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Innovation and Export of Vietnam's SME Sector

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Abstract

Innovation has long been considered an important factor for creating and maintaining the competitiveness of nations and firms. Common knowledge stands that innovation is the cause of the increase of exports. However, contradicting empirical evidences are reported in the literature on the causality between innovation and export. In this paper we examine whether innovation performed by small and medium enterprises (SMEs) enhances their exporting likelihood in the context of a developing country of Vietnam. Using an uniquely rich Vietnamese SMEs database, we find that innovation as measured directly by 'new products', 'new production process' and 'improvement of existing products' are important determinants of exports by Vietnamese SMEs. We add to the current literature by examining modification of existing products as an innovation activity. We also find evidence of endogeneity of innovation that may lead to biased estimate of innovation in previous studies, which failed to take this problem into account.

JEL Code: F02, L2, O3

Keywords: Innovation, Export, Vietnam, SME, Instrumental Variable, Bivariate Probit

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1. Introduction

During its transition to a more market-based economy, Vietnam has achieved a rapid economic growth and the expansion of the external sector (Belser 2000, Dollar and Kraay 2004). Since its economic reform known as "doi moi" in 1986, the Vietnamese economy have become one of the fastest growing economies in the world with the average GDP growth rate of over 7 percent per annum. Even more spectacular is the growth rate of about 20 percent per year of the export sector. As Vietnamese domestic enterprises are dominated by small and medium enterprises (SMEs) and given the importance of export growth, a key question naturally faced by policy makers is how to improve the competitiveness of these SMEs in order to sustain its export growth. Among various initiatives being proposed to improve the competitiveness of Vietnam's SMEs, innovation policy has attracted attention not only from policy makers, but also from researchers and the business community.

Cassiman and Martinez-Ros (2004) argue that innovation and exports relate to measures of national competitiveness at macro and micro levels. At macro level, innovation is an important measure for growth of industry and country and exports represents an indication of competitiveness of nations. At firm level, innovation is important for the competitive advantage of firms and determines their growth potential.

In addition to the comparative advantages resulting from factor endowment, economic theories suggest that innovation activities can play an important role for success in international market. International trade models developed by Vernon (1966), Krugman (1979), among others, suggest that innovation is the driving force behind exports. These models suggest that the causation runs from innovation to export. As developing countries imitate the innovative products exported from developed countries, they will later be able to export these matured products back to the developed markets. For developed countries, they have to innovate to keep up their exports and income level. At the firm level, it has been argued that innovating firms have incentives to expand into other markets so as to earn higher returns from their investment (Teece, 1986). Through innovation the innovating firms will obtain and sustain their competitive advantage domestically and internationally. Therefore we can expect a positive link from innovation to export.

At macro level, while there are ample empirical evidence of the linkage between a country's export performance and its innovation activities (Greenhalgh 1990, Verspagen and Wakelin 1997, Narula and Wakelin 1998, Montobbio and Rampa 2005 and DiPietro and Anoruo 2006), at the micro level, the empirical evidence is not conclusive. On the one hand, a number of authors have reported a positive and significant impact of innovation, measured by inputs (R&D expenditure) or output (number of innovations), on exporting and export performance. Analyzing the relation between R&D expenditures and export behavior of Israeli firms, Hirsch and Bijaoui (1985) find that innovative firms are more likely to export. Smith et al. (2002) also find R&D is an important predictor of exporting for Danish manufacturing firms. Harris and Li (2006) study the relation between R&D and export for the U.K, and report that R&D plays an important role for firms to overcome barriers to internationalization, but conditional on having entered export markets R&D does not increase export intensity. Özçelik and Taymar (2004) find the positive effect of innovation activity and R&D intensity on export performance of Turkish manufacturing firms. Basile (2001) examines the relationship between R&D activity and probability of exporting of Italian manufacturing firms. He finds that the export likelihood of innovating firms is higher than that of non-innovating firms. Similar results are reported by Pla-Barber and Alegre (2007) for the French biotechnology industry. On the other hand, some contradicting results are also reported in the literature. Wakelin (1998) finds that UK innovators are less likely to become exporters than non-innovators of the same size. Some studies even report that the association between innovation and export is insignificant (Lefebvre et. al. 1998, and Sterlacchini 1999).

A problem inherent in establishing the causal direction between innovation and export is the potential endogeneity of innovation to trade. As pointed out by Lachenmaier and Wößmann (2006), most of the previous studies failed to deal with the problem of endogeneity between innovation and export. Only recently has the problem of endogeneity been dealt with explicitly (Lachenmaier and Wößmann 2006, Smith et al 2002, Kleinknecht and Oostendorp 2006, Becker and Egger 2007). This endogeneity is due to the fact that (i) competition on the international markets would force exporting firms to innovate to remain competitive and (ii) the exporting firms may 'learn by exporting' as they are exposed to a richer source of knowledge, expertise and technology that is often not available in the home market. Several approaches could be used to handle the endogeneity of innovation. Smith et al (2002), and Kleinknecht and Oostendorp (2006) adopt the simultaneous equation approach while Lachenmaier and Wößmann (2006) use the instrumental variable approach. Most recently, Becker and Egger (2007) use the propensity score matching approach. The conclusion from these studies is that after taking into account the endogeneity issue, innovation measured by R&D or directly observed is found to be an important determinant of export.

