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Dynamics of Innovation and Internationalization among Small and Medium-Sized Enterprises in Viet Nam

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Abstract

This paper examines the bidirectional causality between innovation and internationalization in the context of developing countries. Using a dynamic bivariate probit model and adopting a broad definition of internationalization, this paper analyzes these issues using a panel dataset of small and medium-sized enterprises in Viet Nam. The results show a high persistence in process and product innovations and internationalization decisions. Furthermore, we find that, for non-micro firms, past internationalization has a positive effect on process innovation, but past process innovation does not have a significant effect on the internationalization decision. For this group of firms, we also find signs of cross-dependence between process innovation and the internationalization decision. Our results, however, do not show dynamic interdependence between internationalization and product innovation.

JEL Classification: L20, L25, O31

Contents

1. INTRODUCTION

Innovation and exports are related to national competitiveness at the macro and micro levels (Cassiman and Martínez-Ros 2007). At the macro level, innovation is an important measure for industry and country-level growth and exports are an indication of national competitiveness. At the micro level, economic theory suggests that innovation is the driving force behind export activity. A growing body of literature is exploring firm internationalization and innovation activities. However, most of the current studies usually consider one of these activities to be determinant of the other (Esteve-Pérez and Rodríguez 2013).

Empirical evidence has shown that exporting firms are more productive than non-exporting firms (Wagner 2007, Greenaway and Kneller 2007). Some recent literature suggests that this difference is partly explained by the greater engagement of exporting firms in innovation activities. Moreover, evidence also shows that innovative firms are likely to internationalize. Grossman and Helpman (1991) and Aw et al. (2008 and 2011) have provided a theoretical foundation for the interdependence of internationalization and innovation at the firm level. Empirically, there are a growing number of studies that examine this relationship (e.g., Cassiman and Martínez-Ros 2007, Nguyen et al. 2008, Damijan et al. 2010, Becker and Egger 2013, Lööf et al. 2014). Most of these studies use data from developed economies; we have limited knowledge on this issue in developing countries in general and among small- and medium-sized enterprises (SMEs) in these economies in particular.

This paper examines the dynamics of internationalization and innovation at SMEs in a developing country. More specially, we address whether there is persistence (i.e., over time) in the innovation and internationalization decisions of SMEs and whether this persistence, if any, is “true” or spurious. We also examine whether the persistence of one activity determines the persistence of the other activity when the persistence is present in both activities. Following Cassiman and Martínez-Ros (2007), Becker and Egger (2013), and Damijan et al. (2010), we distinguish two types of innovation: product innovation and process innovation. For internationalization, we consider a firm to be internationalized if it either exports goods to foreign markets or sells output to foreign investment firms (so-called domestic export). To this end, in this paper we use a large SME firm-level dataset, collected biannually from 2005 to 2013 in Viet Nam.

Our results show a high persistence in carrying out process and product innovations and in engaging in international activities. Furthermore, we find that, for non-micro firms (i.e., with six or more full-time, permanent workers), past internationalization has a positive effect on process innovation but past process innovation does not have a significant effect on internationalization. For these firms, we also find signs of cross-dependence between process innovation and internationalization. Our results, however, do not show dynamic interdependence between internationalization and product innovation. For micro firms, we do not find any evidence of interdependence between internationalization and either type of innovation. However, past internationalization does have a negative effect on process innovation of these micro firms. The result also indicates a cross-persistence in these activities, although such cross-persistence is not high.

This paper makes a contribution to the literature in three ways. First, although there are a growing number of studies that examine the dynamic interdependence of innovation and export decisions, there is rather little evidence on this issue for SMEs in developing countries. In previous studies, SMEs are usually ignored (Monreal-Pérez et al. 2012). This is due to (i) the conventional view that SMEs do not have adequate resources to

conduct and manage innovation activities, and (ii) a lack of firm-level data on SMEs (Majocchi and Zucchella 2003; Wignaraja 2008). Our data can be used to examine the dynamic interdependence of innovation and internationalization among SMEs in the context of developing economies.

Second, our data also allows us to determine bidirectional causality between internationalization and product and process innovation. Product innovation and process innovation are two different concepts and play different roles (Cohen and Klepper 1996; OECD 2005). While process innovation reduces the cost of production and enhances productivity, product innovation gives firms a competitive advantage by introducing new or improved goods to the market (OECD 2005). And thus, the relationship between each type of innovation and exporting may be different. A large share of the literature views innovation in terms of expenditure for R&D and thus cannot distinguish the roles of process and product innovation. Other studies look separately at either product innovation or process innovation, and very few look at the relationship of both with internationalization.

Finally, we use a broader interpretation of internationalization than most studies. We define a firm as internationalized if it not only exports products but also sells products to foreign direct investment firms operating in the country. Firms that have technical cooperation with foreign firms or import their inputs are also defined as internationalized. Ottaviano and Martincus (2011) and Bøler et al. (2012) suggest that innovations are not only linked to exports but other internationalization activities such as sourcing from abroad. While exporting incurs large sunk costs that may discourage many domestic firms, especially smaller firms, selling to multinational corporations operating in the country can be a channel that helps firms improve productivity and encourages them to innovate. Using this broader definition of internationalization has significant policy implications. The results may help governments design appropriate policies to integrate SMEs into the global value chains, not only directly by exporting but also indirectly by joining chains domestically.

In general, the approach we use in this paper is similar to the one used in Higon and Driffield (2011) and Esteve-Pérez and Rodríguez (2013). But there are some aspects that distinguish our paper from these papers: we look at innovation output and use a broader definition of internationalization in the context of a developing country. Finally, our paper uses panel data, which allows us to examine the dynamics of these two decisions, while Higon and Driffield (2011) use cross-sectional data for the UK. This paper is complementary to Nguyen et al. (2008), which also examines the bidirectional causality of exporting and innovation; however, that paper uses cross-sectional data,[1] thus they could not examine dynamic interdependence.

