120.0	115.8	4.3	2.2	3.2	0.2	96.5
27	Electrical	155.9	138.6	17.3	2.9	3.9	1.0	88.9
28	Machinery and equipment	459.3	432.8	26.6	8.6	12.1	1.5	94.2
29	Motor vehicles	95.7	86.9	8.8	1.8	2.4	0.5	91.0
30	Other transport equipment	25.1	23.2	1.9	0.5	0.6	0.1	92.4
31	Furniture	366.8	185.9	180.8	6.8	5.2	10.1	51.2
32	Other transport equipment	142.5	97.0	45.5	2.7	2.7	2.5	68.5
33	Repair	271.9	178.9	93.0	5.1	5.0	5.2	65.5

Source: Statistik Austria; own calculations.

Table B.7: Export intensity (annual averages 2008-2019)

		2008			2019		
NACE	Description	Top05	Top10	Top25	Top05	Top10	Top25
10	Food	76.7	91.7	99.7	66.1	86.2	99.2
11	Beverages	93.9	96.5	98.9	93.6	96.2	99.1
12	Tobacco	.	.	.	.	.	.
13	Textiles	45.1	62.5	82.5	44.5	63.9	87.2
14	Wearing apparel	64.5	80.0	91.0	19.2	53.1	86.6
15	Leather	27.6	46.7	88.3	0.0	24.6	82.6
16	Wood	70.6	85.8	96.5	68.0	84.3	96.2
17	Paper	34.3	52.9	82.8	26.0	45.9	78.0
18	Printing	89.4	94.8	98.7	73.9	83.9	96.3
19	Coke	.	.	.	.	.	.
20	Chemicals	61.4	74.4	90.9	74.3	82.1	92.3
21	Pharmaceuticals	46.2	73.3	95.3	40.9	65.2	87.7
22	Rubber and plastics	47.6	66.5	87.4	50.6	69.0	88.5
23	Non-metallic	81.9	92.1	99.5	75.8	90.6	99.3
24	Basic metals	31.2	51.6	78.1	36.6	53.0	78.7
25	Fabricated metals	73.8	87.3	98.2	69.2	81.4	95.4
26	Computer etc.	56.7	70.3	87.0	66.2	77.2	89.1
27	Electrical	46.1	69.0	89.9	44.0	66.6	88.2
28	Machinery and equipment	47.8	63.9	86.3	51.0	66.7	86.4
29	Motor vehicles	66.5	80.0	93.7	64.0	79.6	91.6
30	Other transport equipment	31.2	60.6	90.0	38.0	72.2	92.4
31	Furniture	80.1	89.8	98.3	70.2	84.8	97.7
32	Other transport equipment	69.1	82.9	97.4	66.5	85.1	97.0
33	Repair	83.2	91.7	98.7	72.6	85.8	96.9

Source: Statistik Austria; own calculations.

Table B.8: Size ratios by industry (annual averages 2008-2019)

NACE	Description	Persons employed	Hours worked	Staff costs	Turn-over
10	Food	2.6	2.9	4.3	9.3
11	Beverages	1.2	1.2	1.2	2.9
12	Tobacco	.	.	.	.
13	Textiles	2.0	2.1	2.6	3.2
14	Wearing apparel	3.6	4.0	5.1	6.2
15	Leather	4.7	5.0	4.8	2.6
16	Wood	2.7	2.8	3.5	4.9
17	Paper	2.7	2.7	3.7	3.5
18	Printing	1.9	1.8	1.8	2.4
19	Coke	.	.	.	.
20	Chemicals	0.9	0.9	1.2	2.9
21	Pharmaceuticals	6.4	7.2	9.6	20.7
22	Rubber and plastics	1.6	1.6	2.0	2.2
23	Non-metallic	4.2	3.9	4.7	3.4
24	Basic metals	.	.	.	.
25	Fabricated metals	2.5	2.6	3.1	3.6
26	Computer etc.	4.5	4.5	6.0	9.0
27	Electrical	5.3	5.1	7.0	8.9
28	Machinery and equipment	3.3	3.2	3.9	5.8
29	Motor vehicles	4.5	4.8	6.5	11.7
30	Other transport equipment	0.4	0.4	0.5	0.4
31	Furniture	2.4	2.3	2.9	3.1
32	Other transport equipment	2.7	2.7	3.9	8.9
33	Repair	2.8	2.9	3.3	3.4

