# Dynamics of innovation and internationalization among Vietnamese SMEs

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***Abstract:***

Innovation and internationalization have been considered as the major sources of growth for a long time. Various theoretical models suggest a bi-directional causality relationship between these two decisions. However, so far there is limited empirical evidence on whether there is a dynamic interdependence of innovation and internationalization decisions among SME firms in developing countries. Using a dynamic bivariate probit model and adopting a broader definition of internationalization, this paper analyzes the dynamic interdependence of internationalization and innovation decisions at the firm level in a developing country, by using a rich panel data set of SMEs collected biannually from 2005 to 2013 in Vietnam. Our empirical results show a high persistence in process, product innovations and internationalization decisions. Furthermore, we find that, for non-micro firms (i.e. firms with at least six fulltime permanent workers), past internationalization has a positive effect on process innovation but past process innovation do not has a significant effect on internationalization decision of these firms. For this group of firms, we also find signs of cross-dependence between process innovation and internationalization decision. Our empirical results, however, does not show dynamic interdependence between internationalization and product innovation. For micro firms, we do not find any evidence relating to interdependence of internationalization and both types of innovation.

*Keywords*: internationalization, process innovation, product innovation, persistence of innovation, dynamic random effect bivariate probit, SME, Vietnam

## 1. Introduction

Innovation and exports are related to national competitiveness at macro and micro level (Cassiman and Martínez-Ros 2007). While at the macro level, innovation is an important measure for industry and country-level growth and export represent an indication of national competitiveness. At the micro level, economic theories suggest that innovation is the driving force behind export. 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 (e.g, Wagner, 2007; Greenway and Kneller, 2007). Some recent literature has figured out that this difference in productivity is partly because the exporting firms engage more in innovation activities. Moreover, evidence also show that innovative firms are also likely to engage in the internationalization decision, albeit not as strong as the other direction of relationship. Grossman and Helpman (1991) and Aw et al (2008 and 2011) have provided theoretical foundation for the interdependence of internationalization and innovation decision 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 are using data from developed economies. Yet we have limited knowledge on this issue in developing countries in general and among small- and medium-sized enterprises in these economies in particular.

This paper aims to examine the dynamics of internationalization and innovation decisions at the small- and medium-sized enterprises in the context of a developing country. More specially, we address whether there is a persistence in innovation and international decision among SMEs and whether this persistence (if any) is "true" or spurious persistence. We also examine whether the persistence of one activity determine the persistence of the other activity, if the persistence is present in both activities. Following Cassiman and Martínez-Ros (2007), Becker and Egger (2013), Damijan et al (2010), we distinguish two types of innovation: product innovation and process innovation. For internationalization, we consider a firm as an internationalized firm if it either exports their goods to foreign markets and sells their output to foreign investment firms (so-called domestic export). To this end, in this paper, we use a large SME firm-level data, collected biannually from 2005 to 2013 in Vietnam.

Our empirical results show a high persistence in carrying out process, product innovations and engaging international activities. Furthermore, we find that, for non-micro firms (i.e. firms with at least

six fulltime permanent workers), past internationalization has a positive effect on process innovation but past process innovation do not has a significant effect on internationalization decision of these firms. For this group of firms, we also find signs of cross-dependence between process innovation and internationalization decision. Our empirical results, however, does not show dynamic interdependence between internationalization and product innovation. For micro firms, we do not find any evidence relating to interdependence of internationalization and both types of innovation. However, past internationalization has a negative effect on process innovation of micro firms. The result also indicates a cross-persistence in these activities, although such cross persistence is not high.

This paper makes some contributions to literature. First, although there are growing number of studies that examines the dynamic interdependence of innovation and export decisions, there is rather little evidence on this issue in SMEs in developing countries. In previous studies examining the relationship between innovation and internationalization, 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) lack of firm-level data on SMEs (Majocchi and Zucchella, 2003 and Wignaraja, 2008). Our data used in this paper could provide necessary information to examine the dynamic interdependence of innovation and internationalization among SMEs in the context of developing economies.