2. THEORETICAL FOUNDATION AND RELATED LITERATURE

2.1 Theoretical Foundation

For a long time, various macroeconomic models suggested a bidirectional causality between internationalization and innovation. Traditional trade theory such as Vernon (1966) and Krugman (1979) suggested a positive relationship between innovation and exports and that innovation is the driving force behind a firm's internationalization. Trade theory models argue that because internationalization incurs a high entry cost,

[1] The first cross-section of data in our sample (2005) is the same as Nguyen et al. (2008).

only those firms that are more productive, have lower costs, and have higher profit margins are able to internationalize. Innovation is considered the major source of productivity differences between internationalized and non-internationalized firms. Meanwhile, endogenous growth models predict that the causality runs from internationalization to innovation (Grossman and Helpman 1991). There are a number of reasons that explain the causality between innovation and internationalization. First, exposure to international markets and selling to multinational corporations may increase the pool of knowledge and technology of local firms. This facilitates the innovation process of the internationalized firms. Second, stronger competition in international markets forces firms to innovate and adapt to market conditions (Wagner 2007). Third, innovating firms have incentives to expand to other markets to earn higher returns (Teece 1986). Fourth, internationalization could reduce the cost associated with innovation by providing access to the cheapest available sources of R&D inputs (Kotabe et al. 2002).

Recent heterogeneous firm theories further strengthen the argument that the relationship between internationalization and innovation is bidirectional. For example, the model by Costantini and Melitz (2008) shows that innovation and exporting are the result of the endogenous choices of firms. Their drivers are a priori unclear: firms may innovate in anticipation of exporting or may start exporting after successfully innovating. In the latter case, innovation is one of the steps for embarking on export activity, which gives rise to observed self-selection effects.

2.2 Empirical Literature

2.2.1 From Innovation to Export

A large number of empirical studies have examined the effect of innovation on exporting. While some studies do not find a positive and significant impact of innovation on export performance (Wakelin 1998 for the UK and Alvarez 2007 for Chile), most of them do. For example, using firm-level data from the United States, Bernard and Jensen (1999) find substantial evidence that successful product innovations lead to exporting. Cassiman et al. (2010), using probit models and instrument variables to deal with endogeneity of innovation, find that product innovation increases the probability of exporting. Van Beveren and Vandenbussche (2010), using instrumental variable estimators, also show that firms self-select to innovate before exporting. Similar evidence is found among German and UK firms (Roper and Love 2002, Ebling and Janz 1999) and Spanish firms (Cassiman and Martinez-Ros 2007).

Some studies find that the causal relationship from innovation to export may depend on the type of innovations or firm characteristics. Becker and Egger (2013) analyze the effects of new product innovation versus process innovations on export propensity at the firm level. They find that both types of innovation raise a firm's propensity to export, but product innovation is quantitatively more important. Hwang et al. (2015), using Korean Innovation Survey data from 2005, 2008, and 2010, find that firms can improve their export performance if they carry out product and process innovations simultaneously.

2.2.2 From Export to Innovation

Fewer studies explore the impact of export on innovation and find weak support for the learning-by-exporting hypothesis. According to Love and Ganotakis (2013), detecting learning by exporting effects at the firm level is not straightforward. A large number of studies examine the learning-by-exporting hypothesis using productivity as the

outcome variable (Wagner 2007; Greenaway and Kneller 2007) for literature reviews of papers using productivity as the outcome. However, firm productivity is extremely heterogeneous, even among firms operating in similar sectors (Bartelsman and Doms 2000) and is subject to many influences unrelated to exporting. In addition, firms learn from many external and internal sources which have nothing to do with exposure to export markets, thus it is not always easy to identify the learning-by-exporting effect. As a result, estimates of the effects of learning-by-exporting on firm performance have generated very mixed results (Wagner 2007).

Recent literature examines the learning-by-exporting hypothesis using other variables that are more likely to represent firms' learning process than productivity. These variables include R&D expenditure (i.e., innovation inputs), patent counts, and types of innovation (i.e., innovation outputs). For example, Salomon and Shaver (2005) examine exporting behavior and ex post innovative outcomes among Spanish manufacturing firms. They find that exporting is associated with ex post increase in product innovation and patent count. Salomon and Jin (2008, 2010) also find direct evidence of the positive effects of exporting on innovation for both technically leading and lagging firms in Spain. Hahn (2010), using firm-level data of manufacturing firms in the Republic of Korea, finds some evidence supporting the learning-by-exporting hypothesis (i.e., exporting promotes new product innovation). Girma et al. (2008), using a bivariate probit model, find positive evidence of the effect of exporter status on the decisions of Irish firms to invest in R&D. Criscuolo et al. (2010) find that globally engaged firms (including multinational corporations and exporters) innovate more, because they learn from worldwide intra-firm pools of information and from international customers and universities. Liu and Buck (2007) use subsector-level data for Chinese high-tech industries and find a positive and significant effect of different types of internationalization on product innovation. Fafchamps et al. (2008) use a panel of Moroccan manufacturers and find that product innovation is positively related to the length of exporting experience.

The effect of learning-by-exporting, however, is also inconclusive. Moreover, the literature does not provide answers for the question of which modes of innovation benefit from internationalization. For example, Aw et al. (2011) find that past export experience is not an important factor in determining a firm's decision to carry out R&D. Damijan et al. (2010) find a positive effect of a firm's export status on process innovation, but not on product innovation. Meanwhile, Lileeva and Trefler (2010) and Bustos (2011) find trade liberalization impacts both types of innovation. Bratti and Felice (2012) do not examine the effects of export status on process innovation, but view it as the pathway for exporting to affect product innovation. However, they do not find process innovation to be the major factor that explains the positive association between innovation and export status.

As Salomon and Jin (2008) point out, we still know relatively little about how exporting affects performance at the firm level. More specially, Salomon and Jin (2010) argue that little is known about how different groups of firms learn from exporting and whether any differences exist between them in the effects of learning-by-exporting. This is extremely true for SMEs.

2.2.3 Bidirectional Causality of Innovation and Internationalization

Following the implications from economic theories and empirical evidence, the recent literature attempts to examine bidirectional causality between internationalization and innovation. Using a structural model of the producer's decision to invest in R&D, Aw et al. (2008) find that self-selection of high-productivity plants mainly drive participation in both activities, and that both R&D and exporting have a positive effect on a

plant's future productivity, reinforcing the selection effect. Hahn and Park (2012) examine bidirectional causal relationships among export, innovation, and productivity for Korean manufacturing firms and find a significant positive effect of exporting on new product innovation, but do not find a statistically significant effect of innovation on exporting. Higon and Driffield (2011) examine the interdependence of innovation and internationalization. While they find an apparent causal relationship running from innovation to internationalization, after correcting for endogeneity, the causal relationship leading from exporting to innovation is not robust. According to Higon and Driffield (2011), process innovation seems to have little impact on exporting decisions. Overall, their results point to the importance of product innovation relative to process innovation, at least in terms of the internationalization of firms.