			Investment		
NACE	Description	GOS	Total	Software	Environment
10	Food	7.8	7.1	14.9	27.7
11	Beverages	4.1	1.9	14.5	14.7
12	Tobacco	.	.	.	.
13	Textiles	-13.1	9.0	5.1	13.3
14	Wearing apparel	147.5	6.1	36.0	2.9
15	Leather	3.9	11.3	27.8	213.8
16	Wood	4.6	4.7	5.1	8.5
17	Paper	8.1	6.5	12.2	24.3
18	Printing	3.0	2.7	5.0	3.9
19	Coke	.	.	.	.
20	Chemicals	1.4	3.5	91.4	14.2
21	Pharmaceuticals	31.4	85.0	60.7	148.7
22	Rubber and plastics	1.4	1.4	2.9	1.4
23	Non-metallic	3.4	4.3	5.4	12.3
24	Basic metals	.	.	.	.
25	Fabricated metals	3.8	5.1	6.7	4.9
26	Computer etc.	5.8	9.8	7.9	17.9
27	Electrical	8.3	8.4	5.0	22.4
28	Machinery and equipment	5.9	4.9	9.6	18.6
29	Motor vehicles	14.3	16.4	25.9	8.3
30	Other transport equipment	0.3	0.5	0.9	5.9
31	Furniture	2.3	2.7	4.6	7.3
32	Other transport equipment	7.1	5.7	26.3	7.5
33	Repair	3.1	4.2	4.0	18.8

Source: Statistik Austria; own calculations.

Table B.9: Importance measures (annual averages 2008-2019)

NACE	Description	Firms	Persons employed	Hours worked	Staff costs	Turn-over
10	Food	41.4	65.1	67.2	75.4	86.8
11	Beverages	74.7	77.4	77.4	78.2	88.7
12	Tobacco	100.0	.	.	.	.
13	Textiles	94.0	96.8	97.1	97.6	98.1
14	Wearing apparel	86.4	95.6	96.1	96.8	96.9
15	Leather	88.1	98.3	98.4	98.4	97.1
16	Wood	64.8	83.3	83.5	86.4	89.8
17	Paper	95.8	98.1	98.1	98.4	98.1
18	Printing	71.8	82.7	82.3	82.2	85.7
19	Coke	60.4	100.0	100.0	100.0	100.0
20	Chemicals	95.9	94.3	94.1	93.2	98.3
21	Pharmaceuticals	91.4	98.6	98.7	99.0	99.5
22	Rubber and plastics	89.8	93.5	93.2	94.7	95.0
23	Non-metallic	38.5	72.5	71.1	74.6	68.1
24	Basic metals	98.7	100.0	100.0	100.0	100.0
25	Fabricated metals	63.2	81.0	81.4	83.9	86.0
26	Computer etc.	96.5	99.2	99.2	99.4	99.6
27	Electrical	88.9	97.6	97.6	98.2	98.6
28	Machinery and equipment	94.2	98.0	97.9	98.2	98.8
29	Motor vehicles	91.0	97.8	98.0	98.5	98.2
30	Other transport equipment	92.4	92.1	92.3	92.8	90.5
31	Furniture	51.2	71.0	70.7	74.8	76.2
32	Other transport equipment	68.5	85.2	85.5	89.4	94.9
33	Repair	65.5	83.1	83.7	84.4	84.9