Second, our data also allows us to distinguish the bi-directional causality between internationalization and either product innovation and process innovation. Product innovation and process innovation are two different concepts and play different roles (Cohen and Klepper, 1996 and OECD, 2005). While process innovation are intended to reduce the cost of productions and enhance productivity, product innovations give firms a competitive advantages by introducing new or improved goods to the markets (OECD, 2005). And thus, their relationship with exporting may be different. A large share of literature view innovation in terms of expenditure for R&D and thus cannot distinguish the role of process innovation and product innovation. A number of other studies separately look at either product innovation or process innovation and very few look at the relationship of both mode of innovation with internationalization decision.

Finally, we use a broader interpretation of internationalization. We define a firms as an internationalized firms if they not only exports their products abroad but also sells their products to foreign direct investment firms (FDIs) operating in the country. Firms that have technical cooperation with foreign firms, or import inputs for their production are also defined as internationalized firms. Ottaviano and Martincus (2011) and Bøler et al (2012) suggest that innovations are not only linked to exports but other internationalization activities such sourcing from abroad and importation of

materials and inputs. While exporting occurs a huge sunk cost and may discourage domestic firms, especially smaller firms to engage in such activities, selling to MNCs operating in the country is also a channel that help firms to improve their productivity, and hence encourage them to engage in innovation activity. Using this broader interpretation of internationalization have a significant policy implications. The results will help the governments to design appropriate policies to integrate SMEs into the global value chains, not only directly by exporting but also indirectly by joining the chain available domestically.

In general, the approach we use in this paper is rather 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. First, we look at innovation output instead of innovation input (i.e. R&D expenditure). Second, we also use a broader definition of internationalization by including firms that sell their products to FDIs, import inputs for production and have technical cooperation with foreign firms. And thirdly, we look at the interdependence of innovation and exports amongst SMEs in the context of a developing country. Finally, our paper uses a panel data, thus 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 a complementary to Nguyen et al (2008), which also examine the bi-directional causality of export and innovation. However, data used in Nguyen et al (2008) is cross-sectional data,[1] thus they could not examine the dynamic interdependence of innovation and exports.

The paper is organized as follows. Section two briefly review the theoretical foundation and related empirical evidence. Data and empirical approach will be discussed in section three. Section 4 provides some descriptive statistics, followed by empirical results in section five. The conclusion will be presented in section six.

## 2. Theoretical foundation and related literature

### *Theoretical foundation*

For a long time, various macroeconomic models suggest a bi-directional causality between internationalization and innovation. Traditional trade theory such as Vernon( 1966) and Krugman (1979) suggest that there is a positive relationship between innovation and export and that innovation is driving force behind firm's internationalization. The trade theory models argues that because internationalization incurs a high entry cost , only those firms that are more productive, have lower

[1] The first data point in our sample is the same as Nguyen et al (2008).

costs and higher profit margins could be able to internationalize. Innovation is considered as the major sources of productivity differences between internationalized firms and non-internationalized firms. Meanwhile, endogenous growth models predict that the causality run 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 the international markets and selling to MNCs may increase the pools of knowledge and technology of local firms, This will facilitate the innovation process of the internationalized firms. Second, stronger competition in international market force firms to innovate and adapt to market conditions (Wagner 2007). Thirdly, innovating firms have incentives to expand to other markets for earning higher returns from their investment (Teece 1986). Fourthly, internationalization could reduce the cost associated with innovation by accessing to 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 bi-directional. For example, Costantini and Melitz (2008)'s model show that innovation and exporting are the result of the endogenous choices of firms. Their drivers are a priori unclear: firms may conduct innovation activity in anticipation of exports or may start exporting after successfully innovating. In the later case, innovation is a type of "window-dressing" and part of the firm's preparation for embarking export activity, which gives rise to an observed self-selection effects.

