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by Holger Görg, Richard Kneller and Balázs Muraközy

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JEL classification: F12, F14

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Abstract

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1 Introduction

Firm level heterogeneity and its implications for globalization have dominated the research agenda of international economists over the last few years. Theoretical work includes Montagna (2001), Jean (2002), and Bernard et al. (2003), although the specific modelling approach of Melitz (2003) has received the greatest attention. On the empirical side, the literature has extensively documented different aspects of firm level heterogeneity and how it shapes firms' decisions to export.[1] Perhaps one of the most recent and promising extensions to this literature takes into account not only heterogeneity at the level of the firm, but also at the level of the product.

In this regard, the stylised facts set out by Bernard, Redding and Schott (2006a) and Bernard, Jensen, Redding and Schott (2008) are striking. US firms producing multiple products account for 90 percent of total output in manufacturing and among those firms, adding and dropping products is rife. Over 90 percent of US manufacturing firms add and/or drop a product over a given five-year interval. Of interest to international economists, Bernard, Jensen, Redding and Schott (2008) document that exporters that export more than one product represent 58 percent of the total number of exporters, but these account for 96 percent of total export value in US manufacturing.

This prevalence of multi-product firms and, more importantly, multi-product exporters raises a number of new and exciting questions. Some of the aspects related to the former have been asked by Bernard et al. (2006a): what are the implications of the prevalence of multi-product firms for the theory on the boundary of the firm? Why are some firms multi-product and others single-product? What are the implications for firm growth? Related questions arise when considering exporters: Why do some firms export one and others multiple products?

[1] For example, Bernard et al. (2008) show that there is substantial heterogeneity among firms that export and do not export in the US. Bernard and Jensen (2004) look more formally at what shapes export decisions at the firm level and Görg et al. (2008) examine how heterogeneity matters for the relationship between receipt of subsidies and exporting at the plant level. For a general review of the literature see Greenaway and Kneller (2007).

What types of products are added and dropped? Why are some products more successful than others, in terms of staying longer in the portfolio of exported products? How are these processes related to characteristics of the exporting firm? These gaps in our understanding of the export process form the starting point for this paper. We focus on the last set of questions and ask, specifically, what determines the success of export products, where success is defined as the duration over which products are retained in the export mix of the firm. To the best of our knowledge, this topic has not been explored in the literature.[2]

These questions are difficult to answer theoretically as well as empirically. Theory would have to combine heterogeneity in both firms and products. On the empirical side, data would have to be available not only on characteristics of the firm but also in a detailed manner on the products produced and exported by the firm. Such data are not easy to come by and are not widely available. One prominent example is the data for the US described in Bernard et al. (2008). In our paper we exploit a very detailed and unique dataset for Hungary, which is ideally suited for our purposes.

There are a number of reasons for expecting that Hungary would provide an interesting case study for this type of analysis. Between 1992 and 2003, the economy experienced a rapid transition from a planned to a market economy. This transformation was accompanied by rapid trade liberalization, exposing Hungarian firms to competition on international markets on a new scale. The pace of trade liberalization was similarly quick over the 1990s and early 2000s, until Hungary joined the EU on May 1st, 2004. Accession in the EU required Hungary to open its markets fully to competition from other member states.

The extent of the trade liberalisation that took place is shown clearly in Figure 1. After 1994 average tariffs decreased in a continuous way. Import tariffs for products coming from the

[2] A strand of literature in industrial organization examines product survival in general, see, e.g., Greenstein and Wade (1998) and Stavins (1995). There is also a somewhat related field in international economics examining the duration of imports (Besedes and Prusa, 2006a,b; Nitsch, 2007). This literature uses only information on imports of products, not at the firm-product level as in our paper. Also related is work by Greenaway et al. (2007) who consider industry switching as a strategy to survive the globalisation process

EU decreased from about 12% below 3% on average. In case of non-EU countries, the decrease was less substantial: from about 12% to 10%. The EU accession in 2003 led to further decrease in tariff rates from 2003 onwards.

[Figure 1 around here]

Trade liberalization and intensive restructuring led to a surge in foreign trade. Figure 2 illustrates the growing importance of international transactions for the Hungarian economy. The ratio of exports to GDP grew from around 30% in 1992 to more than 80% in 2003. This growth slowed down only after the turn of the century. In this context it is illuminating to study how firms adapted to this "natural experiment" of trade liberalization in their exporting behaviour and to examine what internationalisation strategies succeeded and which did not.

[Figure 2 around here]

Initial observation of the product data confirms that these aggregate data represent rapid turnover of products at the level of the firm. First, most of the firms in our sample produce a large number of products: the average was about 20 in 2003. The number of exported products has also increased markedly with time. Second, firms alter their mix of exported products in each year, with product additions being as common as product drops. As our data show, in 2003 roughly 75 percent of exporters added at least one product to their export mix, while 79 percent of firms dropped at least one product. Firms actively rearranged their product portfolio over the sample period; product addition or withdrawal is not an irreversible decision.

The theoretical paper by Bernard, Redding and Schott (2006b) provides a useful basis for our analysis. They examine the implications of trade liberalization for heterogeneous multi-product firms and their model draws a clear picture of firm-level adjustment to trade liberalization. In the model, firm productivity in a given product is decomposed into two factors: firm-level "ability" and firm-product-level "expertise", which are both stochastic and unknown before the entry cost is sunk. Higher firm-level ability means greater productivity across all products and a lower critical value, or cutoff, for product expertise, above which they export the product. Firms with high ability levels can therefore profitably produce and export a larger range of products than their low-ability counterparts. This suggests an endogenous ordering of products – as trade liberalization advances firms start to export products for which they have lower and lower expertise.

A second set of insights offered by Bernard, Redding and Schott concerns cross-industry differences in the response to trade liberalisation. Multi-product firms in comparative-advantage industries behave differently from firms in comparative-disadvantage industries. According to their analysis, firms in the comparative-advantage industries are (i) more likely to focus on their core competencies (and hence export a smaller number of products), (ii) have a higher critical value for firm-level ability and (iii) a larger increase in weighted-average productivity. These results imply significant differences in export dynamics between comparative-advantage and comparative-disadvantage industries.

We can use the model to motivate some empirical hypotheses on the firm level determinants of export product success. In the model, firm level productivity is an important determinant of export duration. On average, firms with greater ability (which have lower cutoff values for product expertise) export products that are further above the threshold productivity value. Hence, these products should have high duration in export markets. Second, products that are more important to the exporter and represent their "core competencies" should again be farther away from the critical productivity cutoff point. This should imply that products in which the firm has greater experience should have a better chance of survival in export markets. Finally, there should be a difference between industries in which Hungary has a comparative advantage and those that it does not. Concentrating on core competencies should ensure that survival in export markets for a product will be longer in comparative advantage industries. These three hypotheses are strongly confirmed by our empirical analysis.