				Investment		
NACE	Description	Firms	GOS	Total	Software	Environment
10	Food	41.4	84.6	83.0	90.8	94.9
11	Beverages	74.7	89.3	83.8	93.7	96.5
12	Tobacco	100.0	.	.	.	.
13	Textiles	94.0	97.5	98.7	96.3	99.0
14	Wearing apparel	86.4	98.1	95.1	96.1	93.1
15	Leather	88.1	97.5	99.1	99.9	99.9
16	Wood	64.8	88.7	88.8	89.1	92.4
17	Paper	95.8	99.0	98.8	95.8	98.9
18	Printing	71.8	88.0	85.1	90.9	89.6
19	Coke	60.4	100.0	100.0	100.0	100.0
20	Chemicals	95.9	94.4	93.2	96.4	98.1
21	Pharmaceuticals	91.4	99.7	98.4	99.5	100.0
22	Rubber and plastics	89.8	92.1	92.0	92.8	92.2
23	Non-metallic	38.5	66.9	72.3	73.0	86.7
24	Basic metals	98.7	100.0	100.0	100.0	100.0
25	Fabricated metals	63.2	86.1	88.9	91.8	89.0
26	Computer etc.	96.5	99.3	99.4	98.8	99.8
27	Electrical	88.9	98.4	98.3	96.2	99.4
28	Machinery and equipment	94.2	98.7	98.6	99.2	99.5
29	Motor vehicles	91.0	99.7	99.3	99.4	98.7
30	Other transport equipment	92.4	86.6	88.7	79.3	95.4
31	Furniture	51.2	70.5	73.1	82.1	88.1
32	Other transport equipment	68.5	93.4	91.8	98.0	93.6
33	Repair	65.5	78.9	87.6	80.7	92.4

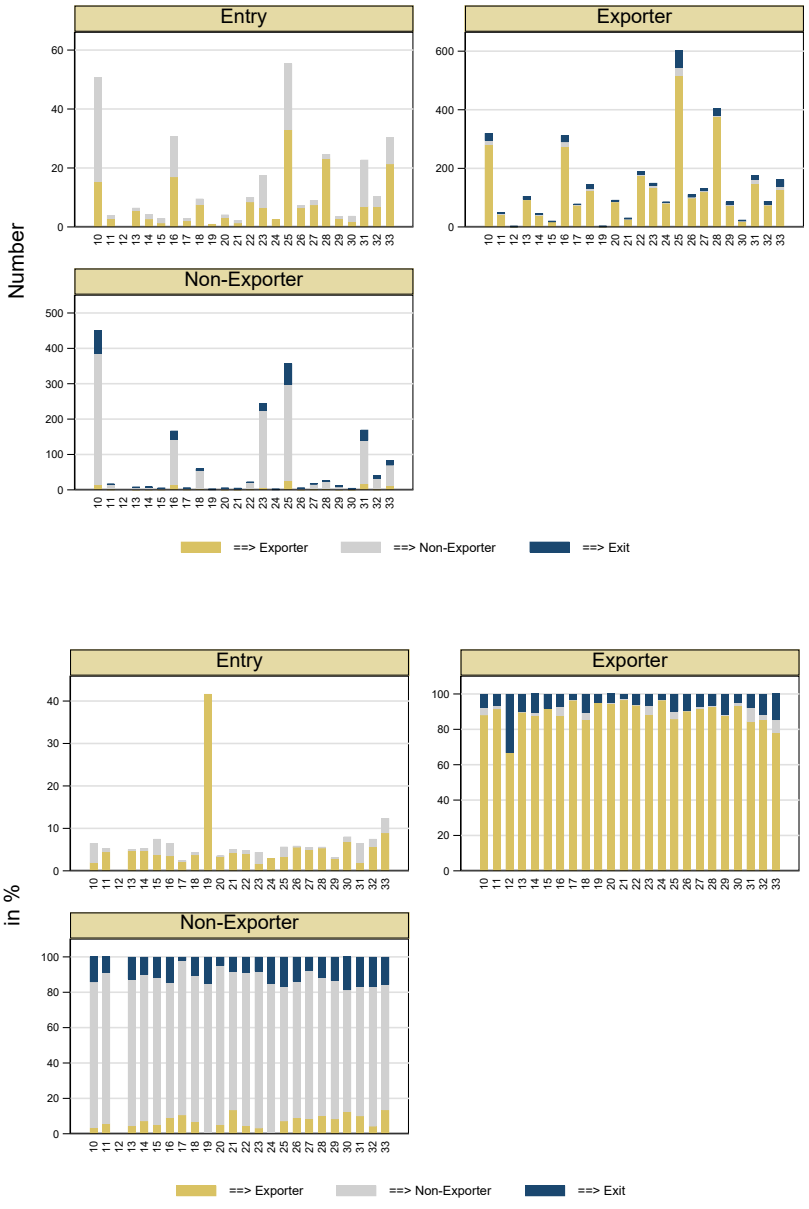
Source: Statistik Austria; own calculations.

