The Determinants of Export Performance in Developing Countries: The Case of Indonesian Manufacturing

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Abstract
In this paper we analyse export behaviour of Indonesian companies using a unique database covering all manufacturing firms active in 1995. We test a range of determinants, pointed out by the literature, separately for 28 industries at the three-digit level. Furthermore, the Pavitt taxonomy is applied look for broad sectoral patterns. To estimate the relation between export and its determinants we use a novel empirical model especially suited for estimating fractional variables. Our analysis points that both technology and cost related factors determine export behaviour in supplier dominated firms and, to a lesser degree, scale intensive firms. Our model works less well in explaing export of science base and specialised supplier firms. Also, we find export behaviour to differ between industries within the same Pavitt sector.

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Introduction

Recently, the World Bank published the report *Globalisation, Growth and Poverty: Building an Inclusive World Economy (2001)*. The report shows that 24 developing countries, which increased their integration into the world economy, achieved higher growth in incomes, longer life expectancy and better schooling. Besides foreign direct investment, exporting is one of the most important channels through which developing countries can link with the world economy. Exporting allows firms in developing countries to enlarge their markets and benefit from economies of scale. In addition, several scholars have pointed out the importance of exporting as a channel of technology transfer (e.g. Pack, 1993). In order to formulate trade and industrial policies aimed at stimulating exports, it is important to understand which factors stimulate or deter firms to enter foreign markets.

Most empirical literature has focused on the explanation on inter-country trade patterns using data at the country or sectoral level (e.g. Soete, 1981; Amable and Verspagen, 1995). Presently, the increasing availability of large micro-datasets has triggered research at the firm level (Lefebvre et al., 1998;Sterlacchini, 2001)(e.g. Wagner, 1995; Lefebvre *et al.* 1998; and Sterlacchini, 2001). However, most of this work has been focussed on industrialised countries. This study tries contribute to the understanding of export behaviour of firms in developing countries using a unique dataset, covering virtually all manufacturing plants in Indonesia. The dataset is sufficiently rich to test for a wide range of determinants of export propensity pointed out in the literature. One of our aims is to analyse differences in export behaviour between industries, rarely done in firm level studies. This is important because industries differ substantially in their technology base (Dosi, 1988). The relation between technology related variables such as R&D and economies of scale and export are therefore likely to vary between industries (Wagner, 2001). To do so, we apply a novel econometric model, recently pointed out by Wagner (2001) to make our estimations.

The structure of the paper is as follows: First, an overview is given of several important determinants of export behaviour, pointed out by literature. Subsequently, the relation between size, technology, (human) capital, other determinants and differences between industries are discussed. Secondly, the data and some descriptive statistics are presented followed by the empirical model applied and the obtained results. Finally, we end with a conclusion and some implications for policy formulation.

Determinants of Export

Economists have proposed several theories to explain international trade. For a long time the neoclassical Heckser-Ohlin model has been the dominant paradigm. The model states that

countries specialize in the production and export of products in which they have a comparative cost advantage caused by relative abundance of a certain factor of production. For a typical developing country with a relative plenty of labour and a shortage of capital, this would imply export in labour intensive goods such as textiles. In contrast, industrialised countries, would export capital-intensive goods. However, to reach this conclusion the Heckser-Ohlin model requires very strong assumptions such as perfect competition, no economies of scale and costless availability of technology. In the eighties, so-called new or strategic trade theory loosened some of these stringent assumptions to allow for other sources of comparative advantage. Various models were constructed in which imperfect competition and economies of scale determined international trade patterns (Helleiner, 1992). In addition, neo-technology or technology-gap theories emphasize the role of technology in determining international trade patterns (Dosi *et al.*). Innovation, specialisation and learning are the main determinants of comparative advantage in this literature.

Although the theories outlined above are very broad and mainly used to explain trade patterns between countries, they also provide useful guidance in explaining export at a lower level of aggregation. Previous empirical research showed that comparative advantage in costs, scale economics, perfect competition and technology are also important determinants of export at the firm and sectoral level. In the next sections this research is briefly reviewed.

Size

Traditionally, most research has focussed on the relation between firm size and trade. (see Bonaccorsi, 1992 and Berry, 1992 for overviews). Often, for both developing and industrialised countries, an inverted U-shaped relationship between size and export propensity has been found (e.g. Wagner, 1995; Kumar and Siddharthan, 1994). In the literature, economies of scale in production and export marketing, higher capacity for taking risks, better opportunities to raise financing and sufficient managerial, financial, R&D, and marketing resources have been pointed out as causes for a positive impact of size on export performance.[1] Furthermore, often an inverted u-shaped relation has been found between size and export indicating that advantages of size only hold to a certain threshold point when coordination costs cause further expansion to be non profitable (Wagner, 2001). Another explanation for the non-linear relation between exports and size is pointed out by Wakelin (1998). "Although size is an advantage in exporting, this may not apply to very large firms which can be more orientated towards the domestic market due to, for example a domestic monopoly giving them no incentive to export." (Wakelin, 1998, p. 833). This

[1] See Sterlacchini (2001) for a theoretical model analysing the relation between firm size and exports.

argument is of particular relevance in a developing country such as Indonesia where high import tariffs distorts competition with foreign firms.[2]

R&D, Technological Capabilities and (Human) Capital

In line with the neo-technology/ technology gap theories, R&D has often been used as a proxy for technology. Overall results are mixed. Willmore (1992) and Wagner (2001) find a positive effect of R&D on exports for large pooled samples of Brazilian and German firms respectively. Lall (1981) finds R&D to be significantly negative for a sample of about 100 Indian engineering firms and in the study of Lefebvre *et al.* (1998), R&D is not significant at all for a number specialised suppliers firms.[3] Two explanations can be offered for the different outcomes. First, the importance of R&D on export intensity differs between sectors and/or countries. This is discussed in one of the following sections. Secondly, R&D is only a partial measure of technology because it does not take into account incremental improvements of products and processes. This especially holds for small and medium firms, who do not have a formal R&D department (Brouwer and Kleinknecht, 1993) and in general for firms in developing countries were R&D is low because overall technical change is of an adaptive nature (Kumar and Siddharthan, 1994).