In this paper, we investigate how the firms' export behavior depends on their innovation activities, or whether the more innovative firms are more likely to export. We capture innovation activities in three different ways: a new product innovation, a new production process and a modification of existing products. In doing this we take advantage of a newly available dataset, the Vietnam Small and Medium Enterprise Survey 2005. This is a uniquely rich database as it allows us to distinguish different forms of innovation, i.e. product innovation, process innovation and modification/ improvement of existing product. The differentiation is essential to analyze the impact of innovation activities on the decision to export at the micro level.

A rough distinction can be made between product innovation (including both new product innovation and modification of an existing product) and process innovation. Process innovations are a way to improve productivity and reduce production costs, while product innovation gives the innovating firms a competitive advantage. Following Utterback and Abernathy (1975) and Cassiman and Martínez-Ros (2004) we could hypothesize that product innovations and process innovations have a different effect on export performance. But often, product innovation and process innovation are linked as newly developed products or modified products often requires new production technology[1] (Kirbach and Schmiedeberg 2006).

According to Utterback and Abernathy (1975) innovations are produced by a few "performance-maximizing" firms, that have strong technological capabilities and connection with the market, implying that product innovations are first produced in

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[1] We can also distinguish between proper innovation and imitation. It is also argued that competitive advantage will result only from innovation in a strict sense. However, imitation and modification of existing product may allow firms to keep up with its competitors. Thus innovation which are new for the whole market are expected to have a stronger impacts than imitation and modification. However, in Vietnam, most of the firm may be able to imitate only.

the advanced technology countries. For smaller and developing countries like Vietnam, Cassiman and Martínez-Ros (2004) suggest that exports and product innovation should be positively related, as demand in the domestic market is not well developed yet and firms discriminate between domestic and international markets for these novel products for which they do have some market power.

In the case of process innovations we get a different effect as this type of innovation arrives typically in more mature markets where product innovations introduced by "sale-maximizing" firms are often a variation of existing products rather than for creating entirely new products. Process innovations are beginning to build up and along with product innovation they are stimulated by advanced technology (Utterback and Abernathy 1975; and Klepper 1996). Cassiman and Martínez-Ros (2004) suggest that the effect of process innovation on export is less strong than the effect of product innovation. Process innovation helps securing a firm's market position given the characteristics of its product supply. Both modes of innovation are expected to raise firm's propensity to export. In the literature, there are only a few empirical studies that distinguish between different types of innovation. There is empirical evidence suggesting that product innovation rather than process innovation matters for trade performance (Brouwer and Kleinknecht 1993, Basile 2001, Huergo and Jaumandreu 2004, Lachenmaier and Wößmann 2006 and Becker and Egger 2007).

With respect to product modification, firms competing in foreign markets may choose to adapt the physical characteristics or attributes of a product and its packaging to fit the needs and desires of consumers in different countries better and so bear additional costs. To be successful, a modified product must add sufficient incremental revenue such that the additional manufacturing and marketing costs that result from adapting the product are recovered. Though product adaptation is a core aspect of customizing an export market offering, little research has investigated the modification of the physical product and packaging (Calantone et al 2004). We hypothesize that given Vietnam's current technological position, product modification is expected to be the most frequent type of innovation. Our analysis in this paper is an attempt to fill the gap in the literature.

The remainder of this paper is structured as follow. The next section discusses data and variables. Section 3 discusses estimation strategy. Section 4 presents the estimation results while section 5 concludes.

2. Data and variables

TABLE 1 Number and performance of Vietnamese SMEs 2000-2005

	Year	2000	2001	2002	2003	2004	2005
1.	Total number of firms	42,288	51,680	62,908	72,012	91,755	112,952
2.	SMEs (share of total firms)	39,897 (94%)	49,062 (95%)	59,831 (95%)	68,687 (95%)	88,222 (96%)	109,338 (97%)
3.	SMEs' share of total labor force	36%	34%	35%	35%	36%	38%
4.	SMEs' share of total capital stock	38%	29%	29%	31%	34%	33%
5.	SMEs' share of total gross output)	48%	45%	49%	48%	45%	46%

Source: Enterprise Census 2000-2005 of General Statistic Office (GSO) of Vietnam

Table 1 presents a clear picture of SMEs positioning among Vietnamese firms in terms of population and performance over the period of 2000-2005. SMEs continuously account for a large majority of Vietnamese firms i.e. from 94% of 42,000 firms in 2000 to 97% of more than 110,000 firms in 2005. With regards to the observable performance indicators, SMEs employed a rather stable portion of total labor force 34%-38% each year and fluctuating share of capital stock with the peak of 38% in 2000 and its bottom at 29% in 2001. Gross output produced by SMEs are kept at a constant trend at around 45%-49% share of total gross output. The above mentioned figures show that SMEs are the backbone of Vietnam's economy.

In this paper, we use the Vietnam Small and Medium Enterprise Survey conducted in 2005 (SME 2005) to investigate the link between innovation activities and exporting. The survey has been conducted four times in 1991, 1997, 2002 by the Ministry of Labor, Invalid and Social Affairs (MOLISA) and the Stockholm School of Economics and in 2005 by MOLISA and University of Copenhagen. Although attempts have been made to make it possible for researchers to construct a panel data, in our study we use only the 2005 wave as previous waves do not contain the necessary innovation information for our purpose. In particular, while data from previous waves are not available, the SME survey in 2002 did not distinguish between product vs. process innovation. The SME 2005 was meant to be a nationally representative survey and was conducted in ten provinces in Vietnam. In all areas covered by the survey, the sample was stratified by ownership to ensure that all types of non-state firms are included. The SME 2005 is a rich dataset, containing a battery of information about firms' characteristics including enterprise dynamics and growth, bureaucracy, informality, tax, employment, education, social insurance, innovation, export, investment and finance. Apart from the Investment Climate Survey of the World Bank, the survey is the only source of data that contains innovation information for enterprises in general and SMEs in particular in Vietnam. The survey distinguishes between whether the firm introduced new products (product innovation), improved existing products (product modification) and introduced new production process/new technology (process innovation). These are the measures of innovation we used in this paper.[2]