In the context of developing countries, Nguyen et al. (2008) examine the causation of several types of innovation (i.e., product and process innovation and product modification) on export using SME data for Viet Nam and find that there is a statistically significant positive correlation between innovation and exporting. However, the study uses cross-sectional data and thus does not capture the dynamic interdependence of innovation and export decisions. Bravo-Ortega et al. (2014) using plant-level data from Chile find that firms that invest in R&D are considerably more likely to export, but the reverse is not true. They argue that the factors that determine a firm's decision to conduct R&D and to internationalize are not the same and that the operational mechanism is that a firm invests in R&D to increase productivity in order to be able to export.

Some studies find the effects are limited to a specific sample or cohort of firms. Damijan et al. (2010) apply propensity score matching techniques, where firms are classified either by their propensity to innovate or their propensity to export and are matched to compare their likelihood to export or to innovate. Using a bivariate probit model, they find that export increases the probability of process innovation. However, they do not find empirical support for learning-by-exporting. They also find that the effects are only found among medium-sized and large firms. Lööf et al. (2014) examine how differences in innovation strategy among exporting firms influence their total factor productivity growth and find that among firms that are permanently present in export markets, persistent innovators grow faster than firms that switch between being an active and an inactive innovator. However, firms that start or stop their innovation activity within the sample period still have a higher annual growth rate than non-innovators. A similar pattern is found among nonpersistent exporters, but the estimates are nonsignificant or only weakly significant. Similarly, Love and Ganotakis (2013) investigate the learning-by-export hypothesis by examining the effect of exporting on the subsequent innovation performance of a sample of high-tech SMEs in the UK. They find that exporting helps the UK's SMEs in high-technology industries innovate subsequently. However, only firms that are consistently exposed to export markets are able to overcome the innovation hurdle. And as Halilem et al. (2014) put it, internationalization and innovation are linked by different sets of relations.

3. DATA AND EMPIRICAL STRATEGY

3.1 Data

The data were jointly collected by the University of Copenhagen and two Vietnamese research institutes (Central Institute for Economic Management and Institute for Labor Studies and Social Affairs) in 2005, 2007, 2009, 2011, and 2013. The surveys were conducted in 10 provinces in Viet Nam. In each province, the sample was stratified by

the form of ownership to ensure that all types of nonstate enterprises, including formal and informal firms, were represented. Subsequently, stratified random samples were drawn from a consolidated list of formal enterprises and an on-site random selection of informal firms was made. After each survey round, to replace exited firms or a small number of firms which declined to continue the survey, some firms were randomly selected from a list of formal firms compiled by the government statistics office in the previous year and an on-site selection of informal firms. The sample size for each round of the survey was about 2,500 firms.

Although the sample has been slightly adjusted over time, the questionnaires are nearly the same. Information collected includes production, sales, markets, and other characteristics of the firm and of the owner or manager. The questionnaire also contained questions about innovation activities of the firm that were undertaken in the previous 2 years, i.e., between surveys.

3.2 Empirical Strategy

We model two binary indicators, internationalization and innovation, for firm i at time t ($t = 1 \ldots 5$). The set of dependent variables y_{it} are modeled in terms of a set of continuous latent variable y_{it}^{*} as given by Equation 1. Each latent variable y_{it}^{*} is a function of a vector of lagged observable explanatory variable x_{it-1}, lagged dependent variables y_{it-1} {s; unobservable time invariant firm-specific random effects μ, and a time-varying idiosyncratic random error term u_{it}.

$$y_{it} = x_{it-1}^{'}\beta + y_{it-1}\gamma + \mu_i + u_{it} \quad (1)$$

In our dynamic probit model, it is assumed that $u_{it}|y_{i1}, y_{i2}, \ldots y_{it-1}, x_{it}$ is independently and identically distributed (i.i.d.) as $N(0,1)$ and u_{it} is uncorrelated with y_{i1}, x_i, or μ_i. The conventional dynamic probit random effects estimator assumes that the individual effects (μ_i) are independent of the observed characteristics (x_{it}). This assumption, however, seems unrealistic. To account for this issue, we follow Mundlak (1978) and Chamberlain (1984) to assume that $\mu_i = \bar{x}_i\, \alpha + \epsilon_i$, of which ϵ_i is i.i.d. as *N*(0,1) and independent of x_{it} and u_{it} for all i and t.

Additionally, for estimation of dynamic models such as Equation 1, we need to deal with two important problems: (i) persistence and unobserved individual heterogeneity (μ_i) and (ii) the treatment of initial conditions (y_{i1}). The first problem could be solved by using a random effects dynamic probit model to distinguish the unobserved heterogeneity from true state dependence. Meanwhile, the second problem usually arises in a longitudinal binary process when the process has a first-order Markov property and contains unobserved heterogeneity. This implies that the first observation y_{it-1} is generated by the same process as other observations and therefore is endogenous. To deal with the initial conditions, Wooldridge (2005) proposes an approach that is based on conditional maximum likelihood for serially independent errors. Wooldridge (2005) assumes that y_{i1} is random and specifies the distribution of μ_i conditional on y_{i1} and $\bar{x}_i$ as follows:[2]

$$\mu_i = \alpha_0 + \alpha_1 y_{i1} + \alpha_2\, \bar{x}_i + \epsilon_i;\ \epsilon_i \sim iid \text{ and uncorrelated to } y_{i1} and\ \bar{x}_i \quad (2)$$

[2] Heckman (1981) also proposes another approach to deal with the initial conditions. According to Esteve-Pérez and Rodríguez (2013), the econometric literature shows that the Heckman (1981) and Wooldridge (2005) estimators produce quite comparable results.