Scholars working in the field of technology and development have frequently stressed that investment in technological capabilities is crucial for successful accumulation of technology (Bell and Pavitt, 1993)(Katz, 1987; Bell and Pavitt, 1993). Technological capabilities are the technical, managerial and organisational skills to generate and manage technical change.[4] Formal R&D is only very small part of capability building in developing countries. "It predominantly consists of practical, shop floor-based, problem solving involved in setting, running, maintaining, repairing and making minor changes to technology in response to local conditions that are different from the circumstances under which the technology was developed" (Romijn, 1997, p. 359). Recently, several studies have tried to quantify technological capabilities into a firm specific technology index by aggregating scores for the various components of technological capabilities, such as product and process improvements, linkages, investment in new equipment, etc. Wignaraja (2001) and Wignaraja and Ikiara (1999) test the relationship between exports and the technology index for firms in Mauritius and Kenya, respectively. Both studies found a positive and significant coefficient. Unfortunately, the sample size of the two studies was small (about 40 firms) and OLS was used which may have biased the results. Sterlacchini (1999) and Nassimbeni (2001) estimate the effect of a number of non-R&D related indicators of innovative activities on exports for a sample of small and medium firms in Italy. They find that share of sales on design and

[2] Fane and Condon (1996) estimated an average real effective rate of protection (RERP) of 16 percent in 1995 for manufacturing.
[3] See section on industry differences for an elaboration on specialised supplier firms.
[4] See Lall (1992) for a taxonomy of capabilities at the national and firm level.

engineering, the technological level of capital stock and product innovation are positively related to export propensity.

Strongly related with technological capabilities are indicators for human capital, such as share of skilled employees or expenditures on training. Wagner (2001) and Wakelin (1998) find human capital to be a positively related to exports for samples of German and British companies, while Willmore (1992) and Ramstetter (1999) find negative signs for large samples of Brazilian and Indonesian firms. The latter results are in line with Heckser-Ohlin theory, which predicts that countries with an abundance of unskilled labour (e.g. Brazil and Indonesia), skilled labour is a scare and expensive factor and therefore negatively related to the amount of goods exported. The same argument vice versa holds for industrialised countries such as Germany and the UK, with relative large endowment of skilled labour. Neo-technology theory, however, predicts that, human capital has a positive impact on exports because skills are positively related to the technological capabilities of the firm. Furthermore, highly educated people have certain abilities, such as speaking foreign languages that make it easier to establish and maintain contacts with foreign customers. The latter might be especially relevant for developing countries. Thus, there seems to be some kind of trade-off between cost disadvantages and skill advantages of human capital.

The same studies investigating the export human capital relationship also incorporated a variable for capital (i.e. fixed assets) in their empirical models.[5] The outcomes are again in accordance with Heckser-Ohlin theory. Capital-intensive industrialised countries turn up with a positive coefficient for capital while the opposite is true for developing countries where capital is scarce. Another argument why capital intensity enhances export success is that it embodies past innovations (Wakelin, 1998) or reflects economies of scale. The latter effect, however, might also hold for firms in developing countries. We believe that the (human) capital-export relation differs between sectors and a more disaggregated analysis as discusses in this section provides different outcomes.

Other Determinants

Besides, size and technology, foreign ownership and market structure are important determinants of export behaviour. Multinational enterprises (MNE) are expected to export more ceteritus paribus because they enjoy certain benefits not available to locally owned firms. Ramstetter (1999) describes two mechanisms how this works. First, because of access to superior production technology and management know-how, MNEs can produce more efficiently and secondly, MNEs possess sophisticated (international) marketing networks that facilitate exporting. Testing for this hypothesis, Ramstetter finds foreign ownership to be significant and positively related with export

[5] Except for Wagner (2001).

propensity using the same dataset on Indonesian firms as used in this study but a different time period.[6] The same result is also found by Willmore (1992).

Through, economies of scale and sharing of resources, firms are also expected to benefit from being part of a multibranch organisation. Furthermore, a dummy for multibranch firm serves as a control variable. "Within a conglomerate, a firm's R&D results may be use by other companies in the group; vice versa, it can make use of R&D done by other firms in the group. In other words, it may behave as if it did R&D while not reporting R&D activities" (Brouwer and Kleinknecht, 1993, p.321). Studying the export behaviour of some 2000 Dutch firms, Brouwer and Kleinknecht (1993) only obtain a positive and significant coefficient for their R&D variable after inclusion of such a dummy.[7]

Another likely determinant of export behaviour is the market structure of an industry. The relationship between these variables is not clear at forehand. If economies of scale are important, high levels of concentration are positively correlated with exports. On the other hand, if concentration implies monopoly power, the effect on export might be negative.