TABLE 2 Innovation and export

Type of innovation / Export status	Product innovation		Process innovation		Product modification	
	Active	Non-active	Active	Non-active	Active	Non-active
Export	117 (11%)	59 (4%)	98 (12%)	78 (4%)	145 (9%)	31 (3%)
Not export	996 (89%)	1567 (96%)	711 (4%)	1852 (96%)	1509 (91%)	1054 (97%)
Sub-total	1113 (100%)	1626 (100%)	809 (100%)	1930 (100%)	1654 (100%)	1085 (100%)
Total surveyed sample (manufacturing only)	2739		2739		2739	

Table 2 presents innovation and export activities of total survey sample firms. Among 2739 surveyed manufacturers, 1113 firms are product innovators, 809 firms are process innovators and 1654 firms engaged in product modification. The table suggests that our innovation measures are positively correlated with the export decision of firms. As shown above, 11% of the product innovation active firms are

[2] Although contaning information on innovation, this survey is not comparable to Conmmunity Innovation Survey or Canadian Survey of Innovation used to collect innovation data in Europe and Canada respectively. Further details of the survey could be found in (Rand and Tarp, 2007).

exporters, whereas for non-product innovators the rate is only 4%. With regards to correlation between process innovation/product modification and export: 12% of process innovators vs. 4% of non-process innovators and 9% of product adapter vs. 3% of non-product adapter are found accordingly.

The description of variables and related statistics are provided in Table 3.

3. Estimation strategy

Following Roberts and Tybout (1997) and Bernard and Jensen (1999), we assume that the decision to export is made by rational and profit maximizing firms. If the expected return from exporting is greater than not exporting the firm will export its products. Following previous studies, the reduced form export model is specified as follows:

$$Export = \beta_0 + \beta_1 X + \theta_2 Innovation + \varepsilon \qquad (1)$$

where *Export* is an indicator taking value of 1 if firm *i* is an exporter in the survey year and 0 otherwise, X is a vector which includes firm's characteristics such as firm size, turnover, capital intensity, regional dummies, sector dummies, and ε is an error term. As the dependent variable *Export* is a binary response variable, the equation (1) is estimated as a probit or logit model.

As discussed above, our data allows us to distinguish between product innovation, process innovation and product modification, *Innovation* in (1) is a generic measure of innovation. In particular in the empirical investigation we consider three measures of innovations

- *Product Innovation:* This is a dichotomous variable that takes the value 1 when the firm introduces new products in the survey year; and 0 otherwise.
- *Process Innovation*: This is a dichotomous variable that takes the value 1 if the firm introduces new production processes/new technology; and 0 otherwise.
- *Product modification*: This is a dichotomous variable that takes the value 1 if the firm introduces any major improvement of existing products or changed specification in the survey year; and 0 otherwise.

Following previous research, we also control for a range of variables in the vector X that possibly affect the decision to export. Several studies have confirmed a non-linear relation between firm size and exports. Larger firms have access to more resources with which to enter foreign markets. The skill level within a firm has also been identified as important determinant of exporting. Wakelin (1998) use average wages to capture the skill level. Roper and Love (2002) use the proportion of graduates among plant employees as a proxy for skills. Our control variables include location and sectoral dummy variables.

Previous studies have pointed out the potential endogeneity between innovation and exporting (Becker and Egger 2007, Lachenmaier and Wößmann 2006). Hence, direct estimation of the equation (1) above using logit/probit model without taking the endogeneity into account will lead to a biased estimate of the causal effect of innovation on export. This is because the innovation measures may be correlated with the error term ε.

A common approach in the literature to deal with the endogeneity is the instrumental variable (IV) approach which has been employed in Lachenmaier and Wößmann (2006).[3] The basic idea of the IV approach is to find variables that are highly correlated with innovation but not with the error term, ε, in the *Export* equation (1) above. Usually, in the traditional framework of linear regression model, a first-stage equation is specified for *Innovation* as follow:

$$Innovation = Z\gamma + u \tag{2}$$

where Z is the vector of instruments. The difficult part of the IV approach is to identify appropriate instruments. Our strategy is to use the fitted value of innovation obtained after estimating equation (2) as the instrument in equation (1). As the innovation measure in (2) is a binary variable, using fitted probabilities from the first stage binary response model as an instrument is a good strategy. Wooldridge (2002, pp. 623-625) points out that the standard error and test statistics are asymptotically valid and that even when equation (2) is not correctly specified, the fitted probabilities can still be used as an instrument when *z* is partially correlated with *Innovation*.