Finally, the questions we are able to consider using this data are new relative to those found from the modelling of firm export dynamics in the current literature. There, survival within export markets has been modelled as a zero-one decision at the level of the firm, with past export experience and other firm characteristics playing a prominent role (see, e.g., Roberts and Tybout, 1997, Bernard and Jensen, 2004). As is made clear from our analysis a number of interesting aspects of the internationalisation decision of firms is lost by this aggregation of products. Compared to this literature, we are also able to show that firm characteristics matter for product survival and that past export experience within the firm is a more refined concept than commonly acknowledged.

The structure of the remainder of this paper is the following. Section 2 describes the database and section 3 our empirical methodology. Section 4 summarizes descriptive statistics which illustrate the importance of analysing multi-product firms and product switching. We also illustrate the relationship between the main variables and product survival, as well as presenting our main results using survival analysis. Section 5 concludes.

2 Description of the data

The data used for our empirical analysis were gained from the Hungarian Customs Statistics and merged with the firms' balance sheet and earning statements using a common identifier.[3] The dataset consists of a panel of large Hungarian exporting firms from 1992 to 2003. Large exporting firms are defined as those that exported above 100 million HUF (approximately 400,000 EUR in 2003) in any of the years; all such firms operating in manufacturing are included in the dataset. As a result, the sample consists of 2,043 large

[3] A detailed description of this dataset can be found in Halpern et al. (2005).

exporting firms. The firms in the sample export 89% of all manufacturing exports, and their turnover is 75% of manufacturing turnover in Hungary.[4]

While the use of financial and accounting data is widespread in the literature, the use of customs data with both firm and product dimension is very rare. The Hungarian Customs Statistics has both these dimensions. The dataset contains the annual export and import traffic of firms, both in value and weight. The product dimension of the dataset is broken down to 6-digit Harmonized System (HS) level. We define a product as a 6-digit category.[5] "Motor cars and vehicles for transporting persons" is an example for a 4-digit category, while "Other vehicles, spark-ignition engine of a cylinder capacity not exceeding 1,500 cc" is an example 6-digit category.

In this paper our interest lies in the time span a firm exports a product. Because of this, the cross-section dimension of the panel consists of firm-product combinations. A very important question in this respect is how one treats multiple spells: when a firm exports a product with shorter or longer pauses. We decided to treat multiple spells as separate spells.[6] Finally, our analysis is constrained to spells beginning after 1991, as we cannot proxy the duration of spells beginning before that date.

Initial investigation of the data also suggests some anomalies that do not reflect the output produced and exported by the firm but instead assets or inventory sold on foreign markets[7] (see table A1 in Appendix A for an example). Inclusion of these data points is not supported by the theoretical model but may influence the empirical results presented in the paper. We therefore choose to omit these data points from the analysis. We identify the sale of inventories and firm assets as products that are exported for only one or two periods, but

[4] Appendix A contains some further discussion on how representative our sample is of the population of manufacturing firms.
[5] We are cautious to point out, however, that using more aggregated (4-digit) categories does not change our results.
[6] Again, modifying this assumption does not change the results in any significant way.
[7] This feature of the data suggests that the same problem may appear in higher levels of aggregation. Small and volatile trade flows of some products between two countries may be a consequence of this phenomenon.

which are very distant from the industry in which the firm operates, and where the firm has not exported similar products at a regular basis. To account for the possibility that large firms produce a wide range of products, we identify the industry the firm operates in using a broad measure. In practice we define this as when at least one product was exported by the firm regularly in the same 2-digit HS category for at least for 3 years. The export observations that do not satisfy these criteria are excluded from the analysis.[8,9] Subsequently we will use the word ‘product’ as a synonym for ‘output’.

An important stylized fact evident within our data is that large firms export a large number of products. Figure 3 shows the evolution of the number of products exported. In 2003 the average number of products exported was just below 20, while it was just above 7 in 1994.[10] There are a few large firms that exported more than 100 products. Our data also show that in 2003 less than 8% of firms were single-product firms. Hence, in our sample multi-product firms clearly dominate. Overall these figures are in line with arguments in Bernard et al. (2006b); extensive adjustments at the level of export mix constitute a significant fraction of total firm level adjustment in our data.

[Figure 3 around here]

Regarding the turnover of products in export markets, in each year about 15% of the total number of product were dropped. Table 2 shows the fraction of firms adding or dropping at least one product. The statistics suggests that it is extremely common among large exporting firms to modify their product mix. For example in 2003 more than two thirds of the firms in the sample added *and* dropped at least one product. The great number of dropped products suggests that firms not only introduce new products as an effect of trade liberalization, but

[8] Another approach for identifying output products would be to use the industry identifier of the firm. However in case of such large firms it is a reasonable assumption that these are real multi-product firms. Also the database suggests that the same firm exports regularly and in large quantities very different products.

[9] Slight modifications of this procedure (i.e. using 4-digit categories instead of 2 digit and using 2 years instead of 3) lead to very similar results.

[10] Recall, that these are only products classified as the output of the firm – the number of products actually exported are much larger than these numbers.

they constantly modify their product mix to remain competitive.[11] These findings are very much in line with the results in Bernard et al. (2006a).

[Table 2 around here]

The central variable in our analysis is the duration of exporting a given product. Table 3 shows the distribution of this variable. About 15% of durations in our sample are not completed: firms had not stopped exporting the product until 2003. This large ratio of unfinished spells suggests that right-censoring is an important issue. Also it is clear that completed spells are not very short – about three-quarters of cases relate to exports of a product for 4 years or more.

[Table 3 around here]

3 Econometric Methodology

Survival analysis is a natural framework to address the question of success of export products. In our case time is intrinsically continuous, but the econometrician can only observe product survival on a yearly basis. This makes the use of discrete-time survival models necessary. A widely used model in this case is the complementary log-log model, which is the discrete time version of the proportional hazard models.[12] In proportional hazard models, the hazard rate $\theta(t, X)$ satisfies an important separability assumption:

$$\theta(t, X) = \theta_0(t)\exp(\beta' X),$$

thus it is the product of a baseline hazard $\theta_0(t)$, which depends only on time at risk, and $\exp(\beta' X)$ which is independent of t and depends on the attributes of the export product (X). The appropriate discrete-time hazard function, $h(j, X)$ shows the interval hazard for

[11] Arguably, the assumptions of fixed firm-product level productivity and foreign demand made in many theoretical model sit uncomfortably with these results.

[12] See Jenkins (2005) for an excellent overview of complementary log-log and proportional hazard models.

the j^{th} time interval, i.e. the period between the beginning and the end of the j^{th} year after the introduction of the product. This hazard rate takes the following form:

$$h(j, X) = 1 - \exp[-\exp(\beta' X + \gamma_j)]$$

Our main interest lies in identification of the β parameters, which show the effect of the explanatory variables on the hazard rate. Positive estimates suggest that the larger values of the explanatory variables increase the hazard, or equivalently, decrease the probability of survival. The γ_j parameters represent the differences in values of the integrated hazard function for different durations, thus, for example γ_1=1 if the product was introduced by the firm one year ago, and γ_1=0 otherwise. While it is possible to impose some restrictions on these parameters, we see no reason for this. Thus we estimate a full set of γ_j s, transforming the model to a type of semi-parametric one in this respect.