Sectoral Variations

As already briefly indicated above, there are reasons to assume sectoral patterns on the relationship between exports and its determinants. Scholars working in the fields of evolutionary economics argue that industrial sectors differ considerably in terms of technological opportunities and development (Dosi, 1988, Marsilli, 2001). This automatically implies that the role of technology as a determinant of exports will differ between sectors. Another argument why there are inter-sectoral differences in export patterns is provided by product life cycle theory (Vernon, 1966), which predicts that developing countries will specialize in the export of products in mature industries where comparative advantage is mainly determined by production costs.

Following Laursen and Meliciani (2000) and Amable and Verspagen (1995), who analyse export shares of OECD countries, we use the taxonomy of Pavitt (84) to investigate broad sectoral patterns. The taxonomy is composed of four groups of firms: supplier-dominated firms, scale-intensive firms, science-based firms and specialised- supplier firms. In supplier dominated firms, new technology is mainly introduced by suppliers of machinery or other capital goods. Process innovation is relatively more important than product innovation and firms are typically small. Supplier dominated sectors are mature industries such as the textile and food industry. Scale intensive firms produce mainly bulk materials such as cement or steel. Besides specialised

[6] Ramstetter (1999) distinguished four ownership groups, local plants (with foreign ownership shares smaller than 10 percent), foreign plants with low foreign ownership shares (10-50 percent), foreign plants with moderate ownership shares (50-90 percent) and foreign plants with large ownership shares (90 percent and higher). The results indicated that foreign firms had exported more than local firms. However, foreign firms in a higher ownership group exorted relatively more than firms in lower fownership groups.

supplier firms, technical change comes mainly from improvements in the design and operation of the production process learning by doing and incremental change. In science–based firms internal R&D is the main source of technology. In addition, universities provide an important external source of knowledge and technology. The electronic and (parts of the) chemical industry are typical science based industries. Specialised-suppliers develop machinery, instruments and software to be used in all four Pavitt groups. The emphasis is on product innovation by means of in-house design and development. We use OECD (1992) to classify the three digit industries into Pavitt sectors.[8]

Given the characteristics of each Pavitt group, we can make some predictions about the relation between a firms export propensity and the determinants described in the previous sections. In supplier dominated sectors, comparative advantage is likely to be determinated by cost advantages as predicted by the Heckser-Ohlin model (Bell and Pavitt, 1993). We therefore expect unit labour costs to be an important determinant of export behaviour in this group. This outcome has also been found in aggregate studies by Amable and Verspagen (1995) and Laursen and Meliciani (2000) Capital intensity, reflecting economies of scale should play a relative important determinant of export propensity in the group of scale-intensive firms.

In science based industries and to a lesser extent in specialised supplier firms international competitiveness is likely to be based on innovation and hence, R&D should turn up as a significant determinant of exports. The latter result has also been obtained by the two aggregate studies just mentioned.[9] For developing countries, however, such as Indonesia, this might be not the case as is illustrated by the study of Kumar and Siddharthan (1994). They investigate export behaviour of thirteen industries at the three-digit level using a large sample of Indian firms. The industries are divided into three categories, low, medium and high technology industries. The first and second categories correspond roughly to supplier dominated and scale intensive firms, while the third category overlaps with science based and specialised supplier firms. R&D only has a significant and positive effect in low and medium technology industries and not in high technology industries. Kumar and siddharthan argue that "...developing country enterprises are unlikely to achieve competitive advantage on the basis of their own technological activities in high technology industries because of their inability to compete through product innovations, shorter product life cycles, firm specific nature of the knowledge and hence significant economies of vertical integration and geographical diversification" (Kumar and Siddharthan, 1994, p. 293). In our estimates we expect R&D to have a positive effect in supplier

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[7] Brouwer and Kleinknecht (1993) used a dummy explicetly indicating whether or not a firm strongly depends on the mother company for developing new products.

[8] In other work, industries are assigned differently to Pavitt sectors. See Laursen and Meliciani (2000) for an overview of other classifications[check].

[9] Amable and Verspagen (1995) use patents instead of R&D as a technology indicator.

dominated and scale intensive firms and to be of less significance in science based and specialised supplier industries.

The effect of skills, age and market structure on export behaviour per Pavitt sector are unclear at forehand. Size and foreign ownership are expected to positively influence exports in all four Pavitt sectors.

Data and Variables

The data used in this paper is supplied by the Indonesian Central Bureau of Statistics (Biro Pusat Statistik, BPS). Every year, BPS conducts an industrial survey in which all Indonesian establishments with more than 20 employees are required to fill in a questionnaire covering a wide range of questions on labour, capital, output, etc. Although there were some problems with under coverage in the past (Jammal, 1993; Takii and Ramstetter, 2000), currently, the census covers virtually all active manufacturing establishments.[10] An establishment is defined as a plant in contrast to a firm, which may consists of multiple plants. The database has already been extensively used to analyse various other topics such as total factor productivity (Aswicahyono, 1998), spillovers (sjoholm, 1999) and trade (Ramstetter, 1999). For the analysis in this paper, the industrial census of 1995 was used, describing data of 20.239 plants. After removal of firms with missing data or unrealistic figures, a dataset of 20.161 firms was left.[11] The petroleum and gas industry is also removed from the sample because it is almost completely controlled by the state owned company Pertamina.