Once we adopt an IV approach, another complexity is introduced by the fact that our dependent variable is binary, i.e. equal to 1 if a firm is an exporter, and 0 otherwise. Consequently, instead of the linear probability model, a non-linear limited dependent

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[3] It is important to note that while the IV identification strategy allow us to estimate the impact of innovation on exporting, it does not allow us to test the reverse effect of exporting on innovation.

variable specification that could accommodate the treatment for the endogeneity of the innovation variable must be adopted. On the other hand, proper tests do not exist to ensure the validity and strength of the instruments for this class of models. Consequently, we first run all diagnostic tests on the OLS specification[4] and then use the selected instruments in the instrumental variables probit specification.[5]

In addition to the IV approach, as the dependent variable and the endogenous variable are both binary variables, we follow Wooldridge (2002, pp. 477-478) and Smith et al (2002) to estimate the export equation (1) and the innovation equation (2) jointly using the maximum likelihood estimation method. The covariance of the error terms in the above two equations is given by $Cov(\varepsilon_i, u_i)=\rho$. The appropriate model for the two equations is the bivariate probit model.[6]

For identification purposes, the vector Z in (2) should include at least a variable not included in (1). In our case, the excluded variables are the number of employees having college education (SKILLWORKER), the awareness of the owners/managers regarding the difficulty of lacking skilled workers (LACKSKILLEDWORKER), training activities (TRAINING2) and the investment strategy of the enterprises ranging from invest to raise the capacity of firms (INV_CAPACITY), invest to replace equipment (INV_REPLACE), invest to improve productivity (INV_PRODUCTIVITY), invest to improve quality of product (INV_QUALITY), invest to develop new product (INV_NEW), with the base group as no investment). We believe that the investment strategy of the enterprise, perception toward skilled workers and the number of skilled employees will be important determinants for innovation but not for export.

[4] These diagnostic tests will be made availble upon request.

[5] We use the STATA **-ivprobit-** procedure which is designed to fit models with dichotomous dependent variables and endogenous regressors.

[6] We use STATA **-biprobit-** which is designed to fit maximum likelihood two-equation simultaneous probit model.

4. Estimation results

This section presents the results of the estimation of our empirical models, starting with the simple binary probit estimation, followed by instrumental variable probit results and bivariate probit results.

4.1 Binary probit results

As a baseline comparison, Table 4 reports the results for probit regression for each type of innovation measures. Specification (1) uses the product innovation dummy. Controlling for various firm's characteristics, regional and sectoral dummies, firms that introduced product innovation are more likely to export than firms that did not introduce product innovation. Specifications (2) and (3) report similar results. Both process innovation and product modification are found to be important determinant of exporting. The conclusion from these simple models is that more innovative firms will be more likely to export. However, in specification (3'), when we include all three measures on innovation in one model to see if the effects are the same, only the product innovation (NEWPRODUCT) remains statistically significant, both the process innovation (NEWPROCESS) and product modification (MODIPRODUCT) lose their statistical significance. The implication of this finding is that product innovation seems to be the most robust predictor of exporting.[7]

In terms of control variables, firm size as measured by revenue (LOGREV04) and labor cost structure as measured by (WAGESHARE04) are significant predictors of firm's exporting likelihood. These two variables are positive and statistically significant. The variable average wage (WAGEMEAN04) is statistically significant but having negative sign, implying the higher the cost of labor the less likely the firm will export. This is quite interesting and consistent with the situation of Vietnamese firms and SMEs in particular whose exports are labor intensive. As a result, firms producing labor intensive products (higher wage share) will be more likely to export while firms producing relatively capital intensive products (higher average labor cost) will be less likely to export products. These results are of similar magnitude and consistent across models for different innovation measures.

4.2 Instrumental variable probit results

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[7] We thank an anonymous referee for this suggestion.

As discussed above, we adopt the instrumental variable probit model to estimate the causal effect of innovation on exporting. Results of these IV regressions are reported in Table 5. Specifications (4), (5) and (6) are for product innovation, process innovation and product modification. [8] Qualitatively the results estimated from the IV models support the results in the previous section. The product innovation, process innovation and product modification are all statistically significant, confirming the results from the simple probit models that firms that engaged in the innovation activities are more likely to export. However, the magnitudes of the estimated coefficients from the IV models are larger than the same innovation measures estimated in the simple binary probit models.

In an attempt to form an econometric foundation for our claim regarding instrumental validity, we perform several statistical tests. As pointed out earlier, however, the proper tests are not readily available for our limited dependent variable models. We instead perform these tests using the framework of the linear probability model. Consequently, the test statistics should be interpreted with caution. The results of these tests are presented in Table 6. As we follow Wooldridge (2002) to use the fitted probabilities in the first stage probit estimation as an instrument, the model is exactly identified with one endogenous variable and one instrument. Therefore, there is no over-identification test statistics available. Table 6 provides the results of relevant tests regarding the strength of our instruments. At the outset, the p-values for the Anderson Identification (IV Relevance) Tests support our claim regarding the adequate explanatory power of our instruments. Complementing these findings, we present the first stage regression results for these three innovation models in Appendix 1 to substantiate our assertion regarding instrumental relevance. As indicated in Table 6, the Cragg-Donald F-statistics estimated for the three models are 97.5, 126.2 and 135.5, which are all higher than 10 and pass our "rule-of-thumb" test. Finally, the calculated Wu-Hausman and Durbin-Wu-Hausman test statistics suggest that the instrumental variables estimator should be employed.

4.3 Bivariate probit results

[8] Ideally we should have specified and estimated an instrumental variable probit model which includes all three measures of innovation like the specification (3’). However, it is extremely difficult to find appropriate instruments for each of the three innovations separately.