***Empirical literature***

*From innovation to export*

A huge number of empirical studies on the effect of innovation on exporting. While some studies don't find a positive and significant impact of innovation on export performance (Wakelin, 1998 for the UK and Alvarez 2007 for Chile). Most of such studies find a strong positive effect of innovation on exporting. For example, using the US firm level data, Bernard and Jensen (1999) find substantial evidence that success product innovations leads 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 IV estimators, also show that firm self-select into innovation before exporting. The similar evidence is also found among the UK and German firms (Roper and Love, 2002; Ebling and Janz (1999), for Spanish firms (Cassiman and Martinez-Ros, 2007).

Some other studies find that the causal relationship leading from innovation to export may depend on the types of innovations or firm's characteristics. Becker and Egger (2013) empirically analyze the effects of new product versus process innovations on export propensity at the firm level. They find that both types/modes of innovation are expected to 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 could improve their export performance if they carried out product and process innovation simultaneously.

*From export to innovation*

Fewer number of studies exploring the impact of export on innovation and thus find weak support for 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 examines the learning-by-exporting hypothesis with the outcome variable is the productivity (see Wagner, 2007 and Greenaway and Kneller, 2007)for detailed literature review of papers using productivity as the outcome). However, firm productivity is extremely heterogeneous, even between 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 as well internal sources which may have nothing to do with exposure to export market, thus it is not always easy to identify the learning by exporting effect. As a results, empirical results of the effects of learning by exporting on firm performance have 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 such as R&D expenditure (i.e. innovation inputs), patent counts, and modes of innovation (i.e. innovation outputs). For example, Salomon and Shaver (2005) examine exporting behavior and ex post innovative outcomes among the 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 on the positive effects of exporting on innovation for both technically leading and lagging firms in Spain. Hahn (2010), using Korea's firm-level data of manufacturing firms, find some evidence that support for learning-by-exporting hypothesis, i.e. exporting promotes new product innovation. Girma et al (2008), using a bivariate probit, find positive evidence of the effect of exporter status on the decision to invest in R&D for Irish firms. Criscuolo et al (2010) find that globally engaged firms (including MNCs and exporters) innovate more, because they learn more from worldwide intra-firm pool of information and from international customers and universities. Liu and Buck (2007) uses sub-sector level data for Chinese high tech industries and find a positive and significant effect of different types of internationalizations

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 export, however, is also inconclusive. Moreover, the literature also could not provide answer for the question of which modes of innovation are benefit from internationalization. For example, Aw et al (2011)find that past export experience is not an important factor in determining firm's decision to carry out R&D. Damijan et al. (2010) find 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 an impact of trade liberalization on 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 the relationship between export and product innovation. However, they do not find process innovation as the major factor that could explain 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 exit between them in the effects of learning by exporting. This is extremely true for SMEs.

*Bi-directional causality of innovation and internationalization*

Following implications from economic theories and empirical evidence, recent literature attempts to examine bi-directional causality between internationalization and innovation. Using a structural model of producer's decision to invest in R&D, Aw et al (2008) find that self-selection of high-productivity plants mainly drive the participation in both activities, and that both R&D and exporting have a positive effect on plant's future productivity, reinforcing the selection effect. Hahn and Park (2012) examine bi-directional causal relationships among export, innovation and productivity among 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. However, 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. (No evidence that process innovation enhances the probability of SMEs to export beyond the impact of innovation).

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

Some studies find the effects are limited to a sample of firms. Damijan et al (2010) apply propensity score matching techniques, where firms are classified either by their propensity to innovate or propensity to export and 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 the empirical support for learning by exporting. They further find that the effects are only found among medium and larger firms. Lööf et al (2014) examine how differences in innovation strategy among exporting firms influence their TFP 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 innovator or inactive innovator. Firms that either start or stop their innovation activities within the sample period have a higher annual growth rate than non-innovators. A similar pattern is found among non-persistent exporters, but the estimates are non-signifiant 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 US. They find that exporting help UK's SMEs in the high technology industry innovate subsequently. However, only firms that consistently expose to export markets are able to overcome innovation hurdle. And as Halilem et al (2014) put it, internationalization and innovation are linked by different set of relations.

## 3. Data and empirical strategy

### *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 Vietnam. In each province, the sample was stratified by the form of ownership to ensure that all types of non-

state 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 exit 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 survey was around 2,500 firms.