As set out in previous sections, research points out many possible determinants of export behaviour. In our empirical model we test the relationship between the propensity to export (*EXP*), defined as export to production ratio, on the following variables:

- *Relative firm size (RSIZE)* is measured by the average number of workers per month, normalized by the average number of persons in all firms in the 4-digit industry. The normalisation is done to account for the fact that some firms are small in their own industry but large in others (Wagner, 1995). To control for non-linearity between firm size and export propensity, the square of firm size *(RSIZE2)* is also included in the model.
- *Share of skilled labour (SKILL)* was approximated with the share of skilled employees. In the 1995 industrial census there is a question on the number of employees categorised by seven educational levels: Not finished primary school, primary school (Sekolah Dasar), junior high school (SLTP), senior high school (SLTA), college (sarjana muda/D3), Bachelor (S1), Master

[10] See the appendix in Ramstetter (1999) for a discussion of several important features of the database.
[11] A few firms have values for capital and output ten times higher than the next firm. We assumed reporting errors of some kind and removed the firms from the sample.

(S2) and PhD (S3). The share of skilled employees is defined as the sum of D3, S1, S2 and S3 in total employees.

- *R&D (RD)* is measured by the expenditures on R&D to output ratio.
- A variable for *Training (TRAIN)* is used to estimate the effect of measured by the share of training expenditures in output.
- To examine MNE association, a dummy *(DFOR)*, taking the value of one when more than fifty percent of the firm is in foreign hands, is used.
- A dummy (*DMBRANCH*) is introduced when a firm belongs to a multibranch organisation.
- *Capital intensity (CAPI)* is measured by the ratio of total capital stock to labour. Total capital stock is the sum of the estimated value of land, buildings, machinery and equipment, vehicles, and other fixed capital.
- *Unit labour costs (ULCOSTS)* are defined as the share of labour costs in output.
- *Hirschman-Herfindahl index (HHINDEX*) is used as an indicator for concentration.[12] The index is calculated at the four-digit industry level.
- *Age (AGE)* is introduced as a control variable. The relation between age and exports is ambiguous. Older plants might have higher export propensities because they are more experienced with international trade. In contrast, newer plants are expected to export more because they use relatively modern technology, which increases productivity and product quality. Furthermore, newer plants may also be more inclined to export because Indonesia's trade and industrial policies became more liberal after 1980 (Ramstetter, 1999).

The data available are all from the same year. Preferably, we would have liked to use lagged variables for RD and TRAIN to certify causality runs from the independent variables to exports. In theory, income from exports might for example stimulate expenditures on R&D or training. We, however believe that the main effect works the other way round.

Descriptive Statistics

Table 1 presents descriptive statistics for all variables per Pavitt sector.[13] As is common in a developing country, most firms operate in low technology industries described by the supplier dominated group. Next in size are subsequently the scale intensive, specialised supplier and science based sectors.

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[12] The Hirschman-Herfindahl index is calculated as: $HHINDEX = \sum_{i=1}^{n} a_i^2$, where a_i is market share for firm i in percentages and n is the number of firms in the industry.

[13] The absolute size (SIZE) in number of employees is used instead of the relative size (RSIZE) which would be one for every group.

[TABLE 1 HERE]

The Table clearly reflects the characteristics of the Pavitt taxonomy. Of the four groups, science based and specialised supplier firms have the highest percentage of firms engaged in R&D, 26.6% and 19.5% respectively. The percentages for scale intensive and supplier dominated are much lower with 9.5% and 6.8%. Also expenditures on R&D are highest in science based followed by the three other groups in the same order. Similar patterns are found for SKILL, TRAIN, %FOR and %DMBRANCH, except that the differences between specialised supplier and scale intensive are less pronounced. In addition, conform the Pavitt taxonomy, CAPI is the highest in scale intensive firms. However, contrary to what one would expect, average SIZE of this group is the smallest. Probably, as is common in developing countries, industries are characterised by a dual market structure, composed of small traditional firms and large modern enterprises, each serving their own market (James and Khan, 1998, Blömstrom and Wolff, 1997). This is confirmed by highly positively skewed distribution of SIZE, meaning that there are a small number of very large firms. Relatively most specialised supplier firms export (24.5%) while, export propensity (EXP) is the highest for supplier dominated firms with 0.73. For scale intensive and science based firms, the percentage of firms exporting and the export propensity is somewhat lower. Of the 3-digit sectors (not presented), the furniture (332) and rubber industry (355) are the most export orientated. Both industries have the highest percentage of firms exporting (>30%) with on average, the highest export intensity (>80%).

Empirical Model

To estimate the relationship between the variables outlined above and the export propensity a specific econometric model is required. Ordinary least squares is not suitable because it does not take into account that exports frequently takes a value of zero and is bounded between zero and one. Wagner (2001) recently reviewed the way to model export behaviour. He distinguishes between two basic approaches, a one and a two step model. In the one step model one equation is estimated using both data of non-exporters and exporters. In the two stage model, the decision to export or not is separately modelled from the question of how much to export. Among others, Wakelin (1998), Sterlachinni (1999) and Nassimbeni (2001) use this specification. Wagner rejects the latter approach on the grounds that a profit maximizing firm does not make such a distinction and simultaneously decides if and how much to export.