Table B.10: Relative performance measures (annual averages 2008-2019)

NACE	Description	Staff costs	Turn-over	GOS	Investment Total	Investment Software	Investment Environment
10	Food	1.4	2.7	2.3	2.3	5.7	5.8
11	Beverages	1.1	2.6	2.7	1.2	4.6	4.3
12	Tobacco	.	.	.	.	.	.
13	Textiles	1.1	1.7	3.0	4.0	3.1	4.4
14	Wearing apparel	1.2	1.4	3.4	1.5	14.2	1.2
15	Leather	1.2	1.3	1.7	2.4	4.1	5.8
16	Wood	1.3	1.6	1.4	1.9	1.3	1.9
17	Paper	1.2	1.2	1.7	1.8	2.8	5.2
18	Printing	1.0	1.0	1.1	1.4	1.7	1.4
19	Coke	.	.	.	.	.	.
20	Chemicals	1.1	3.7	2.1	2.1	225.5	9.2
21	Pharmaceuticals	1.2	2.8	4.4	10.3	23.0	3.3
22	Rubber and plastics	1.2	1.2	1.4	2.2	1.3	1.4
23	Non-metallic	1.1	0.5	0.5	1.0	1.6	2.6
24	Basic metals	.	.	.	.	.	.
25	Fabricated metals	1.1	1.2	1.2	1.6	2.2	3.1
26	Computer etc.	1.2	1.5	2.2	1.1	1.8	0.8
27	Electrical	1.0	1.1	1.3	1.6	1.3	5.0
28	Machinery and equipment	1.2	1.5	2.4	1.4	2.6	2.9
29	Motor vehicles	1.2	1.5	5.0	3.0	7.8	1.7
30	Other transport equipment	1.1	0.9	0.9	1.2	6.0	0.3
31	Furniture	1.2	1.1	1.0	1.1	1.7	1.6
32	Other transport equipment	1.3	2.2	1.8	2.0	10.3	1.6
33	Repair	1.1	1.1	1.0	1.2	1.7	2.6

Source: Statistik Austria; own calculations.

Figure B.2: Entry, exit and status transitions by industries (annual averages 2008-2019)



Source: Statistik Austria; own calculations.

C Additional econometric results

Results from fixed effects estimations (2008-2019)

Table C.1: Size premium: Panel FE (2008-2019)

	(1) Persons employed	(2) Hours worked	(3) Staff costs	(4) Turn-over	(5) GOS	(6) Total	(7) Investment Software	(8) Environmental
EXPstatus	0.037***	0.041***	0.056***	0.054***	0.043**	0.111***	-0.024	0.034
	(0.005)	(0.005)	(0.006)	(0.006)	(0.018)	(0.024)	(0.049)	(0.025)
Constant	3.679***	11.052***	7.408***	8.774***	6.451***	4.996***	2.617***	3.058***
	(0.003)	(0.004)	(0.004)	(0.004)	(0.013)	(0.017)	(0.039)	(0.020)
Observations	64,184	64,077	64,101	64,482	55,507	61,988	25,391	21,802
Number of i	8,812	8,771	8,778	8,859	8,444	8,627	5,698	4,059
r2_o	0.113	0.115	0.148	0.165	0.132	0.105	0.0767	0.103
F	65.14	62.85	96.42	75.24	5.593	21.72	0.250	1.870

