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# The Role of Product Innovation Output on Export Behavior of Firms


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## Abstract

This paper analyzes the role of innovation on the export behavior of firms. Using two waves of Swedish CIS data merged with register data on firm-specific characteristics, I estimate the influence of the innovation output of a firm on its export propensity and intensity, respectively. I find that the innovation output of firms (measured as sales due to innovative products) has a positive and significant effect on export behavior of firms. The results also show that it is indeed innovation output, rather than innovation input (innovative efforts), that matters for export behavior of firms. Specifically, innovation output leads to increase in later export propensity and intensity of firms. Moreover, there is also strong association of productivity and ownership structure of firms with export propensity and intensity of firms. The results are robust when unobserved time-invariant heterogeneity of firm and also potential endogeneity of innovation-export are taken into accounted.

**Key words:** Innovation output, innovation input, export propensity, export intensity

**JEL classification:** O31, O33, F14

# 1. Introduction

There are well-established macro-level theories predicting a positive association between innovation and export performance. The earlier technology gap models (Posner, 1961) and product-cycle models (Vernon, 1966; Norton and Rees, 1979; Krugman, 1979) recognized (exogenous) innovation as a key driver of exports. Subsequent models considered the possibility of a reverse effect, i.e. export induces higher innovation, within the trade models of the endogenous growth framework (Grossman and Helpman, 1991). It is only recently that micro-level models that are able to explain the effect of innovation on export behavior of firms have been developed (Melitz, 2003; Caldera, 2010; Bustos, 2011). The basic idea is that product innovation is a key factor for successful market entry in the Schumpeterian growth models based on creative destruction. Such product innovation would create the competitive advantageous for firms to penetrate the competitive export market, based on differentiated products. Accordingly, micro-level empirical studies have provided the microeconomics evidence of the interaction between innovation activity and exporting (Wakelin, 1998; Sterlacchini, 1999; Roper and Love, 2002; Lachenmaier and Wößmann, 2006; Harris and Li, 2009; Ganotakis and Love, 2010; Cassiman and Golovko, 2011; Becker and Egger, 2013). However, most of these studies consider R&D and innovation as interchangeable, and usually proxy innovation with indicators of innovative efforts, such as R&D investment (Aw et al., 2007; Girma et al., 2008; Harris and Li, 2009)[2]. Indeed, several of these studies have found an insignificant relationship between R&D investment and export behavior of firms (e.g. Lefebvre et al., 1998; Becchetti and Rossi, 2000; Sterlacchini, 2001; Van Beveren and Vandenbussche, 2010).

This paper argues that what really matters for firm's exporting is the actual innovation output (in the forms of sales due to innovative products) rather than innovation input (e.g. R&D investment), because the ability to enter the export market is eventually influenced by the firm's capacity to compete internationally (through introducing new products for instance), rather than its mere innovative efforts such as investments in R&D (Ganotakis and Love, 2010). Moreover it is known from innovation literature that R&D can work at best as (part of) the innovation input and it is not necessarily the most important innovation input (Smith,

[2] The study by Ganotakis and Love (2010) is among the few exceptions.

2005) and cannot guarantee the proportional innovation output (Grillichez, 1979). In addition, considering R&D as a measure of innovation excludes those smaller firms who do not have any separate R&D department (and hence no formal R&D investment records), yet who nevertheless innovate (Pavitt et al., 1987; Wakelin, 1998). Therefore, in this paper we consider the association between the actual innovation output and exporting, thanks to the availability of micro-data. While in recent micro-level trade literature there is relatively rich evidences on the positive association between productivity and export behavior of firms, there are fewer studies dealing with the role of innovation for export behavior, especially when innovation is considered as the actual innovation output of firms.

The purpose of this paper is to analyze the effect of innovation on export behavior of firms by empirically testing the predictions of product-cycle models of international trade with micro-level data. The main contribution is the use of the actual innovation output as a measure of innovation, while taking into account several sources of endogeneity in the innovation-export association.

The empirical analysis is based on two waves of Swedish CIS data which are merged with registered data on firm-specific characteristics. We find micro-evidence that innovation output (not input) of firms has a positive effect on their export behavior. Specifically, innovation output leads to an increase in later export propensity and intensity of firms. The effect of innovation output on export propensity (probability of entering the export market) is, however, wiped out after controlling for productivity level and ownership structure of the firm. The results turn out to be robust when unobserved time-invariant heterogeneity of firms and endogeneity of innovation are taken into accounted.