Of the one-stage procedures, TOBIT estimation is the most popular in empirical studies on export behaviour (e.g. Wagner, 1995; Kumar and Siddharthan, 1994, Lefebvre *et al.*, 1998). Wagner also criticises this methodology because "TOBIT is simply not made for a situation when the endogenous variable is bounded by zero or positive by definition – it is appropriate when the value of the variable can be less than a lower limit but observations with such values of the

variable are not observed because of censoring" (Wagner, 2001, p. 231). He proposes another model by Papke and Woolridge (1996) especially developed to deal with percentage variables bounded by zero and one. The model consists of generalised linear model with a logit as link function. Such a model allows the use of the extreme values zero and one. In addition the White "sandwich" estimator is applied to obtain robust standard errors.[14]

We estimate the following equation 28 industries at the three-digit level using both TOBIT and Papke and Woolridge models (PW):

$$EXP = \int (CONSTANT, RSIZE, RSIZE2, SKILL, RD, TRAIN, DFOR, DMBRANCH, CAPI, ULCOSTS, AGE, HHINDEX)$$

The next section presents the estimation results and compares both models.[15]

Results

Table 2 gives the results for the PW and TOBIT models per industry classified into Pavitt Groups. For practical reasons, we present only the direction of the estimated coefficients and their significance level. The full estimates are available from the author on request. Like Wagner (2001), both models give similar results. Except for a very small number of cases, the sign of the coefficient is always the same between the PW and TOBIT models. However, there are a substantial number of estimations in which the significance level of a coefficient differs between the models.

[TABLE 2 HERE]

A first glance at the table shows that there are many differences in sign and significance level of the determinants between industries and Pavitt sectors. However, the relationship between RSIZE, RSIZE2, DFOR and AGE, and export propensity seems to be broadly constant across all industries. For 21 out of the 28 industries RSIZE is significant with positive sign at the 5 percent significance level or less, highlighting the important effect of economies of scale and other advantages of size on export behaviour. RSIZE2 is has a negative sign in all industries, except industrial and agricultural chemicals, and is statistically significant in more than half of the estimates. This suggests an inverted U-shaped relation between exports and size. For the wood, furniture, rubber and transport industries, the coefficients of RSIZE2 in the TOBIT model are significant while this is not the case for the PW model. Although, there is no direct evidence, we

[14] See McCullagh and Nelder (1989) for an detailed explanation of generalised linear models and Greene (2000, section 11.5.6 and 19.41) for more information on the sandwich estimator.

suspect this inverted u-shaped relation to be partly caused by excessive domestic market power of large firms, reducing their incentive to export. Tariff protection is still high and widely dispersed among industries (Fane and Condon, 1996) and many industries (e.g. steel and cement (Chapman, 1993; Plunkett *et al.*, 1997) are subject to government regulation, distorting competition and stimulating the creation of monopolies.[16]

The dummy for foreign ownership (DFOR) is significant and positive for almost all sectors and models at the 5 percent level or less, indicating the positive effect of MNE association on export behaviour. Only for beverages, leather, shoes and measuring equipment, DFOR is insignificant in both the TOBIT and PW models. Experiments using a dummy variable with a threshold of 10 percent for foreign ownership (not reported) give similar outcomes. These findings are in accordance with earlier studies on the effect of ownership on exports in Indonesia (Ramstetter, 1999).

Table 1 clearly shows that younger firms are inclined to export more than older firms do. There is no industy for which AGE is positively correlated with export propensity. Since this relation is so strong across all industries, we do not think that vintage effects of capital are the cause. It is more likely that as pointed out by Ramstetter, changes in trade or industrial polices play a role.

The variable capturing the quality of labour (SKILL) is significant for six industries at the five percent level or less in both PW and TOBIT models. Four of them (food, textile, clothes and wood) are classified as supplier dominated firms and two are part of the scale intensive group. Remarkable is the difference in sign between the two Pavitt sectors. SKILL is mainly positive in the supplier dominated group, while the opposite is true for scale intensive firms. The result implies that skilled employees provide supplier dominated firms with some kind of advantage that makes it possible to compete in foreign markets. Possible advantages of highly educated labour are personal qualities, such knowledge of languages or improvement in technological capabilities. Conversely, in scale intensive firms the negative signs even indicate cost disadvantages associated with the use of skilled labour. In the other two Pavitt sectors, SKILL is not significant at the 5 percent level or lower, meaning international competitiveness is not gained on the basis of skilled labour.

Expenditures on R&D (RD) is significant and positive at the 5 percent level in the textile pulp and paper and transport industries for both TOBIT and PW models and significant and positive in the beverage, non-ferrous metal and other industries for only the PW estimations. The sign of the estimated coefficients is alternately positive and negative in all Pavitt sectors except for science based where the sign is overall negative. Besides the other industry, which captures a

[15] LIMDEB and STATA (version 7) are used to estimate the TOBIT and PW models, respectively.

rather heterogeneous group of firms, the industries belong to either supplier dominated or scale intensive firms. The results tend to support the findings by Kumar and Siddharthan (1994, p. 299) that in high technology industries it is beyond the capacity of developing countries to achieve export competitiveness on the basis of R&D activity. Another resemblance between Kumar and Siddharthan's study and ours is that broadly the same industries turn up with statistically significant RD coefficients. Of the 13 industries Kumar and Siddharthan investigated, RD is significant for transport equipment, manmade fibres and plastic raw materials, paper and rubber at a significance level of 10 percent or less. At this level of significance, three out of the four industries (i.e. transport, plastic and paper and pulp) are the same in both studies. This might suggest that especially these industries developing countries seem to be competing with a certain expenditure on R&D. This might suggest that especially in these three industries developing countries seem to be competing with a certain expenditure on R&D. An explanation could be that the industry specific technology is relatively complex. R&D is required, not to create new technology but to enhance a firms ability to assimilate and exploit already existing technology. This is the second "face"of R&D as pointed out by Cohen and Levinthal (1989).