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

	(1) Persons employed	(2) Hours worked	(3) Staff costs	(4) Turn-over	(5) GOS	(6) Total	(7) Investment Software	(8) Environmental
EXPint	0.302***	0.303***	0.448***	0.529***	0.551***	0.281***	0.364***	0.227***
	(0.010)	(0.011)	(0.013)	(0.014)	(0.044)	(0.054)	(0.092)	(0.051)
Constant	3.625***	10.999***	7.324***	8.666***	6.329***	4.993***	2.464***	3.001***
	(0.003)	(0.003)	(0.004)	(0.004)	(0.013)	(0.016)	(0.035)	(0.019)
Observations	63,770	63,681	63,694	64,056	55,158	61,605	25,243	21,760
Number of i	8,699	8,666	8,669	8,745	8,341	8,523	5,643	4,045
r2_o	0.232	0.231	0.277	0.310	0.256	0.176	0.150	0.181
F	870.8	706.8	1242	1479	160.3	27.25	15.76	20.22

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table C.2: Performance (hours worked) premium: Panel FE (2008-2019)

	(1) Staff costs	(2) Turn-over	(3) GOS	(4) Total	(5) Investment Software	(6) Environment
EXPstatus	0.016***	0.012**	-0.002	0.068***	-0.072	-0.015
	(0.004)	(0.005)	(0.018)	(0.023)	(0.048)	(0.024)
Constant	-3.644***	-2.272***	-4.595***	-6.081***	-8.942***	-8.430***
	(0.003)	(0.004)	(0.013)	(0.016)	(0.039)	(0.019)
Observations	64,077	64,077	55,181	61,786	25,370	21,782
Number of i	8,771	8,771	8,368	8,582	5,692	4,056
r2_o	0.113	0.0582	0.0234	0.0255	0.00198	0.0122
F	17.45	5.964	0.0121	8.349	2.219	0.356

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

	(1) Staff costs	(2) Turn-over	(3) GOS	(4) Total	(5) Investment Software	(6) Environment
EXPint	0.146***	0.227***	0.261***	-0.015	0.030	-0.035
	(0.008)	(0.011)	(0.043)	(0.053)	(0.091)	(0.049)
Constant	-3.675***	-2.330***	-4.672***	-6.034***	-9.013***	-8.428***
	(0.002)	(0.003)	(0.013)	(0.016)	(0.035)	(0.019)
Observations	63,681	63,681	54,854	61,416	25,226	21,740
Number of i	8,666	8,666	8,273	8,483	5,637	4,042
r2_o	0.162	0.0936	0.0420	0.0280	0.00261	0.0105
F	306.5	397.0	36.32	0.0853	0.112	0.494

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Results over longer period 2002-2019

Results from OLS regressions

Table C.3: Size premium: OLS (2002-2019)

	(1) Persons employed	(2) Hours worked	(3) Staff costs	(4) Turn-over	(5) GOS	(6) Total	(7) Investment Software	(8) Environmental
EXPstatus	0.622***	0.644***	0.828***	1.051***	1.044***	1.184***	0.819***	1.262***
	(0.007)	(0.008)	(0.008)	(0.009)	(0.012)	(0.013)	(0.020)	(0.024)
Constant	4.206***	11.573***	7.894***	9.210***	8.533***	5.500***	3.951***	8.398***
	(0.028)	(0.028)	(0.031)	(0.034)	(0.195)	(0.049)	(0.266)	(0.365)
Observations	99,659	99,537	99,570	99,957	86,132	95,628	40,142	29,533
R-squared	0.228	0.230	0.280	0.297	0.240	0.194	0.115	0.276
F	2105	2119	2760	3014	1941	1639	372.1	802.4