The complementary log-log model in its simple form does not allow for unobserved firm heterogeneity. In order to do so we also estimate all specifications using a random-effects version of the complementary log-log model as a robustness check. In these specifications firms were taken as the cross-sectional units.[13]

A note on the interpretation of our estimations: $h(t, X)$ is the hazard rate, i.e., the probability that the firm drops the product in period t given that it had not dropped the product before that period. As the hazard rate is our dependent variable, a negative coefficient estimate on a covariate suggests that the variable is negatively associated with the hazard and, hence, positively affects survival.

The survival of products is measured using the following timing: the firm introduces the product when it exports a positive quantity after exporting zero (t=1), and the firm drops the product from its export mix in the period before it exports zero.

[13] The survival analysis is implemented using the cloglog and xtcloglog commands in Stata Version 9.

In the estimation of the hazard model we consider a number of explanatory variables for the vector X, which capture characteristics of the firm / industry and the product. In this respect we are particularly interested in firm level productivity, and the importance of the products in the export mix. These are the variables highlighted in Bernard et al. (2006b) as the main determinants of export performance and are hypothesised to be important for export survival also.

Firm level productivity is measured as total factor productivity (TFP) from the estimation of a firm level production function. We consider two different measures of TFP, one being the residual from a fixed effects regression and a second being the residual from a production function estimation using the approach developed by Levinsohn and Petrin (2003).[14] As discussed above, the export products of more productive firms are farther away from the zero-profit cutoff, on average, and therefore more likely to survive in the export mix. Consequently our expectation is that firm level TFP is negatively related with the hazard of a product exit.

A second set of variables proxies the expertise of the firm in producing the product. In the theoretical model, products for which the firm has more expertise are exported in larger quantities. If this is the case, then the revenue from products may proxy expertise. One possibility is to measure this with the revenue share for a product in the total revenue of the export mix. However, this variable may become endogenous in some sense – firms may decrease their sales of the product before finally abandoning it. To handle this, we calculate the maximum share of the product from the export mix during the spell as our measure of expertise. According to the reasoning above this variable should have a positive effect on expected duration, i.e., reduce the hazard of product exit.

[14] Further details on the estimation of TFP are provided in a Appendix B.

We also employ an alternative to this measure, using the *order* in which the firm started to export the products as a proxy for expertise. This variable shows how many products were introduced by the firm to export markets before introducing product j.[15] As suggested by the theoretical model, when facing continuous trade liberalization, firms begin to export products with the highest expertise, and continue with products they can less efficiently produce. According to this reasoning, firms have less expertise in exporting products with higher order; the expected sign of order is positive on the hazard of exit.

According to Bernard et al. (2006b) it is likely that the effect of firm level productivity and product expertise differs for comparative advantage and disadvantage sectors. Hence, this should be allowed for in the empirical modelling. The measurement of comparative advantage empirically is, of course, neither straightforward nor uncontroversial.[16] We rely on the commonly used "revealed comparative advantage" measure. Specifically, we calculate the net trade ratio $CA_{jt} = (X_{jt} - M_{jt})/(X_{jt} + M_{jt})$, where X_{jt} is the export of the six-digit product j in year t and, correspondingly, M is imports. The hypothesis is that there is intensive selection and focusing on core products in comparative advantage sectors, hence our expectation is that the hazard of dropping the product is lower in comparative advantage industries, thus the expected coefficient on this variable is negative.

While firm level productivity, product expertise and comparative advantage are the main variables of interest in our analysis it is important to control for other firm and product characteristics to allow for observed heterogeneity. To do so, we include the following control covariates in our analysis:

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[15] If a firm starts exporting more than one product in a year, then *order* takes the same value for all of them.

[16] One of the main problems is that autarchy prices cannot be observed empirically, see, for example, Deardorff (1980) for a discussion.

Product Variables

Heterogeneity in quality within disaggregated product categories may play an important role in export success (Schott, 2004; Hallak and Schott, 2005). For this, in some specifications we include the *relative unit value*[17] of the product:

$$RUV_{ij} = \frac{\sum_{i=1}^{T} UV_{ijt} / UVEU_{jt}}{T}$$

where UV_{ijt} is the unit value of product j exported by firm i at year t, and $UVEU_{jt}$ is the average unit value of the product in EU 15 external imports in USD.[18] This variable measures the relative price the firm was able to sell the product compared to some EU-wide price. We average this price over periods to eliminate short-term fluctuations. As this variable proxies quality, we expect that products with larger relative unit values will be exported for a longer period.

As a proxy for demand shocks that may affect export performance we include the *EU average price change since introduction of the product*. This variable proxies the change in world (EU-wide) price of the product since the firm has started to export it. For firm i and product j it is calculated as:

$$UV\_change_{ijt} = \frac{UVEU_{jt}}{UVEU_{jt_0}}$$

where t_0 is the date when the firm started to export the product. Our expectation is that negative price shocks tend to decrease the survival probability.

To study whether experience within the industry or within the firm matters, we also employ a pair of regressors which measure whether the firm or industry have exported a similar product before. *Firm exported hs4* measures whether the firm has exported a product which

[17] As Hungarian firms are usually small actors on international markets, it is a reasonable assumption, that they are price takers. Thus relative price may be a valid proxy for export quality.
[18] source: Eurostat

is at the same 4 digit HS category. Similarly *industry exported h6* measures whether any firm in the NACE 2-digit industry the firm operated in has exported the same product. Our expectation is that previous exporting experience either in the firm or industry-level helps firms to learn which products to export and how. This experience may lead to longer export success and duration. Significance of the firm-level variable may mean that learning-by-doing is present at the firm level across products. If the industry-level variable is significant, then spillovers may be present among firms within an industry. On the other hand, it is possible to interpret these variables in terms of product diversifications.

Another determinant of the duration of exporting may be the knowledge-intensity of the product. Knowledge intensity may characterize the life-cycle of products. More knowledge-intensive products may have shorter life cycles. Also, firms in a transition economy may try to upgrade their export mix to the direction of more knowledge-intensive products. It is possible that Hungarian firms find it harder to remain competitive in the international markets with these products. Consequently one may expect a negative relationship between knowledge intensity and the persistence of the product in the export mix. To proxy this dimension of the product, we use the OECD process approach to categorise the products (OECD, 2001). This categorisation is a joint work of the OECD and the EUROSTAT, and is based on the R&D intensity of production, taking into account the characteristics of inputs. This approach categorizes all 6-digit products into one of four broad categories: low tech (1); medium low-tech (2); medium high-tech (3) and high-tech (4). We control for this variable in a robustness check.

Firm and Industry Variables

We control for the size of the firm, measured in terms of employment (in 1000 employees). The theoretical sign of this variable is ambiguous, however. In the theoretical model there exists a one-to-one relationship between size and productivity. Beyond this, size may show some efficiency advantage of the firm, unmeasured in productivity (for example heterogeneous technology) or it may simply reflect some kind of rigidity in firm size.