The explanatory power of TRAIN on export propensity is very low. Its sign is both mixed negative and positive in all four Pavitt sectors and only significant (negative) in the beverage industry and (positive) in the clothes industry for both types of models. In the study of Brouwer and Kleinknecht (1993) training also turned out to be insignificant. They argue that TRAIN's nature as a flow variable might be the cause of this. Investment in training takes some time to pay off and therefore a stock measure (such as SKILL) would be better.

In line with our expectations, being part of a multibranch organisation has a positive influence on a firm's ability to export. For five industries, DMBRANCH is statistically significant and positive in the PW and TOBIT model and for most of the other industries the sign is positive. An exception is the clay industry where DMBRANCH is significantly negative at a significance level of 1 percent for the PW model.

The sign of capital intensity is positive for industries. Only for two industries, beverages and tobacco CAPI is significantly positive for both the PW and TOBIT model. For six other industries one of the models, in particular the PW model, obtains significant coefficients at the 5 significant level or less. Only in the furniture industry capital intensity is negatively correlated with exports. Striking is, contrary to our expectations, capital intensity is not an important determinant of exports for scale intensive firms. A reason for this might be that SIZE already captures this effect. In contrast, more capital per employee positively effects exports in several supplier dominated firms. This suggests that a certain degree of automation is required even for

[16] In two reports in 1994 and 1995, the World Bank identified cartel agreements in several large industries such as cement, fertiliser distribution, paper production (Bird, 1999). Only in 2000, a competition law has been passed to prevent abuse of market power.

firms operating in relatively low technology industries to break into foreign markets. Also for the some industries in science based and specialised supplier groups, capital intensity seems to give advantage to compete internationally. These results are however only obtained by the PW model.

ULCOSTS is predominantly significant with negative sign in supplier dominated firms. This result is in accordance with the Heckser-Ohlin Hypothesis and product life cycle theory of Vernon (1966) that developing countries compete internationally in mature industries on the basis of low (labour) costs. Besides the rubber industry, ULCOSTS is not significant at 5 percent or less in both models for any of the other Pavitt groups.

The effect on industry concentration on exports is not clear from the estimates. HHINDEX is significant in the PW and TOBIT model for five industries and negative and significant for two industries. For the remaining estimations where HHINDEX is not significant its sign fluctuates between industries and Pavitt sectors. A reason might be the relative few number of four digit industries within a three digit industry for which HHINDEX is calculated.[17] PW and TOBIT estimations for Pavitt sectors (not reported) using pooled industry samples showed that in supplier dominated firms HHINDEX was significant with a negative sign at the 1 percent significance level and significant and positive at the 5 percent level for scale intensive and science based firms (only TOBIT model). More research is required to find out the relation between market structure and export behavior.

Conclusions

In this paper we have analysed export behaviour of Indonesian companies using a unique database covering all manufacturing firms active in 1995. Due to the richness of the database we are able to test a range of determinants, pointed out by the literature, separately for 28 industries at the three-digit level. We classified the industries according to the Pavitt (1984) taxonomy to look for broad sectoral patterns. To estimate the relation between export and its determinants we used a novel empirical model developed by Papke and Woolridge (PW) especially suited for estimating fractional variables. Results for the conventional TOBIT model are also provided for comparison. Like in Wagner (2001) who first applied the PW model to analyse export propensities, both models give broadly similar outcomes.

Our main findings are summarized as follows: The relationship between relative size, the square of relative size, foreign ownership and age and export propensity is similar across industries. The outcomes suggest that the firm size-export relationship is inverted u-shaped. Economies of scale (proxied by size) helps firms enter foreign markets but only up to a certain threshold point. The largest firms in an industry are less inclined to export because they enjoy

[17] The number of four digit industries headed under a three digit industry varies from 17 in the food industry, to only two in the leather, shoes, industrial and agricultural chemicals, glass and clay industry. The average is about five four digit industries within one three digit industry.

local market power caused by government regulation and trade barriers. Foreign ownership is has a strong positive influence on firms export propensity confirming the beneficial effects of MNE association. Younger firms export are earlier inclined to export than older ones. Because, this effect is observed consistent for almost all industries suggest we think recent changes in trade and industrial policies institutional changes, rather than vintage effects explain this phenomenon.

The influence of skilled labour differs between Pavitt sectors. We find skills to be positively related to exports in supplier dominated firms while the opposite result is obtained for scale intensive firms. No relationship is found for science based and specialised supplier firms. This result is in contrast with similar studies on export behaviour in developing countries that do not distinguish between industries. They find that skilled labour is negatively related with exports because of cost disadvantages in line with Heckser-Ohlin theory. Our findings point out that differences between industries do matter and, especially in the category of supplier dominated firms, skilled labour is essential to break into foreign markets.

Our estimates confirm earlier findings of Kumar and Siddharthan (1994) for India, that R&D in developing countries only benefits exports in relatively mature industries categorised under supplier dominated and scale intensive firms. We suspect that this relation is especially relevant in some industries were R&D is required to assimilate new technology. More research is required to confirm these findings. The predictions of Heckser-Ohlin theory and product life cycle theory that developing countries compete on labour costs in mature industries are also uphold. Capital intensity does not influence export behaviour of scale intensive firms, as we expected. For some supplier dominated industries, however, some degree of automation is necessary to enter foreign markets.