The rest of the paper is as follows. Section 2 provides the theoretical and empirical background on innovation-export association. Section 3 discusses the empirical strategy and introduces the empirical model. Section 4 describes the data. Section 5 presents the empirical results. Section 6 concludes.

## 2. The Innovation-Export association

This section provides theoretical background concerning the Innovation-Export association in both macro- and micro-level (section 2.1). Empirical evidence of the theoretical background is presented afterward (section 2.2).

### 2.1. The theories on Innovation-Export association

Traditionally there are two types of macro-level models that have been able to explain the innovation-export association: (i) technology gap and the product life cycle model (Posner, 1961; Vernon, 1966; Rees, 1979, Krugman, 1979) and (ii) trade models of endogenous growth theory and the Learning-By-Exporting literature (Grossman and Helpman, 1991; Castellani, 2002). Technological gap and Product life cycle models are probably the first models (dating back to 60s) that explicitly recognized the positive association between innovation and export behavior. The main argument in these models is that developed countries (specifically the US) are able to be pioneer in innovation, which leads to export of their differentiated products to less developed countries (Posner, 1961; Vernon, 1966; Rees, 1979, Krugman, 1979)[3]. Subsequently, trade models of endogenous growth theory have been developed which recognized the reverse direction of the effect (Grossman and Helpman, 1991), i.e. exporters will be more likely to innovate in principle because of three reasons: (i) the competition in foreign markets forces firms to invest in innovation activities in order to improve both products and processes and hence remain competitive, (ii) the learning-by-exporting effect: exporters are more exposed to some knowledge inputs from abroad customers, which are not available to firms in the domestic market[4], (iii) the scale effect: exporting extends the market and as R&D investments are largely fixed costs, such investments may be compensated over a larger sales volume. This helps productivity and provides greater incentives to invest in R&D and other innovation activities presumably leading to improvement in innovation (Grossman and Helpman, 1991).

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[3] Technology gap model was more concerned with trade behavior of the homogenous developed countries, rather than distinguishing between developed and less developed countries as in PLC models. The main argument in technology gap model is that trade is caused by the existence of some technical know-how in one (developed) country not available in other developed countries (Posner, 1961).

[4] Accordingly, so called Learning-By-Exporting literature has emerged providing (micro) evidences concerning the higher productivity (not innovation) due to prior export behavior (Castellani, 2002).

Apart from macro-level models concerning the innovation-export association, recently micro-level models have been developed to explain the likely positive effect of innovation on export behavior of firms (Melitz, 2003; Bustos, 2011; Caldera, 2010). Melitz (2003) developed a dynamic industry model with heterogeneous firms (in terms of resources and hence productivity), the so-called self-selection literature. The main argument of this model is that productive firms (not explicitly innovative firms, though) can overcome to the sunk cost associated with entering the export market. In this model, the productivity heterogeneity of firms is given exogenously. Bustos (2011) and Caldera (2010) extend Melitz's model by endogenizing the exogenous productivity heterogeneity of firms. Following Romer's model of endogenous growth, they propose the possibility that firms may invest in innovation inputs both to upgrade their technology (product innovation) and to reduce the marginal cost of production (process innovation), hence endogenizing the productivity heterogeneity of firms. These models, in principal, predict that innovating firms are more likely to participate in exporting than non-innovating firms, because innovators find exporting more profitable than non-innovators. Although innovating and non-innovating firms face similar fixed costs to enter export markets, the innovating firms generate a higher expected profit from exporting, which makes them more likely to export.

### 2.2. The empirical evidences on Innovation-Export association

Early empirical studies provided macroeconomic evidences showing the positive impact of innovation on export behavior (in addition to relative prices) in the country-level (see Fagerberg (1988) for OECD countries and Greenhalgh (1990) for UK). Later studies provided the microeconomic evidences for such a positive association at the firm- or plant-level, thanks to the availability of micro-data. Most of these studies, however, used R&D expenditure as the indirect measure of innovation (in other words innovation input). As noted in the introduction section, the results of these studies using innovation input as the measure of innovation are inconclusive: some of them found a positive and significant effect of innovation on export behavior (Hirsch and Bijaoui, 1985; Ito and Pucik, 1993; Braunerhjeim, 1996; Lefebvre et al., 1998; Becchetti and Rossi, 2000; Sterlacchini, 2001), while others found no significant effect (Lefebvre et al., 1998; Becchetti and Rossi, 2000; Sterlacchini, 2001; Van Beveren and Vandenbussche, 2010). The most recent micro-level studies have used survey data, which allowed them to use direct measures of innovation (in other words actual innovation output). Most of these studies have been concerned with the effect of product versus process innovation (measured by dummies) on export behavior of firms (in terms of "propensity" measured as the probability of exporting and "intensity" measured as the export value per employee). Generally speaking, these studies provide evidences that product innovation has a positive effect on both export propensity (Wakelin 1998; Basile, 2001; Nassimbeni, 2001; Roper and Love, 2002; Becker and Egger, 2013) and export intensity (Basile, 2001; Roper and Love, 2002) by increasing the chance of opening new markets and competitiveness. Evidences of the effect of process innovations, however, are inconclusive: some studies found no relationship to export propensity (Nassimbeni, 2001; Higón and Driffield, 2011), some found a positive effect on both export propensity and intensity (Basile, 2001; Van Beveren and Vandenbussche, 2010).