Therefore, Equation 1 becomes:

$$y_{it} = x_{it-1}^{'}\beta + y_{it-1}\gamma + \alpha_0 + \alpha_1 y_{i1} + \alpha_2 \bar{x}_i + \epsilon_i + u_{it} \quad (3)$$

Given that internationalization and innovation decisions are highly serially correlated and that these two decisions are interdependent, we estimate the two decisions simultaneously by estimating a dynamic bivariate binary choice model.[3] Following Esteve-Pérez and Rodríguez (2013), we extend the univariate model in Equation 3 to a bivariate context:

$$y_{it}^{1j} = x_{it-1}^{'}\beta_{1j} + y_{it-1}^{1j}\gamma_{11j} + y_{it-1}^{2}\gamma_{12} + \mu_i^{1j} + u_{it}^{1j} \quad (4)$$

$$y_{it}^{2} = x_{it-1}^{'}\beta_{2} + y_{it-1}^{1j}\gamma_{21j} + y_{it-1}^{2}\gamma_{22} + \mu_i^{2} + u_{it}^{2} \quad (5)$$

$$y_{it}^{k} = \begin{cases} 1 \; if \; y_{it}^{k*} > 0 \\ 0 \; if \; y_{it}^{k*} \leq 0 \end{cases}$$

$$where \; k = 1j, 2; \; t = 1..T$$

of which

- y_{it}^{1j} and y_{it}^{2} are dependent variables. The first is a dummy variable indicating whether firm *i* carries out a type of innovation in time t. In this paper, we alternatively examine two types of innovation: product and process. The second dependent variable, y_{it}^{2}, is also a dummy variable, indicating whether or not firm i exports and/or sells to foreign direct investment firms in year t.
- y_{it}^{1j*} and y_{it}^{2*}: corresponding latent variables for y_{it}^{1j} and y_{it}^{2}.
- x_{it-1} : vector of (lagged) observable explanatory variables, including owner/manager education, firm age, size, ownership, and either innovation status (for internationalization equation) or internationalization status (for innovation equation).
- y_{it-1}^{1j} and y_{it-1}^{2}: state dependence (i.e., lagged innovation and internalization indicator in innovation and internationalization equations).
- μ_i^{1j} and μ_i^{2}: random individual effects (j= 1,2); (μ_i^{1j}, μ_i^{2}) are assumed to be bivariate normal distribution. The distribution of μ_i^{1j} and μ_i^{2} are conditional on y_{i1}^{1j} and y_{i1}^{2} and $\bar{x}_i$ as discussed above (see Equation 2).
- u_{it}^{1j} and u_{it}^{2}: error terms; (u_t^{1j}, u_t^{2}) are assumed to have a bivariate normal distribution and independence over time.

[3] We thank the reviewer of this paper, Pornpinun Chantapacdepong, of the Asian Development Bank Institute, for pointing out that the Wooldridge (2005) approach may not be suitable for bivariate dynamic probit models. However, it has been employed recently in several studies including Esteve-Pérez and Rodríguez (2013) and Ganter and Hecker (2013). The reviewer suggests the use of Raymon et al. (2010) and/or Miranda (2010) for the estimators of bivariate dynamic probit models. We may use these approaches in subsequent work.

3.3 Variable Construction

3.3.1 Measuring Innovation

In previous studies, longitudinal data on firm innovation activity usually indicated patent registration and R&D expenditure and focused on developed economies (Ayyagari et al. 2011). Although original innovations (that is, new-to-the-world innovations) are important, innovation in the form of adopting new production technology improving the quality of the products, or introducing new products to a country, are more relevant to firms in developing regions, where most firms are engaged in activities far from the technological frontier (UNCTAD 2007). We follow Ayyagari et al. (2011) and others in the context of developing economies in adopting the definition of "new-to-the-firm" innovation. We use two indicators: product innovation and process innovation. Product innovation takes the value of one if a firm either (i) introduces a new product or upgrades existing products in last 2 years, and zero otherwise. Process innovation is also a binary variable, which takes the value of one if a firm has upgraded its production process in the last 2 years, and zero otherwise.

3.3.2 Measuring Internationalization

As Ottaviano and Martincus (2011) and Boler et al. (2012) argue, international activities include not only export activities, but other activities that facilitate the learning process of domestic firms. This paper uses a broader definition of internationalization by considering not only exporters but also those firms that sell to foreign firms that produce in Viet Nam and that export from there. Our definition of internationalization also includes using imported inputs or having long-term partnerships with foreign firms. Indeed, such activities are part of the integration of domestic firms into global value chains.

3.3.3 Explanatory Variables

The following explanatory variables are used in the estimations:

- Size: We divide firms in our sample into two categories: one is micro firms, which are firms with five or fewer full-time employees, and the other is non-micro firms. Non-micro firms usually have more advantages in supporting innovation activities.
- Age: The age of the firm is the log of the number of years of operation at the time of the survey. This variable is to capture the learning-by-doing effects of innovation. However, a flat learning curve and being risk averse may hinder a firm's innovation.
- Owner or manager's education level: An owner or manager having a college degree and/or who has graduated from a technical training school is the indicator used to capture the human capital of the firm. They reflect the potential of either employees or owners in innovation activities.
- Ownership form: A dummy variable is used for the form of ownership and takes the value of one if the firm is incorporated as a partnership, a limited shareholding company, or a joint stock company. It takes a value of zero if the firm is a household firm or private sole proprietorship. Incorporated firms tend to serve more competitive markets than household firms, which mostly serve local customers. Thus, incorporated firms are more likely to engage in innovation activities.
- We also control for the firm's location and industry and include time dummies.

4. DESCRIPTIVE ANALYSIS

Our sample consists of 8,357 firms, of which about half (52.3%) are micro firms with five or fewer full-time permanent workers. The other half are non-micro firms with more than five workers. Table 1 presents descriptive statistics. In general, 35.9% of firms in our sample have engaged in product innovation. The figure is lower for micro firms (25.9%) than for non-micro firms (47.2%). Some 6.2% of micro firms and 19.5% non-micro firms carried out process innovations in the 2 years prior to each survey. Regarding internationalization, although we use a rather broad definition, only 8.5% of firms have one or more internationalization activities. Similar to innovation activities, micro firms are not very international: only 1.0% of micro firms engaged in international activity compared with 16.8% of non-micro firms. Micro firms also have a lower value of production assets, have lower labor productivity, and are less likely to have an owner or manager with a college or technical college degree.

Table 1: Descriptive Data

	All	Micro	Non-micro
Product innovation	35.9%	25.9%	47.2%
Process innovation	12.5%	6.2%	19.5%
Internationalization	8.5%	1.0%	16.8%
Micro firms	52.9%		
College	19.9%	7.2%	34.2%
Capital intensity	10.36	10.27	10.45
	[1.45]	[1.52]	[1.37]
Labor productivity	9.44	9.20	9.71
	[0.82]	[0.82]	[0.72]

Note: Standard errors in brackets where applicable.