A measure of the firm's export share proxies its degree of internationalisation; it is defined as the share of export turnover in total turnover of the firm. Furthermore, we include a dummy variable to indicate whether the firm is foreign-owned. It takes the value 1 if foreign share in the firm is more than 10%, in line with international definitions of multinationals.[19] Multinational firms may have stronger links with firms abroad; also they may have better information on export markets. The final firm/industry variable is the concentration in the industry, measured by the Hirschman-Herfindahl-index. While these firms compete on foreign markets to a large extent, domestic concentration may still matter in terms of sources necessary to pay the fixed costs of exporting.

Table 1 shows summary statistics for the main variables included in our analysis.

[Table 1 around here]

4 Results

4.1 Baseline Regressions

This subsection summarizes our main findings. The main regression results are reported in Table 4. As described above we report the results from the complementary log-log specification and show that the results do not change in an important way by using the random effects complementary log-log model (See Appendix C, Table A2). The latter mainly utilizes within-firm variation and is therefore expected to lead to the loss of statistical significance of some of the coefficients.

To conserve space we do not report the coefficients of the dummy variables representing duration dependence, and instead we present the estimated hazard function using a Cox

[19] Changing this threshold does not change the result in any significant way.

proportional hazard regression (Figure 4). A similar pattern can be seen from examination of the estimates of the time dummies in the semiparametric estimation. As this figure makes clear the hazard reaches its maximum between 3 or 4 years, and then starts to decrease rapidly after six years or so. This length of time is close to those estimated from the duration analysis on imports to the US and to Germany using disaggregated bilateral trade data by Besedes and Prusa (2006) and Nitsch (2007). This finding may be interpreted in different ways. First, this may reflect the product life cycle. Second, it is also possible that it takes time for firms to find out whether the products are likely to return positive profits in the long run, and abandon those that do not. After 4 years they keep only the most lucrative products in their export mix, implying a much lower hazard.

[Figure 4 around here]

Regression (1) in Table 4 presents our baseline specification. As expected, aspects of both the firm and the product are important for product survival in line with theory. Firm productivity has a significant negative coefficient in the hazard model implying that the hazard of dropping the product from the export mix of the firm is decreasing as the productivity of the firm increases. More productive firms export on average, products that are further above the threshold point and that ensures they are more likely to survive in export markets.[20]

We also find that attributes of the product matter. Consistent with our hypothesis we find that products sold in larger quantities (consisting of a larger share of the revenues of the firm) are less likely to be dropped. One interpretation of this result would be that this variable captures the success of a product on the extensive and intensive margins. Products that are further above the cutoff value of ability are exported more intensively and to a greater number of countries.

[20] This is also in line with the literature on firm export behaviour more generally, as surveyed by Greenaway and Kneller (2007), where more productive firms are both more likely to export and are more export intensive.

Product quality (measured by the relative unit value) is also significant, having a negative effect on the hazard rate as expected. Firms with higher quality products are able to remain more competitive on international markets. The significance of this variable is an important sign of the fact that vertical specialization within products is important in the case of multi-product firms. This suggests that theoretical models of firm export decisions should consider quality when modelling firm-level adjustment to trade liberalization. The recent model of Baldwin and Harrigan (2007) has such features. Learning to export higher quality products may also be a very important determinant of firm-level competitiveness in transition economies.

[Table 4 around here]

The other firm controls behave as expected. We find that in addition to firm productivity, larger firms are less likely to drop products, suggesting that our measure of productivity may not capture all aspects of firm organisational advantage. It might be for example that larger firms have broader networks of clients. Conditional on firm size we also find that foreign firms have more stable product mix. This may be explained by the fact that these firms have established links with foreign partners, but also a greater level of export experience. Their more intimate relationship with foreign customers may help them in choosing products that are more likely to be successful in export markets. As far as we are aware this aspect of the advantage of MNEs has not been previously documented.

A somewhat unexpected result in the baseline specification is that for the export share of the firm. Here we find that firms that are more exposed to international markets (which export a larger share of their total revenue) have a higher hazard rate for product exit. Further below we find that this particular result is not robust and occurs because firms with a higher export share *ceteris paribus* tend to concentrate less on their core competences. The effect of concentration is positive when significant. Firms in less competitive industries tend to change their product mix more frequently.

Finally, unit price demand conditions (here proxied by the change of EU-level price) does not seem to be a significant determinant of product survival. Export market competitiveness appears to be fundamentally determined by the attributes of production technology, and not by idiosyncratic demand changes in foreign markets (the effect of macro cycles should be absorbed by the year dummies).

Roberts and Tybout (1997) and Bernard and Jensen (2004) demonstrate convincingly that past experience within export markets has a strong effect on the likelihood that a firm remains as an exporter. We find that experience also matters for product survival, although not always in a positive way. Experience is a more complicated concept than that modelled in the current literature.

In regression (2) we substitute the share of the total revenue accounted for by a given product with the variable *order*, which measures the total number of products that were exported by the firm before they start to export the current product. This aspect of experience has a positive sign. The later the firm started to export the product, the higher the hazard. We interpret this result as consistent with the idea that the firm is exporting products further away from its core competencies. In the model these products are closer to the cut-off threshold for ability and are therefore more likely to fail. An alternative explanation might be that conditional on the size of the firm, a greater number of products results in less managerial or sales time for that product and a reduced focus on the preferences operating within the market.

We investigate this further in regressions (3), where we control instead for whether the firm itself has previously exported a similar product or another firm in the industry has exported the same product before. These variables are very highly significant with very large tstatistic, both having a strong negative effect on the hazard. Previous experience or learning may have a strong effect on success in export markets. Learning may help firms in choosing the right products, or it helps the firm to find the right customers. An interesting finding is that the sign of the export share variable in these specifications changes to negative, its predicted sign. Thus, if one is interested in the effect of export share, it is important to control for product-level experience and the diversification of the export mix.

4.2 The role of comparative advantage

Bernard et al. (2006b) show that the experience of exporters in comparative advantage and disadvantage sectors should be markedly different in respect to the question under consideration here. In order to allow for this we now present estimation results which include our measure of comparative advantage.

In Table 5, specification (1) presents results when including the comparative advantage variable on its own. This variable has a strong negative coefficient, suggesting that export products in which Hungary has comparative advantage, survive for longer. In (2) we include also the interaction of the comparative advantage measure and productivity. The positive sign of this variable suggests that the role of productivity in export dynamics differs between comparative-advantage and comparative-disadvantage industries. More specifically, in comparative-advantage industries firm level productivity has a less important effect. The effects of selection are less keenly felt in industries with better long-term growth prospects. A greater focus on the products in which the firm has the most experience and industry characteristics, whether it is an industry in which Hungary has a comparative-advantage, result in a more stable exporting pattern even in case of relatively less productive firms.

The effect of the order variable (specification (3)) seems to be a function of comparative advantage – in comparative advantage sectors its effect is smaller. Interestingly in comparative advantage sectors, products that were introduced later into the export mix of the firm have a similar hazard to those introduced earlier. Similar to TFP, this can also be interpreted as evidence for the more stable and more informed choices of firms in these sectors.

In specification (4) we study whether experience plays a different role depending on the comparative advantage of the sector. The role of industry experience with the same (6-digit) product also differs between these product categories. Industry experience seems to matter less for products in which Hungary has a comparative advantage.