Many of the determinants we analysed explain the export behaviour of supplier dominated firms. This is less so for scale intensive firms and besides size, foreign ownership and age, which are significant in all Pavitt sectors, our model does not point out any firm specific characteristics which explain export behaviour in science based and specialised supplier firms. Why is this so? We think that our independent variables refer mainly to non-technology factors, which are much more relevant to firms operating in mature industries. Measures for technological capabilities used in the studies by Wignaraja (2001) and Wignaraja and Ikiara (1999) might generate better results.

Finally, even within a Pavitt sector, large differences remain between industries which factors effect export propensity, suggesting that the Pavitt taxonomy is much to broad to capture all industry specific characteristics. An important implication of our study is that industries are different and should be considered different when industrial and trade policy are formulated

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Table 1
Descriptive Statistics: means (standard deviations)

	Supplier Dominated	*Scale Intensive*	*Science Based*	*Specialised Supplier*
% *EXP>0*	18.6 %	13.8 %	19.4 %	24.5 %
EXP (EXP>0)	0.73 (0.31)	0.59 (0.36)	0.43 (0.38)	0.70 (0.32)
SIZE	199 (680)	180 (508)	225 (396)	170 (353)
SKILL	0.02 (0.05)	0.03 (0.06)	0.08 (0.10)	0.03 (0.06)
% *RD>0*	6.8 %	9.5 %	26.6 %	19.5 %
RD (RD>0)	0.0046 (0.0117)	0.0052 (0.0136)	0.0126 (0.0264)	0.0076 (0.0155)
% *TRAIN>0*	8.6 %	11.4 %	20.8 %	11.1 %
TRAIN (TRAIN>0)	0.0021 (0.0063)	0.0023 (0.0049)	0.0041 (0.0095)	0.0033 (0.0090)
CAPI	11355 (49953)	18555 (83515)	16386 (26935)	12403 (25030)
ULCOSTS	0.21 (0.28)	0.23 (0.23)	0.23 (0.20)	0.28 (0.35)
AGE	12.53 (11.62)	11.71 (10.16)	18.47 (14.18)	10.51 (9.69)
HHINDEX	581.79 (1117.36)	678.10 (875.96)	771.73 (934.73)	1740.95 (1237.61)
% *FOR=1*	3.0 %	6.2 %	12.5 %	10.2 %
% *DMBRANCH=1*	13. 7%	14.7 %	15.8 %	14.7 %
N	14204	4910	361	686

Note: For EXP, RD and TRAIN, means and standard deviation are presented for a subsample where EXP, RD and TRAIN larger than zero, respectively. CAPI is expressed in 1000 Rupiah per person.
Source: BPS (1996).

Table 2
PW and TOBIT Models, 28 3-digit industries

		ONE	RSIZE	$RSIZE_2$	SKILL	RD	TRAIN	DFOR	DMBRANCH	CAPI	ULCOSTS	AGE	HHINDEX	Loglikelihood	N
Supplier dominated															
Food	PW	- ***	+ ***	- ***	+ **	-	+	+ ***	+ ***	-	- ***	- ***	-	-903.197	4220
	TOBIT	- ***	+ ***	- ***	+ ***	-	-	+ ***	+ ***	-	- ***	- ***	-	-1459.435	4220
Beverages	PW	- ***	+ **	- *	-	+ **	- **	+	+	+ ***	+	-	+	-28.088	249
	TOBIT	- ***	+ ***	- **	+	+	- *	+	-	+ **	-	- *	+	-61.660	249
Tobacco	PW	- ***	+ ***	- ***	-	+	-	+ *	+ ***	+ ***	+	-	+ **	-69.452	776
	TOBIT	- ***	+ ***	- **	-	-	-	+ **	+ ***	+ ***	+	- *	+ **	-105.636	776
Textile	PW	- ***	+ ***	- ***	+ **	+ ***	-	+ ***	+	+	-	-	+ ***	-381.719	1876
	TOBIT	- ***	+ ***	- ***	+ ***	+ ***	-	+ ***	+	+ ***	-	+	+ ***	-673.308	1876
Clothes	PW	- ***	+ ***	- **	+ ***	+	+ ***	+ ***	+	+	- **	- **	+	-638.106	1678
	TOBIT	- ***	+ ***	- ***	+ ***	+	+ ***	+ ***	+	+ ***	- **	- ***	+	-1042.905	1678
Leather	PW	- ***	+ ***	- ***	+	+	-	+	+	+	-	- **	+ **	-71.480	207
	TOBIT	- **	+ ***	- ***	+	+	-	+	+	+ *	-	- **	+ **	-120.356	207
Shoes	PW	- ***	+ ***	- ***	+	+	+	+	+	+	-	- ***	- ***	-144.057	370
	TOBIT	- **	+ ***	- ***	+	+	+	+	+	+	-	- **	- ***	-242.068	370
Wood	PW	- ***	+ ***	-	+ ***	-	-	+ ***	+ **	+ **	- ***	- ***	-	-816.160	1655
	TOBIT	- **	+ ***	- ***	+ ***	-	-	+ ***	+ ***	+	- ***	- **	+	-1302.231	1655
Furniture	PW	- **	+ ***	-	+	+	+	+ **	-	+	- ***	- ***	-	-603.712	1132
	TOBIT	-	+ ***	- ***	+	+	+	+ **	-	+	- ***	- ***	-	-950.510	1132
Pulp and Paper	PW	- ***	+ *	-	+	+ ***	+	+	+	- **	- ***	- **	+ ***	-50.040	298
	TOBIT	- ***	+ **	- *	+	+ **	+	+	+	-	- ***	- *	+ ***	-96.762	298
Printing and Publishing	PW	- ***	+ ***	- **	-	+	-	+ **	- *	+	-	-	n.a.	-48.061	551
	TOBIT	- ***	+ ***	- ***	-	+	-	+ **	-	+	-	-	n.a.	-78.362	551
Other non-metallic mineral	PW	- ***	+ **	-	+	-	+	- ***	+ **	+	-	-	-	-45.755	273
	TOBIT	- ***	+ **	-	+	-	-	+	+	+	-	-	+	-93.706	273