Table 2 presents the transitional probability matrix. It can be seen that there is a general pattern of strong persistency in innovation and internationalization. Most of the diagonal elements are near or above 50%, except for process innovation. We can infer that 56.5% of firms that have international activities at *t−1* continue to carry out such activities at time t. Meanwhile, about 4% of firms that do not have international activities at *t−1* engaged in internationalization at time t. Thus, the probability of engaging in internationalization at *t+1* was 52.5 percentage points higher for internationalized firms at *t*. This is a measure of unconditional state dependence (since we have not yet controlled for observed and unobserved firm characteristics). Similarly, the probability of engaging in international activities by a firm that carries out product innovation at time *t* was 6.2 percentage points higher than that of non-innovative firms. For process innovation it was 10.1 percentage points higher. Table 2 also indicates that firms with international activities at time t also had a higher probability of carrying out innovative activities, either in the form of product innovation or process innovation, at time *t+1* than non-international firms. The probability of having a product innovation at time *t+1* is 12 percentage points for those firms that have international activities at time *t*. For process innovation it was 15.6 percentage points higher. However, this table also suggests that the persistence is also observed among non-internationalized firms and non-innovative firms (i.e., very few non-internationalized firms and non-innovative firms shifted their status in the subsequent period).

Table 2: Transition Probability Matrix

		Internationalization at t−1 (%)		Product innovation at t−1 (%)		Process innovation at t−1 (%)	
		No	**Yes**	**No**	**Yes**	**No**	**Yes**
Internationalization at t	No	96.0	43.5	94.6	88.4	93.6	82.8
	Yes	4.0	56.5	5.4	11.6	6.4	17.2
Product innovation at t	N0	91	79	75.4	52.3	67.4	50.0
	Yes	9	21	24.6	47.7	32.6	50.0
Process innovation	No	88.9	73.3	91.4	83.5	90.4	75.7
	Yes	11.1	26.7	8.6	16.5	9.6	24.3

Table 3 presents probabilities of internationalization and innovation engagement over the sample period. Column 1 reports the unconditional probabilities of internationalization, product innovation, and process innovation. Columns 2 and 3 show the probabilities of internationalization, product innovation, and process innovation conditional on the past activities of firms. We see that the persistence is much higher among the non-micro firms and incorporated firms. For example, 59% of non-micro firms and 62.6% of incorporated firms would continue having international activities at time *t+1* if they did so at time *t*, while these figures were only about 20% for micro firms. The same patterns are also seen in product innovation and process innovation activities.

Table 3: Unconditional and Conditional Probabilities of Innovation and Internationalization

Internationalization at t		**Unconditional** (%)	**Internationalization at t−1** (%)	**No internationalization at t−1** (%)
All firms		8.9	56.5	4.0
Micro firm	No	16.9	59.4	8.2
	Yes	1.1	19.2	0.8
Incorporated firm	No	2.8	34.0	1.6
	Yes	27.3	62.6	13.6
Product innovation		**Unconditional** (%)	**Product innovation at t−1** (%)	**No product innovation at t−1** (%)
All firms		35.9	47.7	24.6
Micro firm	No	47.2	54.1	36.5
	Yes	25.9	38.8	17.8
Incorporated firm	No	31.7	44.8	21.2
	Yes	49.0	53.9	40.4
Process innovation		**Unconditional** (%)	**Process innovation at t−1** (%)	**No process innovation at t−1** (%)
All firms		12.5	16.5	8.6
Micro firm	No	19.5	29.4	15.5
	Yes	6.2	11.3	5.6
Incorporated firm	No	8.6	17.1	7.3
	Yes	24.2	33.2	19.3

The transitional probability matrixes presented in Tables 2 and 3 suggest a state dependence and interdependence of innovation and internationalization decisions. However, such matrixes do not provide us with adequate information on the sources of such dependency. In the following section, we attempt to figure out the sources of such relationships.

5. EMPIRICAL RESULTS

5.1 Univariate Results

Tables 4 and 5 present our univariate probit estimations, using Wooldridge's (2005) initial condition correction approach. The dependent variables in Table 4 are production innovation in columns 1–3 and process innovation in columns 4–6. The estimates for the whole sample are presented in columns 1 and 4, for the sample of micro firms in columns 2 and 5, and for the sample of non-micro firms in columns 3 and 6. In all specifications, we include variables indicating whether the firm has any international activities in the previous period.

Table 4: Effects of (Past) Internationalization on Product Innovation and Process Innovation Decisions

	(1)	(2)	(3)	(4)	(5)	(6)
Sample	**All firms**	**Micro firms**	**Non-micro firms**	**All firms**	**Micro firms**	**Non-micro firms**
Dependent variables	**Product innovation**			**Process innovation**		
Lagged product innovation	0.085***	0.073***	0.065***			
	[0.014]	[0.016]	[0.021]			
Lagged process innovation				0.041***	0.023**	0.051***
				[0.009]	[0.010]	[0.017]
Lagged internationalization	–0.023	–0.082	–0.014	0.019*	–0.083*	0.033*
	[0.021]	[0.064]	[0.025]	[0.011]	[0.044]	[0.017]
Having college degree (lagged)	–0.016	0.007	–0.031	0.018**	0.010	0.021
	[0.016]	[0.025]	[0.020]	[0.009]	[0.012]	[0.015]
Non-micro firm (lagged)	0.093***	0.060***	0.079***	0.036***	0.011	0.035**
	[0.013]	[0.017]	[0.020]	[0.008]	[0.008]	[0.016]
Labor productivity (lagged)	–0.030***	–0.026*	–0.026*	–0.018***	–0.013*	–0.022**
	[0.010]	[0.013]	[0.014]	[0.006]	[0.007]	[0.010]
Being incorporated firm	0.070***	–0.056	0.071***	0.055***	–0.001	0.066***
	[0.017]	[0.041]	[0.021]	[0.009]	[0.017]	[0.015]
Firm age	–0.036***	–0.032***	–0.015	–0.011*	0.002	–0.020*
	[0.010]	[0.012]	[0.015]	[0.006]	[0.006]	[0.011]
Product innovation at t=1	0.095***	0.067***	0.106***			
	[0.014]	[0.017]	[0.022]			
Process innovation at t=1				0.037***	0.016*	0.052***
				[0.009]	[0.009]	[0.016]
Number of firms	3,227	1,928	1,834	3,227	1,928	1,834
Total observations	8,357	4,418	3,939	8,357	4,418	3,939

Note: Standard errors in brackets; * p < 0.1, ** p < 0.05, *** p < 0.01. The estimates presented in this table are marginal effects. In all specifications, we use the Wooldridge correction approach. We also control for firm's industry, location, and year dummies. Estimations are based on Gauss-Hermite quadrupture approximations using 12 quadrupture points. We also use 16 and 24 quadrupture points to check the accuracy.