4.3 Robustness

Table 6 shows a number of robustness checks. In columns (1)-(4) re-estimate the specifications in table 5 using the random effects complementary log-log model. We allow for firm-level heterogeneity, and doing that does not change our results substantially.

In (5) we include an alternative measure of productivity, estimated by the Levinsohn-Petrin procedure. While the sign remains the same, the magnitude is much smaller compared to the TFP measure estimated by fixed effects. Also, it loses its significance in the random effects specification. While this may show the importance of controlling for the potential endogeneity of inputs, it can also be a consequence of the poor performance of such estimates in transition economies with noisy data on inputs. It is reassuring, however that other coefficients are not substantially different from previous specifications.

Finally, in specification (6) we study the effect of knowledge intensity on hazard rates. Its sign is positive as expected – more knowledge intensive products tend to have shorter life cycles. However, the inclusion of this variable does not change any other aspect of our results.

5 Conclusions

In this paper we use a unique and very detailed database which provides information at the firm-product level. We use this data to study an aspect of export behaviour that has not received much attention in the literature, namely, what determines the survival of a given product in a firm's export mix. The empirical analysis in our paper, inspired by the theoretical modelling by Bernard et al. (2006b), argues that general firm competencies as well as firm-product specific ability are important in determining firms' export behaviour.

Our empirical analysis shows that firm aspects are important determinants of the survival of products in the export mix. All other things equal, firms that are "better" (in the sense of being more productive) export products that survive longer in international markets. We also find that a firm's experience in exporting a given product is an important predictor of the success of that product in the export mix. The more experience a firm has in exporting the product the higher is the chance that the product will survive. These two findings are in line with the theoretical ideas that firm- as well as firm-product competencies are important.

Overall, our empirical analysis highlights the importance of considering multi-plant firms when studying export behaviour, as many firms export more than one product in a given year. Furthermore, many firms drop as well as add products to their product mix, and this process seems to be governed by firm as well as product characteristics.

References

Baldwin, R, and Harrigan, J. (2007). Zeros, quality and space: Trade theory and trade evidence. BER Working Paper No. 13214.

Bernard, A. and Jensen, J.B. (2004). Why Some Firms Export. *Review of Economics and Statistics*, Vol. 86, pp.561–569.

Bernard, A.B., J.B. Jensen, S.J. Redding and P.K. Schott (2008). Firms in international trade, *Journal of Economic Perspectives*, forthcoming.

Bernard, Andrew B.; Stephen J. Redding and Peter K. Schott (2006a). Multi-product firms and product switching. *NBER Working Paper* 12293.

Bernard, Andrew B.; Stephen J. Redding and Peter K. Schott (2006b). Multi-product firms and trade liberalization. *NBER Working Paper* 12782.

Besedes, Tibor and Thomas J. Prusa (2006a). Ins, outs, and the duration of trade, *Canadian Journal of Economics*, 39, 266–295.

Besedes, Tibor and Thomas J. Prusa (2006b). Product differentation and duration of US import trade, *Journal of International Economics*, 70, 339–358

Deardorff, A. V. (1980). The General Validity of the Law of Comparative Advantage. *Journal of Political Economy* vol. 88, pp. 941–957

Görg, H., M. Henry and E. Strobl (2008). Grant support and exporting activity, *Review of Economics and Statistics*, forthcoming

Greenaway, D. and Kneller, R. (2007). Firm Heterogeneity. Exporting and Foreign Direct Investment. *Economic Journal*, Vol. 117, no.517, pp.F134–F161.

Greenaway, D. Gullstrand, J. and Kneller, R. (2007). "'Surviving globalisation", *Journal of International Economics*, forthcoming.

Greenstein, Shane M. and James B. Wade (1998). The Product Life Cycle in the Commercial Mainframe Computer Market, *Rand Journal of Economics*, 29(4) pp. 772–789.

Hallak, Juan Carlos and Peter K. Schott (2006). “Estimating Cross-country Differences in Product Quality”, mimeo http://www.princeton.edu/~ies/Fall06/HallakPaper.pdf

Halpern, László; Koren Miklós and Szeidl Ádám (2005). Imports and productivity. CEPR Discussion Paper 5139

Jenkins, Stephen P. (2005). “Survival Analysis”, mimeo, University of Essex

Levinsohn, James and Amil Petrin (2003). Estimating Production Functions Using Inputs to Control for Unobservables. *Review of Economic Studies*, vol. 70, pp. 317–341.

Nitsch, Volker (2007). Die another day: Duration in German import trade, CESIfo Working Paper 2085.

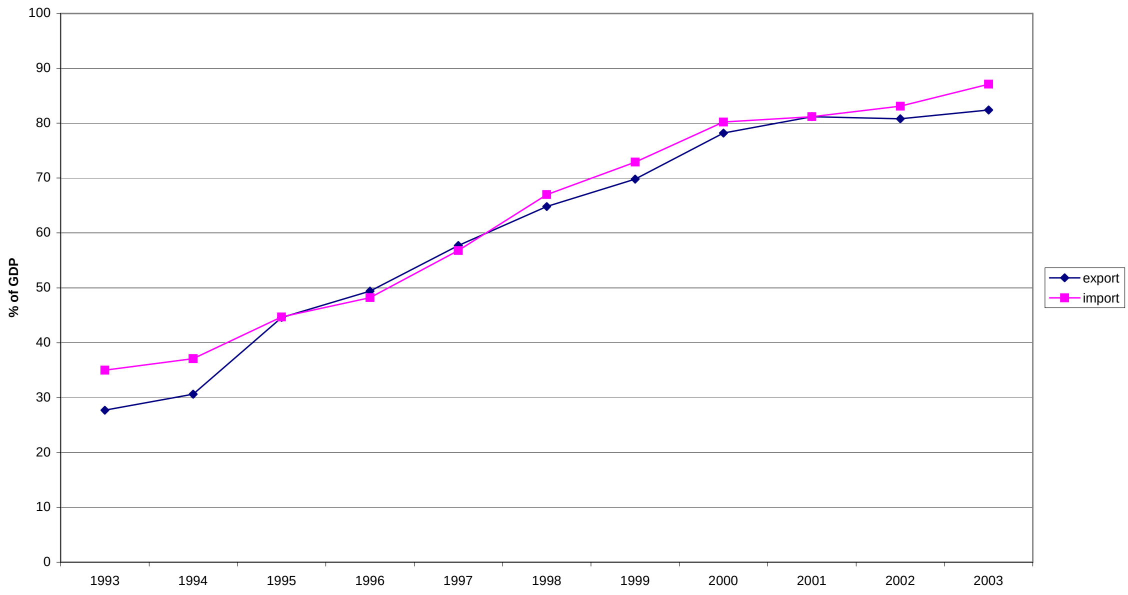
OECD (2001). OECD Science and Industry Scoreboard 2001.

Roberts, M. and Tybout, J. (1997). The decision to export in Colombia: An empirical model of entry with sunk costs, *American Economic Review*, Vol. 87, No. 4, pp.545–563.