Although the sample has been slightly adjusted over time, the questionnaires are nearly the same. Information collected includes the firm's and owner/managers' production, sales and markets, and some other characteristics. The questionnaires also contain questions about innovation activities that the firms have undertaken in the last two years, between surveys.

***Empirical strategy***

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

$$\mathrm{y_{it}} = x'_{it-1}\beta + y_{it-1}\gamma + \mu_i + u_{it}$$

In our dynamic probit models, it is assumed that $u_{it}|y_{i1}, y_{i2}, \dots y_{it-1}, x_{it}$ is iid as $N(0,1)$ and $u_{it}$ is uncorrelated with $(y_{i1}, x_i, \mu_i)$. In order to account for correlation between the individual effects $(\mu_i)$ and the observed characteristics $(x_{it})$, we follow Mundlak (1978) and Chamberlain (1984)to assume that $\mu_i = \bar{x}_i\, \alpha + \epsilon_i$, of which $\epsilon_i$ is iid as N(0,1) and independent of $x_{it}$ and $u_{it}$ for all $i$ and $t$. Additionally, for estimation of dynamic models such (1), we have to solve two important problems: (i) the treatment of initial conditions $(y_{i1})$ and (ii) persistence and unobserved individual heterogeneity $(\mu_i)$. Furthermore, bivariate models bring about the problem of cross-persistence.

Heckman (1981) and Wooldridge (2005)proposes some approaches to deal with the initial conditions. In this paper, we adopt the approach proposed by Wooldrige (2005). Previous econometric literature shows that Heckman (1981) and Wooldridge (2005) estimator produce quite comparable results. Wooldridge estimator is based on conditional maximum likelihood. In this approach, $y_{i1}$ is assumed to be random and the distribution of $\mu_i$ is conditional on $y_{i1}$ and $x_i$.

The second issue is related to the state dependence. It is argued that the nature of state dependence will have different policy implications (Cameron and Trivedi 2005). To deal with issue, we take advantage that both internationalization and innovation decisions are highly serially correlated and that these two decision are interdependent, we estimate the two participation decision simultaneously by estimating a dynamic bivariate binary choice model. The following equation extend the previous univariate model to a bivariate context:

$$y_{it}^{1j} = x'_{it-1}\beta_{1j} + y_{it-1}^{1j}\gamma_{11j} + y_{it-1}^{2}\gamma_{12} + \mu_i^{1j} + u_{it}^{1j}$$
$$y_{it}^{2} = x'_{it-1}\beta_{2} + y_{it-1}^{1j}\gamma_{21j} + y_{it-1}^{2}\gamma_{22} + \mu_i^{2} + u_{it}^{2}$$

$$y_{it}^{k} = \begin{cases} 1 \; if \; y_{it}^{k*} > 0 \\ 0 \; if \; y_{it}^{k*} \leq 0 \end{cases}$$
$$where \; k = 1j, 2; \; t = 1..T$$

of which

- $y_{it}^{1j}$ and $y_{it}^{2}$: dependent variables; innovation dummy ($y_{it}^{11} = 1$ if firm $i$ carry out product innovations in year $t$; $y_{it}^{12} = 1$ if firm $i$ carries out process innovation in year $t$; and international status dummy ($y_{it}^{2} = 1$ if firm $i$ either exports and/or sells to FDI 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 level, firm's age, size, ownership, either innovation status (for internationalization equation) or internationalization status (for innovation equations).
- $y_{it-1}^{1j}$ and $y_{it-1}^{2}$: state dependence (i.e. lagged innovation and internalization indicator in innovation and internationalization equation).
- $\mu_i^{1j}$ and $\mu_i^{2}$: random individual effects (j= 1,2); $(\mu_i^{1j}, \mu_i^{2})$ are assumed to be bivariate normal distribution.
- $u_{it}^{1j}$ and $u_{it}^{2}$: error terms; $(u_t^{1j}, u_t^{2})$ are assumed to be bivariate normal distribution and independence overtime.