Table 5: Effects of (Past) Product Innovation and Process Innovation Decisions on Internationalization

	(1)	(2)	(3)	(4)	(5)	(6)
Sample	**All firms**	**Micro firms**	**Non-micro firms**	**All firms**	**Micro firms**	**Non-micro firms**
Dependent variables			**Internationalization**			
Lagged internationalization	0.057***	0.0004561	0.165***	0.056***	0.000	0.164***
	[0.007]	[0.000]	[0.018]	[0.007]	[0.000]	[0.018]
Lagged product innovation	0.002	–0.000098	0.003			
	[0.003]	[0.000]	[0.011]			
Lagged process innovation				0.004	–0.000	0.008
				[0.004]	[0.000]	[0.011]
Having college degree (lagged)	0.013***	0.000116	0.036***	0.013***	0.000	0.035***
	[0.004]	[0.000]	[0.012]	[0.004]	[0.000]	[0.012]
Non-micro firm (lagged)	0.021***	0.0001221	0.052***	0.020***	0.000	0.051***
	[0.004]	[0.000]	[0.013]	[0.004]	[0.000]	[0.013]
Labor productivity (lagged)	–0.003	0.0000107	–0.010	–0.003	0.000	–0.010
	[0.003]	[0.000]	[0.008]	[0.003]	[0.000]	[0.008]
Being incorporated firm	0.038***	0.000445 *	0.088***	0.037***	0.000*	0.087***
	[0.005]	[0.000]	[0.012]	[0.005]	[0.000]	[0.013]
Firm age	0.002	0.0000472	0.009	0.003	0.000	0.009
	[0.003]	[0.000]	[0.009]	[0.003]	[0.000]	[0.009]
Internationalization at t=1	0.038***	0.000866	0.099***	0.038***	0.001	0.099***
	[0.006]	[0.001]	[0.017]	[0.006]	[0.001]	[0.017]
Number of firms	3,227	1,928	1,834	3,227	1,928	1,834
Total observation	8,357	4,418	3,939	8,357	4,418	3,939

Note: Standard errors in brackets; * p < 0.1, ** p < 0.05, *** p < 0.01. The estimates presented in this table are marginal effects. Estimations are based on Gauss-Hermite quadrupture approximations using 12 quadrupture points. We also use 16 and 24 quadrupture points to check the accuracy.

The estimates show that past product innovation has a positive and statistically significant effect on the firm's current product innovation decision. The same is true of the effect of past process innovation on current process innovation. The statistical significance of the value of dependent variables at time t=1 (initial period) indicates that there is a true state dependence in process and product innovation decisions among the micro firms. We find that firms engaged in international activities in the last period are more likely to have product innovation, although this relationship is not statistically significant. The effect of internationalization on process innovation is different between micro and non-micro firms. It has a positive and statistically significant effect on process innovation for non-micro firms, while for micro firms, this effect is negative and significant, implying that micro firms are less likely to carry out the process innovation if they engaged in internationalization in the last period. A potential explanation for this negative relationship is that some firms may not have been successful in international activities in the past period and thus had to reduce their production process. In fact, in our sample of micro firms, only 1% of them had international activities in the last period. Among them, nearly 40% used to be non-micro in the last period.

The results also indicate that non-micro firms are more likely to carry out innovation. This is consistent with the findings of other studies. Being incorporated also increases a firm's probability of carrying out innovation activities. Our results also indicate that older firms seem to be risk averse as the probability of innovating declines with age.

Table 5 presents estimates for the effect of product innovation and process innovation on internationalization. Similar to Table 4, we also use the Wooldridge initial condition correction approach to identify whether there is a state dependency in internationalization. We also control for the firm's industry and location and the year. Columns 1 and 4 contain results for the whole sample, columns 2 and 5 for micro firms, and columns 3 and 6 for non-micro firms. The results indicate that past engagement in international activities has a positive effect on internationalization in this period. Combined with the positive and statistically significant effects of the initial condition (i.e., internationalization decision at t=1), this result indicates that there is a true state dependence in internationalization among firms. Our results, however, do not indicate a significant effect of either product innovation or process innovation on the firm's internationalization.

However, the results show that there is a large difference between micro firms and non-micro firms relating to factors determining the internationalization decision. There is a rather large state dependence with regards to the internationalization decision of non-micro firms, reflected by a large coefficient on the lagged decision to internationalize and the significance of the initial conditions. The same pattern is not seen among micro firms. Other variables, except for being an incorporated firm, do not have a statistically significant effect on micro firms' internationalization decision. These results may be due to the fact that only 1% of micro firms engaged in internationalization and therefore the probit estimation could not provide a good and consistent estimation. For non-micro firms, we find that large firms, incorporated firms, and firms with an educated owner or manager have a higher probability of being engaged in internationalization.

5.2 Bivariate Results

The univariate dynamic random effects estimated in the previous section assessed the relative importance of unobserved heterogeneity and true state dependence in explaining persistence in internationalization and innovation decisions. As the literature suggests, there may be interdependence between innovation and internationalization. Therefore, a bivariate model may provide a suitable estimation method since it allows for correlations between the error terms in the internationalization and innovation equations.

Table 6 reports the results from the dynamic pooled bivariate models. Panel A presents the bivariate estimation results of internationalization and product innovation equations. The estimation results of internationalization and process innovation equations are presented in Panel B. Estimation results in Panel A confirm the true state dependency of product innovation and internationalization decisions. However, similar to Table 4, we do not find the dynamic independence between product innovation and internationalization for all groups of firms. Past product innovation does not have statistically significant effects on current internationalization, and past internationalization does not have significant effects on current product innovation. The statistical significance of ρ in the estimation for the whole sample confirms that firms jointly determine the internationalization and product innovation decisions. As reported in Panel B, for the whole sample and non-micro firms, past internationalization still has positive and statistically significant effects on process innovation. For micro firms, the effect is still negative and significant at the 10% level. Other control variables show similar effects to the ones in Table 5. The statistical significance of ρ also indicates that there is a cross-dependence between process innovation and internationalization. It should be noted that in both Panel A and Panel B, the estimates of the impact of the

lagged dependence variables obtained in the bivariate probit model are higher than those obtained from estimating a dynamic random effects probit. This is because individual heterogeneity is not controlled in the bivariate models. Esteve-Pérez and Rodríguez (2013) suggest that the estimates from the dynamic random effects probit may be more appropriate for state dependence.