As discussed above, due to the unavailability of proper statistical tests for the instrumental variables probit model, we specify and estimate the equations (1) and (2) jointly within the framework of the bivariate probit model as a robustness check for the results obtained from the IV models. The estimation results are presented in Table 7, with specification (7), (8) and (9) are for product innovation, process innovation and product modification respectively. There is some evidence of the endogeneity of innovation. The likelihood ratio tests of the null hypothesis that the Rho coefficient equals zero are rejected for the product and process innovation models (specification 7 and 8) at the significance level of 10 percent and 5 percent respectively with the corresponding Chi-square statistics of 2.8 and 4.2. We are unable to reject the null hypothesis of no correlation for the product modification model (specification 9).. This result suggests that the potential endogeneity between innovation and exporting should also be taken into account in estimating the link between the two.[9]

In all three specifications, the innovation measures are found to be statistically significant, indicating the higher propensity of exporting for innovation-active firms. The estimates from the bivariate models, however, fall between the simple probit and the IV models. As the bivariate probit model is the most efficient model estimating the two equations simultaneously, the preferred specification is the bivariate model. Our results lend support to the few previous studies that examine process innovation and exporting (Lachenmaier and Wößmann 2006; and Becker and Egger 2007).

5. Conclusion

In this paper, we examine whether innovation causes export for a sample of Vietnam's small and medium enterprises. Going beyond previous studies which examined only product and process innovation, we use three measures of innovation, namely product innovation, process innovation and modification of existing product. Thus we add to the literature by examining the impact of modification of existing products on exporting. We employ both the instrumental variable approach and the bivariate probit model to deal with the endogeneity of innovation.

[9] It should also be noted that the bivariate probit models estimated here do not allow any inference on the effects of export on innovation. It would have been interesting to include exports in the innovation equations, but this would lead to a conherency problem as pointed out by Maddala (1983).

Our results indicate that innovations are an important determinant of exporting for Vietnamese small and medium enterprises. All three measures of innovation employed in our paper are statistically significant. Our results have important implication in the context of Vietnam. That is, on top of the comparative advantages that push Vietnamese export, a policy to encourage innovation activities by SMEs should be in place. This makes sense in an SME dominant economy which is integrating into the global market via international trade. Furthermore, government should pay particular attention in its innovation strategy to the breakdown of innovation into the development of new products, the adoption of new production process/technology and the modification of existing products. This paper confirms that boosting firm's competitiveness through fostering innovation cause export growth. Our paper also finds evidence of the endogeneity of innovation. Previous studies which failed to take this endogeneity into account may lead to biased estimate of innovation.

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TABLE 3. Description of variables (N=2739)

Variable	Description	Mean	Std. Dev.
Dependent variable			
EXPORT	1 if exporter, 0 otherwise	0.06	0.25
Innovation			
NEWPRODUCT	1 if firm introduces new product(s), 0 otherwise	0.41	0.49
NEWPROCESS	1 if firm introduces new production process, 0 otherwise	0.30	0.46
MODIPRODUCT	1 if firm makes major improvements of existing product(s) or changes specification, 0 otherwise	0.60	0.49
Control variables			
LOGREV04	Log of firm's revenue in 2004	12.95	1.71
WAGEMEAN04	Ratio of total wage to number of employees (Million Vietnam Dong)	7862.55	12111.32
WAGESHARE04	Ratio of total wage to firm's revenue in 2004	0.13	0.14
Instruments			
SKILLWORKERS	Number of skill workers	3.84	16.61
INV_CAPACITY (investment strategy)	1 if firm invests in their capacity, 0 otherwise	0.38	0.49
INV_REPLACE (investment strategy)	1 if firm invests in replacing old equipment, 0 otherwise	0.11	0.31
INV_PRODUCTIVITY (investment strategy)	1 if firm invests in improving their productivity, 0 otherwise	0.07	0.25
INV_QUALITY (investment strategy)	1 if firm invests in improving their quality of output, 0 otherwise	0.02	0.13
INV_NEW (investment strategy)	1 if firm invests in producing new output, 0 otherwise	0.02	0.15
INV_OTHER (investment strategy)	1 if firm's investment is for other purposes, 0 otherwise	0.02	0.14
LACKSKILLEDWORKER	1 if firm's owner perceived the importance of lacking skilled workers in starting up new projects, 0 otherwise	0.30	0.46
TRAINING2	1 if firm normally trains its existing workers or new workers, 0 otherwise	0.06	0.23
Location			
HCM	1 if firm located in Ho Chi Minh city, 0 otherwise	0.25	0.43
HN	1 if firm located in Hanoi city, 0 otherwise	0.11	0.31
HAIPHONG	1 if firm located in Hai Phong city, 0 otherwise	0.07	0.26
HATAY	1 if firm located in Ha Tay province, 0 otherwise	0.14	0.35
LONGAN	1 if firm located in Long An province, 0 otherwise	0.05	0.21
PHUTHO	1 if firm located in Phu Tho province,	0.10	0.30

	0 otherwise		
QUANGNAM	1 if firm located in Quang Nam province, 0 otherwise	0.06	0.24
NGHEAN	1 if firm located in Nghe An province, 0 otherwise	0.14	0.35
KHANHHOA	1 if firm located in Khanh Hoa province, 0 otherwise	0.04	0.19
Sector			
FOOD	1 if firm engaged in manufacturing food sector (meat, grain, bakery), 0 otherwise	0.25	0.43
BEERTOBACO	1 if firm engaged in manufacturing beer and tobacco sectors, 0 otherwise	0.03	0.16
TEXTILE	1 if firm engaged in textile sector, 0 otherwise	0.09	0.29
WOOD	1 if firm engaged in manufacturing wood sector (wood, pulp and furniture), 0 otherwise	0.21	0.40
PRINTING	1 if firm engaged in publishing, printing and related media sectors, 0 otherwise	0.02	0.15
CHEMICAL	1 if firm engaged in chemical sector (basic chemical and other chemical, coke, petroleum), 0 otherwise	0.02	0.14
RUBBER	1 if firm engaged in manufacturing rubber sector, 0 otherwise	0.13	0.33
METAL	1 if firm engaged in metal sector, 0 otherwise	0.20	0.40
MACHINARY	1 if firm engaged in manufacturing machinery sector, 0 otherwise	0.05	0.23
JEWELLERY	1 if firm engaged jewellery sector, 0 otherwise	0.03	0.17