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

	(1) Persons employed	(2) Hours worked	(3) Staff costs	(4) Turn-over	(5) GOS	(6) Total	(7) Investment Software	(8) Environmental
EXPint	1.393***	1.415***	1.749***	2.144***	2.229***	2.271***	1.530***	2.087***
	(0.011)	(0.011)	(0.012)	(0.013)	(0.017)	(0.020)	(0.025)	(0.030)
Constant	4.096***	10.742	7.798***	9.116***	8.954***	5.464***	4.373***	9.352***
	(0.026)	(3,173.590)	(0.029)	(0.032)	(0.188)	(0.047)	(0.259)	(0.352)
Observations	96,818	96,722	96,736	97,104	83,723	92,985	39,172	29,134
R-squared	0.299	0.296	0.353	0.379	0.311	0.237	0.158	0.326
F	2943	2711	3769	4234	2705	2064	523.1	1006

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table C.4: Performance (hours worked) premium: OLS (2002-2019)

	(1) Staff costs	(2) Turn-over	(3) GOS	(4) Total	(5) Investment Software	(6) Environmental
EXPstatus	0.183***	0.407***	0.389***	0.539***	0.026	0.398***
	(0.002)	(0.005)	(0.009)	(0.010)	(0.017)	(0.017)
Constant	-3.679***	-2.363***	-3.135***	-6.089***	-9.180***	-7.922***
	(0.008)	(0.018)	(0.148)	(0.038)	(0.051)	(0.044)
Observations	99,537	99,537	85,792	95,413	40,115	29,511
R-squared	0.255	0.159	0.069	0.069	0.013	0.208
F	2431	1343	455.2	507.5	38.55	553.6

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

	(1) Staff costs	(2) Turn-over	(3) GOS	(4) Total	(5) Investment Software	(6) Environmental
EXPint	0.333***	0.728***	0.777***	0.852***	0.080***	0.518***
	(0.003)	(0.007)	(0.014)	(0.016)	(0.022)	(0.021)
Constant	-3.836	-2.619	-4.817***	-6.392	-9.200***	-7.847***
	(957.029)	(2,073.264)	(0.032)	(5,436.007)	(0.050)	(0.043)
Observations	96,722	96,722	83,412	92,790	39,153	29,113
R-squared	0.286	0.186	0.085	0.073	0.013	0.210
F	2577	1469	553.1	487.3	37.24	554.1

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Results from fixed effects estimations - 2002-2019

Table C.5: Size premium: Panel FE (2002-2019)

	(1) Persons employed	(2) Hours worked	(3) Staff costs	(4) Turn-over	(5) GOS	(6) Total	(7) Investment Software	(8) Environmental
EXPstatus	0.024***	0.035***	0.035***	0.044***	0.029**	0.089***	-0.006	0.021
	(0.004)	(0.004)	(0.005)	(0.005)	(0.014)	(0.018)	(0.036)	(0.023)
Constant	3.673***	11.042***	7.313***	8.628***	6.353***	4.909***	2.543***	3.055***
	(0.003)	(0.003)	(0.003)	(0.004)	(0.010)	(0.012)	(0.028)	(0.018)
Observations	99,659	99,537	99,570	99,957	86,132	95,628	40,142	29,533
Number of i	12,157	12,116	12,123	12,204	11,577	11,833	8,171	5,236
r2_o	0.118	0.120	0.154	0.175	0.141	0.110	0.0700	0.104
F	40.47	69.08	49.53	70.04	4.162	24.12	0.0301	0.854

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

	(1) Persons employed	(2) Hours worked	(3) Staff costs	(4) Turn-over	(5) GOS	(6) Total	(7) Investment Software	(8) Environmental
EXPint	0.374***	0.377***	0.590***	0.711***	0.711***	0.431***	0.354***	0.399***
	(0.009)	(0.010)	(0.011)	(0.012)	(0.035)	(0.043)	(0.071)	(0.046)
Constant	3.614***	10.988***	7.208***	8.497***	6.204***	4.870***	2.428***	2.943***
	(0.002)	(0.003)	(0.003)	(0.003)	(0.010)	(0.012)	(0.026)	(0.017)
Observations	96,818	96,722	96,736	97,104	83,723	92,985	39,172	29,134
Number of i	11,506	11,474	11,476	11,552	10,991	11,223	7,877	5,093
r2_o	0.240	0.239	0.282	0.312	0.259	0.181	0.137	0.180
F	1813	1539	2762	3455	422.2	101.3	25.00	76.10