Table 6: Interdependence of Innovation (Product Innovation and Process Innovation) and Internationalization Decisions

	(1)	(2)	(3)	(4)	(5)	(6)
	All sample		Micro firm		Non-micro firm	
Panel A						
Dependent variables	**Product innovation**	**Internation-alization**	**Product innovation**	**Internation-alization**	**Product innovation**	**Internation-alization**
Lagged product innovation	0.238***	0.041	0.246***	–0.098	0.168***	0.026
	[0.038]	[0.055]	[0.054]	[0.134]	[0.052]	[0.062]
Lagged internationalization	–0.063	0.920***	–0.274	0.458	–0.033	0.929***
	[0.059]	[0.090]	[0.216]	[0.333]	[0.062]	[0.093]
Having college degree (lagged)	–0.042	0.204***	0.023	0.116	–0.078	0.195***
	[0.043]	[0.064]	[0.085]	[0.194]	[0.050]	[0.068]
Non-micro firm (lagged)	0.257***	0.334***	0.205***	0.125	0.197***	0.290***
	[0.037]	[0.065]	[0.057]	[0.132]	[0.050]	[0.076]
Labor productivity (lagged)	–0.082***	–0.047	–0.088*	0.010	–0.064*	–0.060
	[0.027]	[0.044]	[0.045]	[0.145]	[0.034]	[0.047]
Being incorporated firm	0.194***	0.607***	–0.190	0.451**	0.177***	0.497***
	[0.046]	[0.066]	[0.140]	[0.216]	[0.052]	[0.071]
Firm age	–0.099***	0.035	–0.108***	0.048	–0.036	0.050
	[0.028]	[0.047]	[0.041]	[0.127]	[0.039]	[0.052]
Product innovation at t=1	0.255***		0.226***		0.256***	
	[0.040]		[0.057]		[0.056]	
Internationalization at t=1		0.601***		0.890**		0.550***
		[0.093]		[0.370]		[0.091]
ρ	0.166		–0.045		0.184	
Chi-square	23.409		0.255		22.996	
Panel B						
Dependent variables	**Process innovation**	**Internation-alization**	**Process innovation**	**Internation-alization**	**Process innovation**	**Internation-alization**
Lagged process innovation	0.233***	0.072	0.212**	–0.117	0.201***	0.047
	[0.052]	[0.059]	[0.097]	[0.205]	[0.064]	[0.064]
Lagged internationalization	0.110*	0.913***	–0.740*	0.473	0.129**	0.923***
	[0.062]	[0.091]	[0.412]	[0.337]	[0.065]	[0.094]
Having college degree (lagged)	0.102**	0.202***	0.093	0.121	0.083	0.196***
	[0.050]	[0.065]	[0.113]	[0.196]	[0.057]	[0.068]
Non-micro firm (lagged)	0.203***	0.328***	0.100	0.113	0.136**	0.284***
	[0.046]	[0.064]	[0.073]	[0.134]	[0.061]	[0.075]
Labor productivity (lagged)	–0.101***	–0.047	–0.121*	0.028	–0.085**	–0.058
	[0.032]	[0.044]	[0.062]	[0.147]	[0.039]	[0.047]
Being incorporated firm	0.309***	0.607***	–0.008	0.477**	0.254***	0.494***
	[0.052]	[0.066]	[0.158]	[0.213]	[0.058]	[0.071]
Firm age	–0.060*	0.041	0.018	0.054	–0.079*	0.052
	[0.033]	[0.047]	[0.054]	[0.129]	[0.044]	[0.052]
Process innovation at t=1	0.200***		0.144*		0.194***	
	[0.048]		[0.083]		[0.060]	
Internationalize at t=1		0.605***		0.850**		0.556***
		[0.093]		[0.370]		[0.092]
ρ	0.203		0.372		0.163	
Chi-square	27.38		11.242		15.454	
Number of firms	3,227	3,227	1,928	1,928	1,834	1,834
Total observations	8,357	8,357	4,418	4,418	3,939	3,939

Note: Standard errors in brackets; * p < 0.1, ** p < 0.05, *** p < 0.01. The estimates presented in this table are marginal effects. Estimations are based on Gauss-Hermite quadrupture approximations using 12 quadrupture points. We also use 16 and 24 quadrupture points to check the accuracy.

To facilitate the interpretation of results from the bivariate probit estimation, following Esteve-Pérez and Rodríguez (2013), we calculate the predicted probabilities of engaging in internationalization and carrying out process innovation given four combinations of past internationalization and process innovations. Because the interdependence between innovation and internationalization is partly found in the joint estimation of process innovation and internationalization, we calculate these predicted probabilities for the case of non-micro firms. Panel A of Table 7 reports the predicted probabilities. We find that the predicted probability of engaging in international activity in this period for those firms engaged in these activities in the past period is nearly 50 percentage points higher than those not engaged in international activities in the last period, regardless of whether firms carried out process innovation or not. Meanwhile, the predicted probability of a past process innovator implementing process innovation in this period is 8 percentage points higher than for those who did not engage in process innovation in the previous period. The result also indicates a cross-persistence in these activities, although such cross-persistence is not high. For example, for the firms that did not engage in process innovation in the last period, the probability of carrying out process innovation in this period is 22.8% if the firm had international activities last period, while this figure is only 14.4% if the firms did not have international activities.

Table 7: Predicted Probability and Marginal Effects Given Past Internationalization and Innovation on Current Internationalization and Innovation

Panel A: Predicted probability		
International at t−1, process innovation at t−1	**Internationalization at t**	**Process innovation at t**
(1,1)	0.613 (0.174)	0.359 (0.113)
(1,0)	0.576 (0.177)	0.228 (0.093)
(0,1)	0.104 (0.097)	0.273 (0.102)
(0,0)	0.073 (0.075)	0.144 (0.071)
Panel B: Marginal effects		
	Internationalization at t	**Process innovation at t**
Internationalization at t−1		
No	0.114 (0.007)	0.189 (0.007)
Yes	0.332 (0.025)	0.223 (0.016)
Process innovation at t−1		
No	0.165 (0.006)	0.178 (0.008)
Yes	0.173 (0.009)	0.231 (0.014)

Notes: Calculated based on the results presented in columns 5 and 6 of Panel B, Table 6.