Above reviewed theoretical and empirical backgrounds on innovation-export association leads to the following two hypotheses:

*HP1: Innovation output of firms has a positive and significant (causal) effect on their export propensity and intensity.*

*HP2: Innovation input (innovation efforts) of firms may not have a significant effect on their export propensity and intensity.*

The following section will test the two proposed hypotheses empirically.

## 3. Empirical strategy

This section provides the empirical strategy to test the proposed hypotheses. The basic model to be estimated is introduced (section 3.1). Next, potential endogeneity of innovation-export association is discussed and explicitly taken into accounted (section 3.2).

### 3.1. Basic model

The aim of the empirical analyses is to estimate the effect of innovation output and innovation input on export propensity and export intensity of firms. In order to do so, the basic model is formulated as follows:

$$EXPORT_{it} = INNOVATION\_O_{\ it-2} + INNOVATION\_I_{\ it-2} + \boldsymbol{X}_{\ it-2} + S_j + T_t + \varepsilon_{it}$$

Where $EXPORT_{it}$ is the export propensity and also export intensity of firm *i* in year *t*. Export propensity is a dummy which gets value 1 if firm *i* is an exporter in year *t*, 0 otherwise. Export intensity is measured as the amount (value in SEK) of export per employee for firm *i* in year *t*. $INNOVATION\_O_{\ it}$ is the innovation output of firm *i* in year *t* measured as the amount of sales of innovative products per employee[5]. $INNOVATION\_I_{\ it}$ is the innovation input of firm *i* in year *t* measured as the sum of six categories of investments in innovation effort (expenditures). $\boldsymbol{X}_{\ it}$ is the vector of other (exogenous) firm-characteristic variables, i.e. productivity, size, ownership structure, physical capital, and a cooperation dummy (the precise definitions of all variables is documented in Table A1). $S_j$ is sector-specific component that measures differences between sectors, for instance in terms of export market opportunities or technological capabilities. $T_t$ is time-specific component that takes into account macroeconomic effects and business cycles that may affect the export decision and intensity. $\varepsilon_{it}$ is the error term consists of two components: a firm-specific effect which captures unobserved time-invariant firm heterogeneity (such as managerial ability) that may affect the export decision and intensity and a time-variant component, which catches unobserved shocks.

Innovation output and innovation input are the main variable of interest (based on two proposed hypothesis in Section 2). As noted earlier, innovation input is included because many previous studies used innovation input (more precisely the R&D intensity) as the measure of innovation (Ebling and Janz, 1999; Aw et al, 2007; Girma et al, 2008; Harris and Li, 2009). Although we do not consider innovation input as the true measure of innovation output (as discussed in Section 1 and 2), yet it is useful to include it as a RHS variable for the sake of comparability with previous studies. Moreover, there are sound reasons to include the vector of (exogenous) firm-characteristic variables in the model. Productivity is included

[5] Innovative product is defined as a new or significantly improved product. It could be new or significantly improved to the firm or to the market (OECD, 2005).