TABLE 4 Probit regressions. Dependent variable: *EXPORT*

Variable \ Model	(1) Product innovation	(2) Process innovation	(3) Product modification	(3') 3-type of innovation
NEWPRODUCT	0.344***			0.252**
	(0.100)			(0.116)
NEWPROCESS		0.203**		0.062
		(0.100)		(0.109)
MODIPRODUCT			0.337***	0.178
			(0.119)	(0.136)
LOGREV04	0.513***	0.506***	0.512***	0.507***
	(0.036)	(0.036)	(0.036)	(0.037)
WAGEMEAN04	-0.013**	-0.012**	-0.012*	-0.013**
	(0.000)	(0.000)	(0.000)	(0.000)
WAGESHARE04	2.386***	2.368***	2.406***	2.396***
	(0.267)	(0.266)	(0.267)	(0.269)
HCM	-0.166	-0.239	-0.170	-0.163
	(0.250)	(0.245)	(0.249)	(0.251)
HN	-0.216	-0.293	-0.194	-0.222
	(0.267)	(0.264)	(0.266)	(0.270)
HAIPHONG	-0.913***	-0.971***	-0.937***	-0.931***
	(0.329)	(0.326)	(0.329)	(0.330)
HATAY	-0.496*	-0.571**	-0.520*	-0.511*
	(0.274)	(0.269)	(0.272)	(0.275)
LONGAN	-0.319	-0.313	-0.279	-0.318
	(0.361)	(0.354)	(0.358)	(0.362)
PHUTHO	-0.311	-0.411	-0.292	-0.314
	(0.346)	(0.344)	(0.344)	(0.350)
QUANGNAM	-0.380	-0.430	-0.420	-0.379
	(0.391)	(0.379)	(0.387)	(0.390)
NGHEAN	-0.523	-0.601*	-0.517	-0.534*
	(0.318)	(0.315)	(0.318)	(0.321)
KHANHHOA	0.023	-0.103	-0.039	-0.013
	(0.314)	(0.312)	(0.314)	(0.317)
FOOD	0.385*	0.351*	0.386*	0.397*
	(0.208)	(0.207)	(0.209)	(0.209)
BEERTOBACO	0.309	0.322	0.351	0.317
	(0.357)	(0.348)	(0.355)	(0.359)
TEXTILE	0.885***	0.890***	0.893***	0.883***
	(0.199)	(0.199)	(0.200)	(0.200)
WOOD	0.526***	0.548***	0.523***	0.523***
	(0.192)	(0.192)	(0.193)	(0.193)
PRINTING	0.221	0.227	0.244	0.214
	(0.322)	(0.320)	(0.321)	(0.323)
CHEMICAL	0.022	0.021	0.094	0.044
	(0.375)	(0.372)	(0.366)	(0.374)
RUBBER	0.262	0.265	0.268	0.262
	(0.208)	(0.207)	(0.208)	(0.209)
MACHINARY	-0.024	-0.004	-0.003	-0.031
	(0.249)	(0.249)	(0.250)	(0.251)
JEWELLERY	0.897***	0.911***	0.899***	0.888***
	(0.257)	(0.257)	(0.258)	(0.258)
Constant	-9.250***	-8.980***	-9.299***	-9.265***
	(0.585)	(0.580)	(0.588)	(0.598)
Observations	2739	2739	2739	2739
LR Chi square	478.87(22)	470.90(22)	475.19(22)	481.31(24)
Pro>Chi square	0.00	0.00	0.00	0.00
Pseudo R square	0.3665	0.3604	0.3637	0.3684
Log likelihood	-413.88	-417.86	-415.72	-412.66

Note: Estimated by probit model. – Standard errors in parentheses. – level of significance: *** 1%, ** 5%, * 10%.

TABLE 5 IV probit regressions. Dependent variable: *EXPORT*

Variable \ Model	(4) Product innovation	(5) Process innovation	(6) Product modification
NEWPRODUCT	1.337***		
	(0.305)		
NEWPROCESS		1.148***	
		(0.324)	
MODIPRODUCT			1.313***
			(0.317)
LOGREV04	0.374***	0.359***	0.392***
	(0.073)	(0.074)	(0.067)
WAGEMEAN04	-0.012**	-0.011*	-0.011*
	(0.000)	(0.000)	(0.000)
WAGESHARE04	1.851***	1.974***	2.043***
	(0.363)	(0.326)	(0.325)
HCM	-0.009	-0.194	-0.010
	(0.230)	(0.227)	(0.233)
HN	-0.117*	-0.448*	-0.077
	(0.242)	(0.248)	(0.246)
HAIPHONG	-0.714**	-0.932***	-0.820***
	(0.309)	(0.304)	(0.304)
HATAY	-0.275	-0.591**	-0.453*
	(0.261)	(0.249)	(0.250)
LONGAN	-0.343	-0.318	-0.196
	(0.320)	(0.325)	(0.324)
PHUTHO	-0.175	-0.413	-0.039
	(0.315)	(0.318)	(0.327)
QUANGNAM	-0.109	-0.356	-0.363
	(0.360)	(0.349)	(0.350)
NGHEAN	-0.360	-0.638**	-0.375
	(0.292)	(0.290)	(0.294)
KHANHHOA	0.091	-0.284	-0.069
	(0.284)	(0.296)	(0.285)
FOOD	0.586***	0.341*	0.573***
	(0.189)	(0.190)	(0.193)
BEERTOBACO	0.405	0.136	0.533
	(0.324)	(0.334)	(0.327)
TEXTILE	0.779***	0.803***	0.774***
	(0.193)	(0.194)	(0.196)
WOOD	0.444**	0.532***	0.398**
	(0.177)	(0.178)	(0.184)
PRINTING	0.098	0.053	0.172
	(0.295)	(0.304)	(0.295)
CHEMICAL	0.185	0.039	0.150
	(0.338)	(0.341)	(0.334)
RUBBER	0.303	0.254	0.308
	(0.185)	(0.191)	(0.188)
MACHINARY	-0.006	-0.007	0.038
	(0.222)	(0.229)	(0.225)
JEWELLERY	0.791***	0.812***	0.796***
	(0.243)	(0.247)	(0.245)
Constant	-7.684***	-7.055***	-8.199***
	(1.027)	(1.082)	(0.897)
Rho	-0.490	-0.421	-0.467
	(0.151)	(0.142)	(0.149)
Observations	2738	2738	2738
Wald Chi square	409.95(22)	381.60(22)	368.03(22)
Pro>Chi square	0.00	0.00	0.00
Log likelihood	-2113.21	-1867.34	-2007.11