***Variable construction***

*Measuring innovation*

Previously, longitudinal data on innovation activities at the firm level usually covered activities of firms in the form of patent registration and R&D expenditure in developed economies (Ayyagari et al 2011). Although original innovations (that is, new-to-world innovations) are crucial, imitation in the form of

adopting new production technology, or improving quality of the products or introducing some new products are more relevant to firms in developing countries, where most firms are engaged in activities far from the technological frontier (UNCTAD 2007). We follow Ayyagari et al (2011) and other literature on innovation in the context of developing economies in adopting the definition of "new-to-firm" innovation. We use two indicators to measure the innovation carried out by firms: product innovation and process innovation. Product innovation takes value of one if firms either (i) introduce a new product or upgrade existing products in last two years, and zero otherwise. Process innovation is also a binary variable, which takes value of one if firms upgrade their existing production procedure in last two years, and zero otherwise.

*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 which sell to FDI as exporters. Our definition of internationalization also include using imported inputs and/or having long-term partnership with foreign firms. Indeed such activities ease domestic firms' integrating into the global value chains.

*Explanatory variables*

- Size: The size of the firm is measured by productive asset. In some studies, firm size is measured by number of people employed. However, due to small, and sometimes seasonal, production cycles, during the operation years, firms may recruit temporary workers and thus total full-time employment may not truly reflect firm size, especially in the developing countries context. However, we use the full-time employment data to separate our sample into micro firms and non-micro firms since there is no consensus on the micro firm asset-based definition, The micro firm in our sample is defined as those which have fewer than 5 workers. Large firms usually have more advantages in supporting innovation activities.
- Age: Age of the firm is the log of the number of the firm's operation years at the time of the survey. This variable is to capture the learning-by-doing effect on innovation. However, a flat learning curve and being risk averse may hinder firms to innovate.
- Owner/Manager education level: owners having college degree and owners having technical skills in producing their main products capture human capital of the firms. They reflect the potentials of either employees or owners in innovation activities.

- Being an incorporated firm is a dummy variable. It takes the value of one if the firm is either a limited firm or partnership firm or joint stock firm while it is equal to zero if the firm is a household firm or private firm (sole proprietorship). This variable captures the formality of the firm. Incorporated firms tend to serve more competitive market than household firms, which mostly serve on the local customers. Thus, an incorporated firm is more likely to engage in innovation activities than household firms.
- Finally, we also control for firm's location, industry and time dummies.

## 4. Descriptive analysis

Our sample consists of 8,357 firms, of which 4,418 firms have less than 6 full-time permanent employees, accounting for 52.3% total number of firms in our dataset, and 3,939 firms have at least 6 full-time permanent employees.This paper, we separate firms into micro firms and non-micro firms. Table 1 presents some descriptive statistics. In general, 35.9% of firms in our sample have product innovation activities. This figure is 25.9% for micro firms and 47.2 for non-micro firms. About 12.5% of total firms, 6.2% of micro firms and 19.5% non-micro firms have carried out process innovation in the 2 years. Regarding internationalization, although we use a rather broad definition, only 8.5% of firms have one or more internationalization activities. Similarly to innovation activities, micro firms are also not actively have international activities. Only 1% of micro firms do so. This figure for non-micro firms is 16.8%. The same pattern are also seen in indicators such as proportion of owner/manager having college and technical college degree, production asset and labor productivity.

***[Table 1 about here]***

Table 2 presents the transitional probability matrix. It can be seen that there is a general pattern of strong persistency in innovation and internationalization. The diagonal elements are usually higher than 50% or nearly 50% (as the case of production innovation), except for process innovation. It can infer that 56.5% of firms that have international activities at t-1 continues 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 point higher for internationalized firms at t. This can be seen as a measure of unconditional state dependence (since we have not controlled for observed and unobserved firm characteristics yet). Similarly, the probability of engaging in international activities of a firm that carries out product innovation (process innovation) at time t was 6.2 (10.08) percentage point higher than that of non-innovative firms. Table 2 also indicates that firms with international activities at time t also have higher probability to carry 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 product innovation (process innovation) at time t+1 is 12 (15.6) percentage points for those firms which have international activities at time t. However, this table also suggests that the persistence is also observed among non-internationalized firms, non-innovative firms, i.e. very few non-internationalized firms and non-innovative firms shifted their status at the subsequent period.