We also calculate the average treatment effect of the previous internationalization and process innovation status on internationalization and process innovation in this period. The results are reported in Panel B of Table 7. They show that if, in the previous period, a non-innovator shifted to become an innovator, the probability of carrying out a process innovation in this period increases by about 5%, but the probability to internationalize increases only slightly at less than 1%. This implies a rather weak cross-dependency between past process innovation and current internationalization. The cross-dependency between past internationalization and current process innovation is slightly higher. These results are in line with our previous results.

5.3 Robustness Check

Table 8 presents our robustness checks.[4] We use several approaches to check the sensitivity of our estimations. First, we limit our sample to those firms that are either micro firms or non-micro firms during the entire period of the sample surveys from 2005 to 2013 (i.e., without any changes in their firm category). A firm's propensity to innovate or to internationalize may cause or be affected by its decision to reduce the number of workers (to become a micro firm) or increase the workers to become a non-micro firm (Panel A, Table 8). Second, we use different measures of innovation. Instead of considering firms that just engage in innovation to be innovators, we view firms as innovators if they engaged in innovation and their innovation (process innovation and product innovation) are successful (Panel B, Table 8). Thirdly, we also re-estimate our model using Heckman's correction procedure to deal with initial conditions (Panel C, Table 8). The estimation results using these various procedures are quite similar to the results presented above, which reinforces our findings presented in the previous subsections 5.1 and 5.2.

Table 8: Robustness Check

	Process innovation	Internation-alization	Process innovation	Internation-alization	Process innovation	Internation -alization
			Panel A			
Lagged process innovation	0.233***	0.085	0.205	–0.213	0.154**	0.058
	[0.052]	[0.068]	[0.147]	[0.287]	[0.072]	[0.070]
Lagged internationalization	0.110*	0.930***	–5.023***	0.456	0.132*	0.930***
	[0.062]	[0.099]	[0.383]	[0.656]	[0.068]	[0.098]
Having college degree (lagged)	0.102**	0.197***	0.149	0.434*	0.086	0.181**
	[0.050]	[0.072]	[0.148]	[0.246]	[0.064]	[0.073]
Non-micro firm (lagged)	0.203***	0.319***	0.020	–0.046	0.123*	0.225***
	[0.046]	[0.074]	[0.106]	[0.184]	[0.075]	[0.085]
Labor productivity (lagged)	–0.101***	–0.047	–0.067	–0.295	–0.074*	–0.033
	[0.032]	[0.051]	[0.088]	[0.240]	[0.042]	[0.052]
Being incorporated firm	0.309***	0.640***	0.205	–5.035***	0.244***	0.514***
	[0.052]	[0.076]	[0.458]	[0.371]	[0.065]	[0.080]
Firm age	–0.060*	0.026	–0.009	–0.050	–0.049	0.051
	[0.033]	[0.053]	[0.075]	[0.197]	[0.050]	[0.057]
N	5928	5928	3097	3097	2831	2831

continued on next page

[4] We only report the results of the dynamic random effects bivariate probit model between internationalization and process innovation.

Table 8 *continued*

	Process innovation	Internation-alization	Process innovation	Internation-alization	Process innovation	Internation-alization
			Panel B			
Lagged process innovation	0.160***	0.045	0.053	–0.078	0.176**	0.019
	[0.062]	[0.064]	[0.114]	[0.217]	[0.076]	[0.068]
Lagged internationalization	0.148**	0.918***	–0.492	0.440	0.169**	0.927***
	[0.069]	[0.091]	[0.419]	[0.336]	[0.072]	[0.094]
Having college degree (lagged)	0.086	0.202***	0.068	0.109	0.079	0.197***
	[0.054]	[0.064]	[0.121]	[0.198]	[0.062]	[0.068]
Non-micro firm (lagged)	0.156***	0.335***	0.035	0.123	0.113*	0.291***
	[0.050]	[0.064]	[0.079]	[0.134]	[0.065]	[0.076]
Labor productivity (lagged)	–0.091***	–0.045	–0.130*	0.037	–0.064	–0.057
	[0.034]	[0.044]	[0.068]	[0.145]	[0.042]	[0.046]
Being incorporated firm	0.235***	0.613***	0.111	0.462**	0.180***	0.497***
	[0.057]	[0.066]	[0.166]	[0.215]	[0.063]	[0.071]
Firm age	–0.047	0.039	0.054	0.044	–0.071	0.052
	[0.036]	[0.047]	[0.059]	[0.129]	[0.048]	[0.052]
N	8,357	8,357	4,418	4,418	3,939	3,939

Note: Standard errors in brackets; * p < 0.1, ** p < 0.05, *** p < 0.01. The estimates presented in this table are marginal effects. Estimations are based on Gauss-Hermite quadrupture approximations using 12 quadrupture points. We also use 16 and 24 quadrupture points to check the accuracy.

6. CONCLUSION

This paper aims to examine empirically the dynamic interdependence of internationalization and innovation decisions by SMEs in a developing economy. More specially, the paper investigates whether there is persistence in innovation and international decisions among SMEs and whether this persistence, if any, is a true or spurious persistence. We also examine whether the persistence of one activity determines the persistence of the other activity when persistence is present in both activities. We also distinguish two types of innovation: product innovation and process innovation. We consider a firm to be internationalized if it exports, sells to foreign investment firms (so-called domestic export), has business relationship with foreign partners, or purchases inputs from abroad. We use a large and rich set of firm-level data on SMEs, collected biannually from 2005 to 2013 in Viet Nam. Dynamic random effects probit and bivariate probit models are employed to examine the dynamic interdependence of internationalization and innovation decisions.

Similar to Esteve-Pérez and Rodríguez (2013), our results show high persistence in carrying out process and product innovations and engaging in international activities. Furthermore, we find that, for non-micro firms, past internationalization has a positive effect on process innovation in the subsequent period. However, past process innovation does not have a significant effect on internationalization of these firms. For this group of firms, we also find signs of cross-dependence between process innovation and internationalization. Our empirical results, however, do not show dynamic interdependence between internationalization and product innovation. For micro firms, we do not find any evidence relating to the interdependence of internationalization and both types of innovation.

We find that non-micro firms that had both international activities and process innovation activities in this period have the highest probability of continuing to have international activities in the subsequent period. Moreover, the probability of non-micro firms that had either international activities or implemented process innovation in the last period to continue such activities in the next period is 50 percentage points and 8 percentage points higher, respectively, than those that did not. Our result also indicates a cross-persistence in these activities, although such cross-persistence is not high.

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