Note: Estimated by IV probit model. – Standard errors in parentheses. – level of significance: *** 1%, ** 5%, * 10%.

TABLE 6 Instrumental Variable Model - Test statistics

Statistics \ Model	Product innovation		Process innovation		Product modification	
	Value	P-value	Value	P-value	Value	P-value
Anderson canon. Corr. LM statistic (Underidentification test)	94.99	0.00	121.59	0.00	130.19	0.00
Cragg-Donald Wald F statistic (Weak identification test)	97.58		126.18		135.54	
Wu-Hausman F test	26.82	0.00	43.59	0.00	6.38	0.01
Durbin-Wu-Hausman chi-sq test	26.79	0.00	43.28	0.00	6.42	0.01

Note: Calculated from linear probability model.

TABLE 7 Bivariate probit regressions. Dependent variable: *EXPORT*

Variable \ Model	(7) Product innovation		(8) Process innovation		(9) Product modification	
	Export equation	**Innovation equation**	**Export equation**	**Innovation equation**	**Export equation**	**Innovation equation**
NEWPRODUCT	0.876***					
	(0.288)					
NEWPROCESS			0.819***			
			(0.261)			
MODIPRODUCT					0.853***	
					(0.310)	
SKILLWORKERS		0.004		0.010**		0.003
		(0.004)		(0.004)		(0.004)
INV_CAPACITY		0.271***		0.392***		0.249***
		(0.062)		(0.067)		(0.063)
INV_REPLACE		0.271***		0.476***		0.332***
		(0.088)		(0.093)		(0.090)
INV_PRODUCTIVITY		0.429***		0.422***		0.559***
		(0.108)		(0.114)		(0.117)
INV_QUALITY		0.605***		0.925***		1.177***
		(0.195)		(0.202)		(0.256)
INV_NEW		0.776***		0.851***		0.569***
		(0.183)		(0.183)		(0.204)
INV_OTHER		0.254		0.279		0.002
		(0.185)		(0.199)		(0.186)
LACKSKILLEDWORKER		0.291***		0.138**		0.264***
		(0.058)		(0.061)		(0.062)
TRAINING2		0.466***		0.579***		0.620***
		(0.117)		(0.117)		(0.144)
LOGREV04	0.454***	0.120***	0.418***	0.207***	0.461***	0.134***
	(0.054)	(0.020)	(0.055)	(0.021)	(0.053)	(0.021)
WAGEMEAN04	-0.012**		-0.012**		-0.012*	
	(0.000)		(0.000)		(0.000)	
WAGESHARE04	2.242***		2.206***		2.293***	
	(0.285)		(0.274)		(0.285)	
HCM	-0.090	-0.304**	-0.217	-0.055	-0.081	
	(0.245)	(0.151)	(0.236)	0.163)	(0.249)	(0.159)
HN	-0.167	-0.330**	-0.394	0.379**	-0.130	-0.487***
	(0.260)	(0.161)	(0.256)	(0.172)	(0.263)	(0.169)
HAIPHONG	-0.836**	-0.285*	-0.960***	0.004	-0.901***	0.007
	(0.322)	(0.169)	(0.315)	(0.182)	(0.322)	(0.180)
HATAY	-0.391	-0.434***	-0.588**	0.134	-0.496*	-0.054