		ONE	RSIZE	$RSIZE_2$	SKILL	RD	TRAIN	DFOR	DMBRANCH	CAPI	ULCOSTS	AGE	HHINDEX	Loglikelihood	N
Metal Product	PW	- ***	+ ***	- ***	+	-	-	+ ***	+	-	- **	- ***	+	-164.753	919
	TOBIT	- ***	+ ***	- ***	+	+	-	+ ***	+	-	- **	- ***	+	-313.263	919
Scale intensive															
Industrial and agricultural chemicals	PW	- ***	-	+	-	-	+	+	+	-	+	-	+ ***	-54.444	288
	TOBIT	- ***	+ **	-	-	-	+	+ *	-	+	+	-	+ ***	-116.006	288
Rubber	PW	- ***	+ **	-	- **	-	-	+ ***	+ ***	+	- ***	+	- ***	-188.653	434
	TOBIT	- ***	+ ***	- ***	- **	-	-	+ ***	+ ***	+	- ***	+	- ***	-303.489	434
Plastic	PW	- ***	+ ***	- **	+	+ *	-	+ ***	+	+	-	- ***	n.a.	-147.927	919
	TOBIT	- ***	+ ***	- ***	+	+ *	+	+ ***	+	+	-	- ***	n.a.	-291.283	919
Porcelain	PW	- **	+	-	- ***	+	-	+ ***	+	-	-	-	n.a.	-23.193	95
	TOBIT	-	+ **	- *	- **	+	-	+ ***	+	+	-	-	n.a.	-44.477	95
Glass	PW	- **	+ ***	- **	-	+	+	+ ***	+	-	-	-	-	-17.831	71
	TOBIT	-	+ ***	- **	-	+	+	+ ***	+	-	-	-	+	-29.846	71
Cement	PW	- **	+ ***	- **	- **	-	-	+ ***	+	+	-	+ *	-	-20.943	626
	TOBIT	- ***	+ **	-	-	-	+	+ ***	+	+	-	+	+	-35.847	626
Clay	PW	- ***	+	-	+	-	-	n.a.	- ***	+ **	+	-	+ ***	-24.004	955
	TOBIT	- ***	+	-	+	+	-	n.a.	-	+	+	-	+	-39.023	955
Iron and Steel	PW	- ***	+ ***	- ***	+	+ *	-	+ ***	-	-	-	-	n.a.	-13.438	102
	TOBIT	- **	+ ***	- **	+	+	-	+ ***	+	-	-	-	n.a.	-30.171	102
Non Ferrous Metal	PW	- *	+	-	-	+ **	- **	+ **	- *	+ *	-	-	n.a.	-17.049	62
	TOBIT	-	+ *	-	-	+	-	+ **	- *	+	-	-	n.a.	-29.665	62
Electrical Machinery	PW	- ***	+ ***	- **	+	- **	+ **	+ ***	+	+	-	- ***	- **	-127.800	424
	TOBIT	- ***	+ ***	- ***	+	-	+	+ ***	-	+ *	-	- ***	- ***	-233.503	424
Transport	PW	- ***	+ **	-	+	+ ***	-	+ ***	-	+	-	- ***	+	-77.575	542
	TOBIT	- ***	+ ***	- **	+	+ **	-	+ ***	- *	+	- *	- ***	+	-148.156	542

		ONE	RSIZE	$RSIZE_2$	SKILL	RD	TRAIN	DFOR	DMBRANCH	CAPI	ULCOSTS	AGE	HHINDEX	Loglikelihood	N
Science based															
Basic Chemical Products	PW	- ***	+ ***	- **	-	-	+	+	+ **	+ **	+	- ***	-	-170.466	680
	TOBIT	- ***	+ ***	- ***	+	-	+	+ **	+ **	+	+	- **	-	-325.481	680
Measuring Equipment	PW	- *	+ *	- *	+	-	+	+	-	+	-	- **	+	-17.238	73
	TOBIT	-	+ *	- *	+	+	+	+	-	-	-	- **	+ *	-27.236	73
Specialised suppliers															
Machinery	PW	- ***	+	-	-	-	-	+ ***	+	+ **	-	- **	+	-26.900	287
	TOBIT	- ***	+ *	-	-	-	-	+ ***	+	+	-	-	+	-63.971	287
Other	PW	- ***	+ ***	- *	+	+ ***	+	+ ***	+	+	-	-	-	-187.099	390
	TOBIT	-***	+ ***	- **	+ *	+ *	+	+ ***	+	+	-	-	-	-301.673	390

Notes: n.a. means the coefficient could not be estimated because the variable is constant over the complete sample
*, **, *** indicates significance at 10%, 5%, 1% level, respectively..

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