Schott, Peter K. (2004). Across-Product versus Within-Product Specialization in International Trade. *Quarterly Journal of Economics*, vol. 119, p. 647–678.

Stavins, J. (1995). Model entry and exit in a differentiated industry: The personal computer market, *Review of Economics and Statistics*, 74, 571–584.

Figure 1: Import and export in Hungary (as per cent of GDP)



Source: Eurostat

Figure 2: Import tariff rates in Hungary between 1992 and 2003

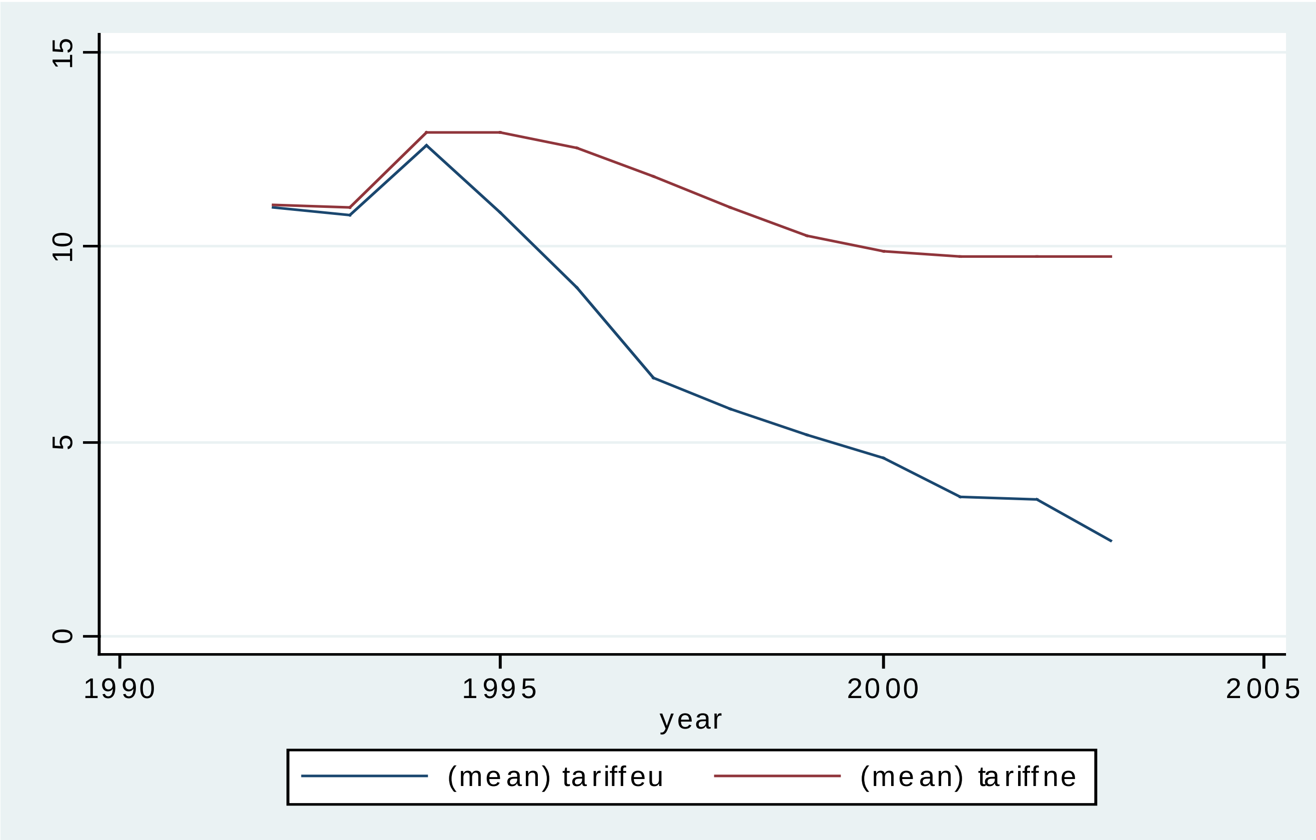


Figure 3: Evolution of the average number of exported products per firm

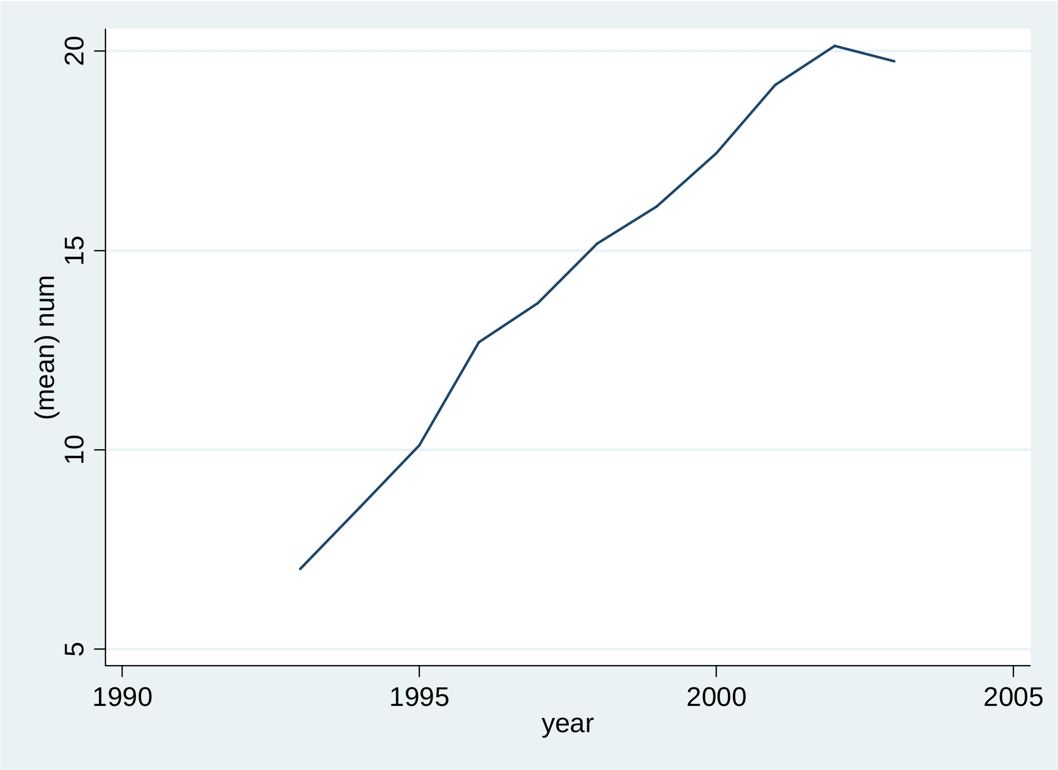


Figure 4 Duration dependence, estimated with Cox regression

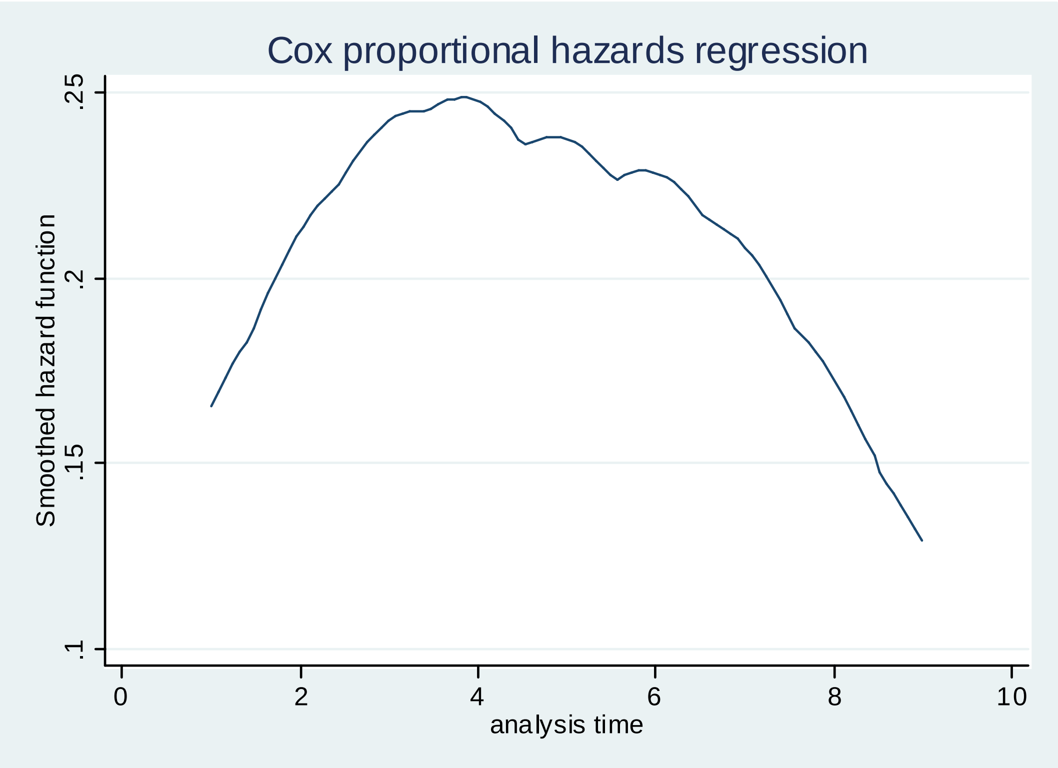


Table 1: Summary statistics of main variables

Variable	Observations	Mean	Std. Dev.	Minimum	Maximum
employment	153145	0.81	1.74	0	19.86
foreign owned	153145	0.67	0.47	0	1
export share	153145	0.16	0.24	0	1
Hirschmann-Herfindahl index	153145	0.18	0.21	0.00	1
TFP	153145	0.34	0.65	-6.59	3.37
relative unit value	153145	1.85	1.59	0.10	9.99
share of product from export mix	153145	0.07	0.19	0.00	1
order	153145	1.12	4.85	0	228
oecd	153145	2.12	0.97	1	4
firm has produced hs4	153145	0.59	0.49	0	1
industry has produced hs6	153145	0.64	0.48	0	1
interact	153145	0.02	0.12	0	7.09
EU average price change since introduction of the product	153145	96.34	110.35	1	682

Table 2: Fraction of firms adding and dropping products

year	Fraction of firms adding at least one product	Fraction of firms dropping at least one product	Fraction of firms both adding and dropping at least one product
1993	.900	.679	.580
1994	.882	.694	.606
1995	.867	.761	.676
1996	.879	.811	.740
1997	.848	.793	.700
1998	.840	.785	.687
1999	.836	.809	.715
2000	.809	.788	.694
2001	.826	.819	.720
2002	.781	.826	.705
2003	.748	.790	.671
Total	.833	.785	.687

Table 3: The distribution of completed durations

Years	Frequency	Percent	Cum.
2	9,01	13.36	13.36
3	10,254	15.20	28.56
4	10,054	14.91	43.47
5	8,027	11.90	55.37
6	7,613	11.29	66.66
7	6,409	9.50	76.16
8	5,967	8.85	85.01
9	4,331	6.42	91.43
10	3,426	5.08	96.51
11	2,355	3.49	100.00
Total	67,446	100.00	

Table 4 Main results

	(1)	(2)	(3)