***[Table 2 about here]***

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. Column 2 and 3 show the probabilities of internationalization, product innovation and process innovation conditional on 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 19.2% for micro firms and 1.6% for household firms. The same patterns are also seen in product innovation and process innovation decisions.

***[Table 3 about here]***

Transitional probability matrices presented in Table 2 and 3 suggests a state dependence and interdependence of innovation and internationalization decisions. However, such matrices could not provide us adequate information on the sources of such dependency. In this section, we attempt to figure out the sources of such relationship.

## 5. Empirical results

Table 4 and 5 presents our univariate probit estimations, using Wooldridge (2005)'s initial condition correction approach (Wooldridge correction approach). The dependent variables in Table 4 is production innovation (columns 1, 2 and 3) and process innovation (columns 4, 5 and 6). The estimations for the whole sample are presented in columns 1 and 4, for sample of micro firms in columns 2 and 5 and for sample of non micro firms in columns 3 and 6. In all specifications, we include variables indicated whether firm has any international activities in the last period or not.

The estimations show that past product (process) innovation has a positive and statistically significant effect on the firm's current product (process) innovation decision. The statistical significance of the value of dependent variables at time t=1 (initial period) indicates that the is a true state dependence in

process and product innovation decisions among the small 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 from group of firms to group of firms. It has a positive and statistically significant effect on process innovation for non-micro firms, while for micro firm, this effect is negative, implying that firms are less likely to carry out the process innovation if they successfully engaged in internationalization in the last period. The negative relationship could be due to the fact that given the high sunk cost of exports (including external export), internationalized micro firms could already have invested state-of-the-art technology, or own special skills that can distinguish them from other competitors. Furthermore, they may not find adequate incentives to carry out changes as long the the current production process still work well. Another potential explanation for this negative relationship is some firms may not be successful in international activities in the past period and thus have to reduce and cut their production process. In fact in our sample of micro firms, only 1% of them have international activities in the last period. Among them them nearly 40% used to be non-micro in the last period.

The empirical results also indicates that larger firms are more likely to carry out innovation. This results is consistent with other studies. Being an incorporated firms also increase the probability to carry out innovation activities. Our estimation results also indicates that older firms seem to be risk averse. Probability of innovation declines with ages. However, we find that firms with higher labor productivity are less likely to innovate. This is partly because the incentives to undertake process innovation and product innovation is not high enough for high productivity firms.

***[Table 4 about here]***

Table 5 presents our estimations for the effect of production innovation and process innovation on internationalization. Similar to table 4, we also use Wooldridge correction approach to identify whether there is a state dependency in internationalization. We also control for firm's industry, location and 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 estimation results indicate that past engagement in international activities have a positive effect on internationalization decision 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 and process innovation on firm's internationalization decision.

***[Table 5 about here]***

However, the empirical results show that there is a large difference between micro firms and non-micro firms relating to factors determining internationalization decision. There is a rather large state dependency of internationalization of non-micro firms, reflected by rather large magnitude of the estimated coefficients on the lagged decision to internationalize and the significant of the initial conditions, while such pattern is not seen among micro firms. Other variables, except for being incorporated firm, do not have a statistically significant effects on micro firms' internationalized decision. This results may be due to the fact that only 1% of micro firms engaged in internationalization and probit estimation, thus, could not provide a good and consistent estimation. For non micro firms, we find that owner/manager having college degree or technical college degree, larger firms and being an incorporated firms will raise the probability to engage in internationalization.

***Bivariate results***

The univariate dynamic random effects estimated in previous section allows assessing the relative importance of unobserved heterogeneity and genuine state dependence in explaining persistence in the internationalization and innovation decisions. As literature has suggested, there may be interdependence between innovation and internationalization decision. Therefore, a bivariate model could provide a suitable estimation methods since it allows the correlations between the error terms in internationalization and innovation equations.