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table C.6: Performance (hours worked) premium: Panel FE (2002-2019)

	(1) Staff costs	(2) Turn-over	(3) GOS	(4) Total	(5) Investment Software	(6) Environmental
EXPstatus	-0.000	0.009**	-0.006	0.053***	-0.041	-0.032
	(0.003)	(0.004)	(0.014)	(0.018)	(0.036)	(0.023)
Constant	-3.729***	-2.411***	-4.694***	-6.162***	-8.972***	-8.445***
	(0.002)	(0.003)	(0.009)	(0.012)	(0.028)	(0.018)
Observations	99,537	99,537	85,792	95,413	40,115	29,511
Number of i	12,116	12,116	11,500	11,787	8,163	5,233
r2_o	0.112	0.0820	0.0338	0.0302	0.000297	0.0118
F	0.000756	5.226	0.211	8.742	1.311	2.058

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

	(1) Staff costs	(2) Turn-over	(3) GOS	(4) Total	(5) Investment Software	(6) Environmental
EXPint	0.212***	0.336***	0.332***	0.057	-0.059	0.097**
	(0.007)	(0.010)	(0.034)	(0.042)	(0.070)	(0.045)
Constant	-3.780***	-2.490***	-4.790***	-6.146***	-8.995***	-8.503***
	(0.002)	(0.003)	(0.010)	(0.012)	(0.026)	(0.017)
Observations	96,722	96,722	83,412	92,790	39,153	29,113
Number of i	11,474	11,474	10,923	11,183	7,871	5,090
r2_o	0.152	0.116	0.0523	0.0340	0.000351	0.0109
F	845.2	1206	94.72	1.823	0.708	4.678

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Productivity and exporting

Table C.7: Productivity and exporting (2002-2019)

VARIABLES	(1) EXPint	(2) EXPint	(3) EXPint	(4) EXPint	(5) EXPint	(6) EXPint
Staff costs$_{t-3}$	0.033***					
	(0.002)					
Turnover$_{t-3}$		0.022***				
		(0.001)				
GOS$_{t-3}$			0.000			
			(0.000)			
Total investment$_{t-3}$				0.000		
				(0.000)		
Software investment$_{t-3}$					0.000	
					(0.000)	
Environmental$_{t-3}$						-0.000
						(0.001)
Constant	0.418***	0.348***	0.294***	0.300***	0.380***	0.391***
	(0.007)	(0.003)	(0.002)	(0.002)	(0.004)	(0.008)
Observations	66,027	66,027	57,968	63,928	28,563	20,543
Number of i	8,478	8,478	8,225	8,355	6,052	3,863
r2_o	0.147	0.114	0.0536	0.0318	0.00120	0.00962
F	346.6	280.2	0.443	0.752	0.814	0.162
p	0	0	0.506	0.386	0.367	0.688

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

	(1) Staff costs	(2) Turn-over	(3) GOS	(4) Total	(5) Investment Software	(6) Environmental
EXPint$_{t-3}$	0.214***	0.220***	0.104**	0.112**	-0.077	0.169***
	(0.008)	(0.011)	(0.042)	(0.052)	(0.087)	(0.048)
Constant	-3.714***	-2.384***	-4.701***	-6.137***	-9.070***	-8.505***
	(0.002)	(0.003)	(0.012)	(0.016)	(0.033)	(0.019)
Observations	64,750	64,750	56,068	62,619	27,323	22,605
Number of i	8,369	8,369	8,014	8,168	5,565	3,823
r2_o	0.166	0.122	0.0545	0.0374	0.00321	0.0107
F	692.7	409.3	6.109	4.611	0.800	12.30
p	0	0	0.0135	0.0318	0.371	0.000454

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: All performance variables are expressed per hour worked.