TFP	-0.057***	-0.059***	-0.059***
	(0.007)	(0.007)	(0.007)
share of product from export mix	-2.583***		-2.482***
	(0.056)		(0.055)
employment	-0.007***	0.004	0.002
	(0.003)	(0.003)	(0.003)
foreign owned	-0.116***	-0.074***	-0.127***
	(0.010)	(0.010)	(0.010)
export share	0.073***	0.119***	-0.071***
	(0.023)	(0.023)	(0.023)
Hirschmann-Herfindahl index	0.034	0.018	-0.035
	(0.026)	(0.026)	(0.026)
relative unit value	-0.012***	0.002	-0.010***
	(0.003)	(0.003)	(0.003)
EU average price change since the introduction of the product	-0.000	-0.001	0.000
	(0.003)	(0.003)	(0.003)
order		0.002***	
		(0.001)	
firm has produced hs4			-0.259***
			(0.011)
firm has produced hs6			-0.495***
			(0.011)
Observations	153145	153145	153145
Number of id	1479	1479	1479

All specifications are estimated by complemenatry log-log regression
Standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 5 The effect of comparative advantage

	(1)	(2)	(3)	(4)
TFP (fixed effects)	-0.058***	-0.053***	-0.056***	-0.059***
	(0.007)	(0.007)	(0.007)	(0.007)
share of product from export mix	-2.554***	-2.554***	-2.570***	-2.480***
	(0.056)	(0.056)	(0.056)	(0.056)
employment	-0.007***	-0.007**	-0.007**	0.002
	(0.003)	(0.003)	(0.003)	(0.003)
foreign owned	-0.119***	-0.120***	-0.123***	-0.127***
	(0.010)	(0.010)	(0.010)	(0.010)
export share	0.073***	0.073***	0.076***	-0.071***
	(0.023)	(0.023)	(0.023)	(0.023)
Hirschmann-Herfindahl index	0.031	0.031	0.027	-0.035
	(0.026)	(0.026)	(0.026)	(0.026)
relative unit value	-0.013***	-0.013***	-0.012***	-0.010***
	(0.003)	(0.003)	(0.003)	(0.003)
EU average price change since the introduction of the product	-0.000	-0.000	-0.000	0.000
	(0.003)	(0.003)	(0.003)	(0.003)
net trade ratio	-0.028***	-0.029***	-0.017**	-0.040***
	(0.007)	(0.007)	(0.007)	(0.010)
TFP * net trade ratio		0.027**		
		(0.011)		
order			0.005***	
			(0.001)	
order * net trade ratio			-0.008***	
			(0.001)	
firm has produced hs4				-0.254***
				(0.012)
industry has produced hs6				-0.486***
				(0.011)
firm has produced hs6 * net trade ratio				0.025
				(0.016)
industry has produced hs6 * net trade ratio				0.038**
				(0.016)
Observations	153145	153145	153145	153145
Number of id	1479	1479	1479	1479