because the firm-selection literature provides strong evidences on the positive association between the productivity level and the export behavior of firms, as discussed in Section 2 (Bernard and Wagner, 1997; Bernard and Jensen, 1999; Delgado et al, 2002; Melitz, 2003). Size is included in order to control for firm's capacity and internal resources (Lachenmaier and Wößmann, 2006; Caldera, 2010; Higón and Driffield, 2011). Physical capital is included in order to take into account the level of firm's financial capacity, which is expected to a have positive effect on export behavior (Ebling and Janz; 1999; Lachenmaier and Wößmann, 2006). Ownership structure (being non-affiliated, being uninational, being domestic MNE, or being foreign MNE) is included in order to take into account the internal linkages to export market (Basile, 2001; Roper and Love, 2002). Being part of the group (either being uninational, domestic MNE, or foreign MNE) could increase the knowledge about export markets, especially those export markets where a MNE has a branch. Cooperation is included in order to take into account the external linkage to export markets (Nassimbeni, 2001). It is an external linkage because a firm can learn from external agents in the exporting market, especially the customers. This is motivated by the Learning-By-Exporting literature, providing evidence about the positive effects of learning from customers on export behavior (Castellani, 2002). Furthermore, not including the above control variables in the model specification would lead to omitted variable biases. For instance, there are empirical evidences showing that productivity is not only positivity associated with export behavior, but also with innovation output. Hence, not including productivity in the model specification can lead to biased estimations of the effect of innovation output on the export behavior of firms.

### 3.2. Endogeneity in the Innovation-Export association

It is argued that innovation is endogenous in the export equation. This implies that simply using OLS as the estimator may at best provide the correlation association between innovation and exports and not any causal association. There are (at least) three sources for endogeneity of innovation. First, there might be unobservable firm-characteristics that can affect both innovation and export (omitted variable bias). Second, the causation between innovation and export can be in both directions. Third, there might be a simultaneity bias because firms usually make their innovation and export decisions simultaneously (Van Beveren and Vandenbussche, 2010).

The first source of endogeneity is accommodated by applying panel estimators, assuming that unobservable heterogeneities are time-invariant (Caldera, 2010; Cassiman and Golovko, 2011). This turns out to be possible thanks to the merging of two waves of the Swedish Community Innovation Survey (this will be discussed further in section 4). However, the panel is short (2 years), nevertheless a similar empirical strategy was chosen in Van Beveren and Vandenbussche (2010), arguing that the relatively short nature of the panel can be compensated by detailed information on firms' innovation characteristics.

The second source of endogeneity is stemming from the dual-directional relationship between innovation and exports, which is motivated by theoretical arguments as well as corresponding empirical evidences. As for the theoretical argument, there are two explanations for the innovation and export association. On the one hand, the technology gap and product-cycle models of international trade predict that innovation is the driving force for the exports of industrialized countries (Posner, 1961; Vernon, 1966; Krugman, 1979). On the other hand, endogenous growth models predict that export contributes to innovation and growth (Grossman and Helpman, 1991). This means there is the issue of endogeneity of innovation with respect to export. Hence analyzing the effect of innovation on export simply by OLS would be biased. Indeed, it is shown that considering innovations as exogenous may lead to downward-biased estimates of the impact of innovations on firm-level exports (Lachenmaier and Wößmann, 2006). There might be several estimation strategies for disentangling the causality association between innovation and export. First, some studies used the Granger-causality test to see which of the innovation effect or the export effect comes first chronologically in panel data studies (Bernard and Wagner, 1997; Bernard and Jensen, 1999)[6]. Second, Becker and Egger (2013) explicitly take into account the self-selection of firms into innovation (both product and process) in order to avoid the assumption stating that firms innovate randomly. This way, they endogenize product and process innovations when estimating their impact on exports. Third, an Instrumental Variable approach is used to endogenously identify the effect of innovation on exports in cross-sectional studies (Lachenmaier and Wößmann, 2006; Harris and Li, 2009; Ganotakis and Love, 2010). For instance, Lachenmaier and Wößmann (2006) used exogenous innovation impulses and

[6] These studies are usually on productivity-export association, rather than innovation-export association.

obstacles as instruments for actual innovation in the export equation. They argue that innovation impulses and obstacles affect innovation but it does not affect exports, hence providing a reliable instrument. We pursued this third option to identify the variation in innovation that is reliably exogenous to exports. In order to further accommodate this source of endogeneity, we used an alternative measure of export propensity, i.e. the *export starter*, instead of merely engaging in export activities. Using this alternative measure allows a clearer causal inference compared to using merely engaging in export activities. This is because, for example, a firm reporting export activity in 2008 may have been a persistent exporter, since several years ago. But if a firm *starts* exporting in 2008, then its prior innovation output in 2006 can be interpreted as a causal effect on its exporting activity, conditional on controlling for other important factors. The result of such an alternative estimation is reported in Table A4 in the appendix.