***[Table 6 about here]***

Table 6 reports the results of the dynamic pooled bivariate models. Panel A present the bivariate estimations 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 international for all groups of firms. Past product innovation (internationalization) do not have statistically significant effects on current internationalization (product innovation). The statistically significance of \rho in the estimation for the whole sample confirms that firms jointly determined internationalization and product innovation decision. As reported In panel B, for the whole sample and sample of non micro firms, the past internationalization still have positive and statistically significant effects on process innovation. For micro firm, the effect is still negative and (weakly) statistically significant at 10%. Other control variables share the similar effects as the ones we obtained in the Table 5. Statistical significance of $\rho$ also indicates that there is a cross-dependence between process

innovation and internationalization decisions. It should be noted that in both panel A and Panel B, the estimates of the impact of lagged dependence variables obtained in the bivariate probit model is higher than those obtained from estimating a dynamic random effect probit. This is because the individual heterogeneity is not controlled in the bivariate models. Esteve-Perez and Rodiguez (2013) suggest that the estimates from the dynamic RE probit may be more appropriate for state dependence.

***[Table 7 about here]***

To facilitate the interpretation of results from bivariate probit estimation, following Esteve-Perez and Rodiguez (2013), we calculate the predicted probabilities of engaging in internationalization and carrying out process innovation given four combinations of past internationalization and process innovation. 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 predicted probabilities. We find that the predicted probability to engage in international activities in this period those firms engaged in these activities in the past period is nearly 50 percentage point 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 probabilities of a past process innovator implement process innovation in this period is 8 percentage point higher than those who did not have process innovation last period. The result also indicates a cross-persistence in these activities, although such cross persistence is not high. For example, given the firm do not have process innovation in the last period, the probability to carry out process innovation in this period is 22.8% if the firms have international activities last period, while this figure is only 14.4% if the firms do not have international activities.

We also calculate the average treatment effect of the previous internationalization and process innovation status on internationalization and process innovation decision in this period. The results are reported in Panel B of Table 7. This result shows that if, in the previous period, a non-innovator shifted himself to become an innovator, the probability to carry out process innovation in this period will increase about 5%, but their probabilities to internationalize only slightly increase 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. This results are in line with our previous results, however.

***Robustness check***

Table 8 present our robustness check.[2] We use several approaches to check the sensitivity of our estimations. First, we limit our sample to those firms which are either micro firms or non-micro firms during the studied period. Firms' propensity to innovate or to internationalize may cause or be affected by firms' decision to reduce the number of workers to become a micro firms or vice versa (see Panel A, table 8). Second, we use different measure of innovation. Instead of considering firms that just engaging innovations 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 reestimate our model using Heckman's correction procedure to deal with initial conditions (Panel C, Table 8). The estimations results are quite similar to the results presented above. This reinforces our finding presented in previous subsetion.

## 6. Conclusion

This paper aims to examine empirically the dynamic interdependence of internationalization and innovation decisions among the SMEs in the context of developing economies. More specially, the paper investigates whether there is a persistence in innovation and international decision among SMEs and whether this persistence (if any) is "true" or spurious persistence. We also examine whether the persistence of one activity determine the persistence of the other activity, if the persistence is present in both activities. We also distinguish two types of innovation: product innovation and process innovation. For internationalization, we consider an internalized firm as a firm to be internalized if they either export their goods to foreign markets and sell their output to foreign investment firms (so-called domestic export). To this end, in this paper, we use a large and rich SME firm-level data, collected biannually from 2005 to 2013 in Vietnam. A dynamic random effect probit and bivariate probit estimators are used.