All specifications are estimated by complemenatry log-log regression
Standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 6 Robustness checks

	(1)	(2)	(3)	(4)	(5)	(6)
TFP (fixed effects)	-0.103***	-0.097***	-0.092***	-0.078***		-0.110***
	(0.012)	(0.012)	(0.012)	(0.012)		(0.012)
share of product from export mix	-3.098***	-3.097***	-3.129***	-2.914***	-3.128***	-3.175***
	(0.062)	(0.062)	(0.062)	(0.061)	(0.062)	(0.062)
employment	-0.015**	-0.015**	-0.008	-0.013**	-0.027***	-0.020***
	(0.006)	(0.006)	(0.008)	(0.006)	(0.010)	(0.007)
foreign owned	-0.063***	-0.063***	-0.066***	-0.074***	-0.072***	-0.065***
	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.022)
export share	-0.049	-0.049	-0.051	-0.094**	-0.063	-0.050
	(0.039)	(0.039)	(0.039)	(0.039)	(0.039)	(0.039)
Hirschmann-Herfindahl index	-0.059	-0.058	-0.041	-0.104*	-0.034	-0.069
	(0.054)	(0.054)	(0.054)	(0.054)	(0.054)	(0.054)
relative unit value	-0.008***	-0.008***	-0.008***	-0.007**	-0.009***	-0.005*
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
EU average price change since the introduction of the product	0.000	0.000	0.000	0.001	0.000	-0.000
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
net trade ratio	-0.044***	-0.045***	-0.034***	-0.057***		
	(0.007)	(0.007)	(0.008)	(0.011)		
TFP * net trade ratio		0.029**				
		(0.011)				
order			0.009***			
			(0.001)			
order * net trade ratio			-0.008***			
			(0.001)			
firm has produced hs4				-0.297***		
				(0.012)		
industry has produced hs6				-0.482***		
				(0.012)		
firm has produced hs6 * net trade ratio				0.019		
				(0.016)		
industry has produced hs6 * net trade ratio				0.029*		
				(0.016)		
TFP (Levinsohn-Petrin)					-0.012	
					(0.012)	
OECD process approach						0.104***
						(0.006)
Observations	153145	153145	153145	153145	152027	151184
Number of id	1479	1479	1479	1479	1473	1478

All specifications are estimated by complemenatry log-log regression
Standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Appendix A: Additional data description

How does our data compare to the population?

We use aggregate data to get an idea of how representative our data is. The comparison is based on the full sample of Hungarian manufacturing firms with double-bookkeeping, which includes practically every firm, except single employee firms. We find that the average firm in our sample is roughly 15-times as large in terms of turnover as the average manufacturing firm. Also, firms in the sample are more likely to be foreign-owned: 56% of the firms in the sample are foreign owned (10% threshold), compared to 16% of all manufacturing. However, it is noteworthy that in terms of sectoral composition, there are few very important differences between our sample and the population of firms, as indicated by the sectoral distribution in the table below.

NACE code	sample	all firms
15	15,82%	14,05%
16	0,36%	0,03%
17	4,43%	3,47%
18	5,37%	5,18%
19	2,32%	1,58%
20	2,76%	5,71%
21	1,81%	1,29%
22	1,96%	12,89%
23	0,22%	0,05%
24	4,79%	2,41%
25	8,06%	4,68%
26	3,63%	7,72%
27	2,54%	1,15%
28	10,16%	13,56%
29	11,68%	9,12%
30	0,94%	0,87%
31	6,39%	2,91%
32	3,70%	2,49%
33	3,19%	3,69%
34	5,08%	0,96%
35	1,16%	0,56%
36	3,41%	5,08%
37	0,22%	0,56%

Table A1: an example from the dataset

hs4	*hs6*	*NAME*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*
8481	848180	Appliences for pipes, boiler shells, tanks or the like					2	82					
8525	852540	still-image video cameras and other video camera recorders										69	
8537	853710	Boards, cabinets and similar combinations of apparatus for electric controll					6						
8538	853810	Boards, panels, consoles and desks…					2972						
	853890	Parts suitable for use solely or principally with the apparetus heading no. 8535, 8536				53786							
	sum:		***0***	***0***	***0***	***53786***	***2972***	***0***	***0***	***0***	***0***	***0***	***0***
8716	871680	Vehicles pushed or drawn by hand and other vehicles not mechanically propelled				91671	7210						
9018	901841	dental drill engines	4443										
9024	902480	Machines and appliances for testing the mechanical properties of materials (ecl. Metals)			963								
9403	940310	Metal furniture for offices (excl. Seats)					46497						
	940320	Metal furniture (excl, for offices, seats and medical …)	311609	343695	128870	262524	1121904	992457	536866	62439	71934	150916	67224
	940360	Wooden furniture (excl, for offices, kitchens, bedrooms and seats)		7300									
	940390	Parts of furniture NES (excl. Seats)				2008		10016	1403				
	sum:		***311609***	***350995***	***128870***	***264532***	***1168401***	***1002473***	***538269***	***62439***	***71934***	***150916***	***67224***

Appendix B: TFP Estimation

TFP is the total factor productivity calculated from a fixed effects regression:

$$\ln Y_{it} = \alpha + \alpha_k \ln K_{it} + \alpha_l \ln L_{it} + \eta_i + \varepsilon_{it},$$

where Y_{it} is real added value of firm i at period t, K_{it} is fixed assets, L_{it} is employment, η_i is the firm-specific fixed effect and ε_{it} is the idiosyncratic shock. Nominal variables were deflated with industry-level deflators. We have estimated this regression separately for NACE-2 industries to take industry heterogeneity into account. As a robustness check we have also estimated productivity by the semiparametric method proposed by Levinson and Petrin (2003). This method tries to solve the problem of endogenous input choice, i.e. that the firm observes the idiosyncratic productivity shock, and adjusts its labour input accordingly. The procedure uses intermediate inputs to estimate the control for the idiosyncratic shock. We use real material costs as the proxy.

Appendix C

TABLE A1: Main results estimated by random effects complementary log-log regression

	(1)	(2)	(3)
TFP	-0.101***	-0.084***	-0.078***
	(0.012)	(0.011)	(0.012)
share of product from export mix	-3.141***		-2.939***
	(0.062)		(0.061)
employment	-0.015**	0.001	-0.014**
	(0.007)	(0.006)	(0.006)
foreign owned	-0.060***	-0.014	-0.072***
	(0.021)	(0.020)	(0.021)
export share	-0.049	0.029	-0.095**
	(0.039)	(0.038)	(0.039)
Hirschmann-Herfindahl index	-0.056	-0.063	-0.101*
	(0.054)	(0.050)	(0.054)
relative unit value	-0.008***	0.005	-0.007**
	(0.003)	(0.003)	(0.003)
EU average price change since the introduction of the product	0.000	-0.000	0.001
	(0.003)	(0.003)	(0.003)
order		0.004***	
		(0.001)	
firm has produced hs4			-0.301***
			(0.012)
firm has produced hs6			-0.490***
			(0.012)
Observations	153145	153145	153145
Number of id	1479	1479	1479

Standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%