	(0.272)	(0.157)	(0.259)	(0.169)	(0.267)	(0.165)
LONGAN	-0.344	0.134	-0.325	0.038	-0.238	-0.214
	(0.349)	(0.183)	(0.339)	(0.198)	(0.350)	(0.189)
PHUTHO	-0.241	-0.521***	-0.423	-0.181	-0.149	-1.016***
	(0.338)	(0.168)	(0.331)	(0.185)	(0.349)	(0.175)
QUANGNAM	-0.250	-0.693***	-0.404	-0.259	-0.399	-0.156
	(0.384)	(0.179)	(0.366)	(0.195)	(0.377)	(0.182)
NGHEAN	-0.447	-0.394**	-0.653**	0.088	-0.446	-0.413**
	(0.311)	(0.160)	(0.305)	(0.171)	(0.315)	(0.165)
KHANHHOA	0.060	-0.272	-0.222	0.453**	-0.057	0.070
	(0.305)	(0.193)	(0.305)	(0.200)	(0.307)	(0.207)
FOOD	0.505**	-0.694***	0.355*	-0.130	0.500**	-0.721***
	(0.207)	(0.083)	(0.199)	(0.088)	(0.212)	(0.081)
BEERTOBACO	0.375	-0.413**	0.205	0.284*	0.466	-0.685***
	(0.348)	(0.172)	(0.344)	(0.170)	(0.352)	(0.168)
TEXTILE	0.852***	-0.070	0.845***	-0.077	0.857***	0.000
	(0.197)	(0.104)	(0.195)	(0.111)	(0.200)	(0.110)
WOOD	0.498***	0.034	0.548***	-0.121	0.465***	0.256***
	(0.187)	(0.082)	(0.185)	(0.089)	(0.194)	(0.088)
PRINTING	0.158	0.165	0.113	0.367*	0.207	0.084
	(0.316)	(0.179)	(0.314)	(0.188)	(0.317)	(0.193)
CHEMICAL	0.109	-0.426**	0.032	-0.056	0.134	-0.195
	(0.366)	(0.200)	(0.357)	(0.215)	(0.358)	(0.198)
RUBBER	0.287	-0.232**	0.256	-0.108	0.297	-0.254***
	(0.201)	(0.093)	(0.200)	(0.101)	(0.203)	(0.096)
MACHINARY	-0.016	-0.082	-0.003	-0.074	0.013	-0.194
	(0.241)	(0.125)	(0.239)	(0.134)	(0.244)	(0.132)
JEWELLERY	0.860***	-0.031	0.853***	0.017	0.867***	-0.020
	(0.252)	(0.157)	(0.251)	(0.165)	(0.254)	(0.167)
Constant	-8.692***	-1.586***	-7.879***	-3.657***	-8.957***	-1.212***
	(0.733)	(0.287)	(0.797)	(0.315)	(0.695)	(0.300)
Rho	-0.345		-0.388		-0.326	
	(0.176)		(0.150)		(0.188)	
Observations	2738		2738		2738	
Wald Chi square	761.54(50)		832.69(50)		833.50(22)	
Pro>Chi square	0.00		0.00		0.00	
Log likelihood	-2029.97		-1812.19		-1945.01	

Note: Estimated by bivariate model. – Standard errors in parentheses. – level of significance: *** 1%, ** 5%, * 10%.

APPENDIX 1 First stage (IV probit regressions)

Variable \ Model	Product innovation	Process innovation	Product modification
LOGREV04	0.127***	0.218***	0.141***
	(0.019)	(0.021)	(0.020)
SKILLWORKERS	0.003	0.007*	0.001
	(0.003)	(0.004)	(0.003)
INV_CAPACITY	0.276***	0.396***	0.253***
	(0.062)	(0.067)	(0.063)
INV_REPLACE	0.285***	0.496***	0.341***
	(0.088)	(0.093)	(0.090)
INV_PRODUCTIVITY	0.447***	0.440***	0.576***
	(0.108)	(0.115)	(0.116)
INV_QUALITY	0.596***	0.927***	1.170***
	(0.198)	(0.204)	(0.257)
INV_NEW	0.815***	0.905***	0.602***
	(0.181)	(0.182)	(0.203)
INV_OTHER	0.261	0.279	0.002
	(0.187)	(0.202)	(0.187)
LACKSKILLEDWORKER	0.278***	0.118*	0.249***
	(0.058)	(0.061)	(0.061)
TRAINING2	0.437***	0.556***	0.600***
	(0.118)	(0.118)	(0.145)
HCM	-0.304**	-0.055	-0.442***
	(0.151)	(0.163)	(0.159)
HN	-0.330**	0.384**	-0.492***
	(0.161)	(0.171)	(0.170)
HAIPHONG	-0.285**	0.009	-0.004
	(0.169)	(0.182)	(0.181)
HATAY	-0.439***	0.129	-0.063
	(0.157)	(0.169)	(0.166)
LONGAN	0.134	0.035	-0.219
	(0.184)	(0.198)	(0.190)
PHUTHO	-0.522***	-0.181	-1.024***
	(0.168)	(0.186)	(0.176)
QUANGNAM	-0.698***	-0.259	-0.163
	(0.179)	(0.195)	(0.182)
NGHEAN	-0.391**	0.099	-0.417**
	(0.160)	(0.171)	(0.166)
KHANHHOA	-0.279	0.452**	0.065
	(0.193)	(0.200)	(0.208)
FOOD	-0.694***	-0.130	-0.720***
	(0.083)	(0.088)	(0.081)
BEERTOBACO	-0.417**	0.283*	-0.688***
	(0.172)	(0.170)	(0.168)
TEXTILE	-0.065	-0.071	0.006
	(0.104)	(0.111)	(0.110)
WOOD	0.036	-0.120	0.257***
	(0.082)	(0.090)	(0.088)
PRINTING	0.171	0.375**	0.093
	(0.179)	(0.188)	(0.194)
CHEMICAL	-0.426**	-0.058	-0.200
	(0.200)	(0.214)	(0.197)
RUBBER	-0.230**	-0.102	-0.251***
	(0.093)	(0.101)	(0.096)
MACHINARY	-0.081	-0.071	-0.184
	(0.125)	(0.134)	(0.132)
JEWELLERY	-0.028	0.021	-0.014
	(0.156)	(0.166)	(0.167)
Constant	-1.670***	-3.795***	-1.290***
	(0.281)	(0.313)	(0.292)

Note: Estimated by first stage of bivariate model. – Standard errors in parentheses. – level of significance: *** 1%, ** 5%, * 10%.