Similar to Esteve-Pérez and Rodríguez (2013), our results show a high persistence in carrying out process, product innovations and engaging international activities. Furthermore, we find that, for non-micro firms (i.e. firms with at least six fulltime permanent workers), past internationalization has a positive effect on process innovation in the subsequent period but past process innovation do not has a significant effect on internationalization decision of these firms. For this group of firms, we also find signs of cross-dependence between process innovation and internationalization decision. Our empirical results, however, does not show dynamic interdependence between internationalization and

[2] We only report the results of dynamic RE bivariate probide model between internationalization and process innovation

product innovation. For micro firms, we do not find any evidence relating to interdependence of internationalization and both types of innovation.

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

Our results have some policy implications. Firstly, because the high persistence of internationalization and innovation observed among firms is reflected by not only the firm heterogeneity (i.e. the firm's differences in innovation and internationalization at the beginning) but also firm's past decision to engage in such activities, the government may have policies to foster the engagement of firms in such activities since it will have longer effects. In fact, if the persistence is only due to past dependence, then government policies have only effects (if any) in this period, not in other period. Secondly, our results also implies on which targets the government should focus more. The cross dependence of internationalization and process innovation indicates that the government may have some policies to encourage firms to carry out both process innovation and internationalization such as preference credit policies for firms to implement process innovation in order to produce internationalized products. This will be more efficient than having policies that separately facilitate either internationalization or innovations.

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***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] |

***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: 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% |

***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] |
| Large 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 | 3227 | 1928 | 1834 | 3227 | 1928 | 1834 |
| Total observation | 8357 | 4418 | 3939 | 8357 | 4418 | 3939 |

Note: The estimates presented in this table is marginal effects. Columns 1 and 4 are estimation results for the whole sample, columns 2 and 5 for sample of micro firms and columns and columns 3 and 6 for sample of non-micro firms. In all specifications, we use Wooldridge correction approach. We also control for firm's industry, location and year. Estimations are based on Gauss-Hermite quadrupture approximations using twelve quadrupture points. We also use 16 and 24 quadrupture points to check the 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 | -0.0000978 | 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*** | .0001161 | 0.036*** | 0.013*** | 0.000 | 0.035*** |
| | [0.004] | [0.000] | [0.012] | [0.004] | [0.000] | [0.012] |
| Large 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*** | .0004447 * | 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*** | .0008664 | 0.099*** | 0.038*** | 0.001 | 0.099*** |
| | [0.006] | [0.001] | [0.017] | [0.006] | [0.001] | [0.017] |
| Number of firms | 3227 | 1928 | 1834 | 3227 | 1928 | 1834 |
| Total observation | 8357 | 4418 | 3939 | 8357 | 4418 | 3939 |

Note: The estimates presented in this table is marginal effects. Columns 1 and 4 are estimation results for the whole sample, columns 2 and 5 for sample of micro firms and columns and columns 3 and 6 for sample of non-micro firms. In all specifications, we use Wooldridge correction approach. We also control for firm's industry, location and year. Estimations are based on Gauss-Hermite quadrupture approximations using twelve quadrupture points. We also use 16 and 24 quadrupture points to check the the accuracy.

***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 | Internatio-nalization | Product innovation | Internatio-nalization | Product innovation | Internatio-nalization |
| 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] |
| Large 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] |
| $\rho$ | 0.166 | | -0.045 | | 0.184 | |
| Chi-square | 23.409 | | 0.255 | | 22.996 | |
| Panel B | | | | | | |
| Dependent variables | Process innovation | Internatio-nalization | Process innovation | Internatio-nalization | Process innovation | Internatio-nalization |
| 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] |
| Large 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] |
| $\rho$ | 0.203 | | 0.372 | | 0.163 | |
| Chi-square | 27.38 | | 11.242 | | 15.454 | |
| Number of firms | 3227 | 3227 | 1928 | 1928 | 1834 | 1834 |
| Total observation | 8357 | 8357 | 4418 | 4418 | 3939 | 3939 |

***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) |

***Table 8: Robustness check***

| | Process innovation | Internatio nalization | Process innovation | Internatio nalization | Process innovation | Internatio nalization |
|---|---|---|---|---|---|---|
| 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] |
| Large 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 |
| 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] |
| Large 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 | 8357 | 8357 | 4418 | 4418 | 3939 | 3939 |