In order to take into account the third source of endogeneity, i.e. the simultaneity bias, one stream of studies use simultaneous equation systems to disentangle the determination of exports in an export equation from the determination of innovation in an innovation equation (Smith et al, 2002; Aw et al, 2007; Girma et al, 2008; Higón and Driffield, 2011). In these studies the innovation (or sometimes R&D) and export equations are simultaneously estimated either by bivariate probit models or 3SLS (depending on depending variable) or alternatively with Maddala (1983)'s 2-stage procedure. Such models can allow the error terms of the two equations to be correlated, since the dependent variable in each equation is among the RHS variables in the other equation. Using a simultaneous equation approach requires meeting some conditions: one needs to (i) find proper exogenous variables in each equation, (ii) consider the rank condition, and (iii) there should not be the same economic agent in both equations (Wooldridge, 2009). However, these conditions are not always easy to motivate. Furthermore, the aim of above mentioned studies using the simultaneous equation was indeed different than the aim of this paper. They were interested in the bi-directional effects in the innovation-export association, while this paper is interested in the causal effect of innovations on exports. Instead, we follow another stream of studies that used lagged RHS variables in order to mitigate the simultaneity bias (Van Beveren and Vandenbussche, 2010; Caldera, 2010).

## 4. Data and descriptives

The innovation related data in this study comes from two waves of the Swedish Community Innovation Survey (CIS) in 2004 and 2006. The CIS 2004 covers the period 2002-2004 and CIS 2006 covers the period 2004-2006 for both manufacturing and service firms in Sweden. Only firms with 10 and more employees are covered in these two CIS waves. Among them, the stratum with 10-249 employees has a stratified random sampling with optimal allocations and the stratum with 250 and more employees is fully covered. The response rate in both waves was slightly more than 60%. We only use manufacturing firms in order to avoid the complication concerning the export behavior of service firms. This leaves us with approximately 1800 manufacturing firms in each wave. In addition, we only kept those firms that participated in both waves, because we are interested in tracing the same firms over time in both waves. This leaves us with 1586 firms that are appearing in both waves (88% of 1800 firms) and in total 3172 observations. Finally, the innovation-related data is merged with other firm-characteristics data (e.g. export, productivity, size) coming from registered firm data in Statistic Sweden (SCB)[7]. The descriptive statistics and correlation matrix is reported in Table A2 in appendix. The mean VIF score is 1.64 and all individual variables get a VIF score of below 3. This implies that multicollinearity is rather mild and may not bias the subsequent regression analyses results in Section 5. Moreover, Table 1 shows the cross tabulation of innovation status and export status of the firms in the sample.

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

Table 1 shows that 43% of the total sample were innovative[8] in 2004. 80% of these innovative firms were already exporter in 2004. This is an initial indication that there is strong association between being innovative and being exporter. Moreover, there was a 1% increase in being an exporter among these innovative firms two years later in 2006. Although a tiny increase, it is an initial indication for the possible positive effect of the innovation of firms on their export behavior. Looking at year 2006, 39% of the firms in the sample were innovative.

[7] In terms of data cleaning, only export intensity is subject to transforming the missing values to zero. Moreover, only two observations got negative values after logging the export intensity.

[8] In line with previous CIS studies in Sweden, a firm is perceived innovative if it has a positive value in its product innovation output (Lööf and Heshmati, 2006).

81% of these innovative firms were already exporters in 2006. Again this is an initial indication that there is a strong association between being innovative and being an exporter. Moreover, there was a 1% decrease in being an exporter of these innovative firms two years later in 2008. This is indeed a tiny decrease in export behavior of these innovative firms. Nevertheless, it seems as if the economy as a whole generated less exports in 2008 compare with 2006 data because the number of exporters who were non-innovative in 2006 dropped more dramatically between 2006 and 2008 by a 5% decrease. Hence once again, being an innovative firm seems to benefit firms in terms of their export behavior. However, this is just an initial indication and for a solid interpretation other important factor should be controlled for. This is done in the next section.

## 5. Results

This section provides the results of the empirical estimation of several models: the basic model, the model that takes into account unobserved time-invariant heterogeneity, the model that takes into account the potential endogeneity in innovation-export association, and finally a model that uses an alternative measure of export propensity. The basic model is reported in Table 2. Model specifications (1) and (2) are explaining the export propensity and specifications (3) and (4) are explaining export intensity. Innovation output has positive but not significant effect on the probability of exporting in model specification (1). Some previous studies found similar results (Sterlacchini, 1999; Roper and Love, 2002)[9]. Sterlacchini (1999) found that the extent of firms' innovative activity (both input and output) plays a relatively little role in explaining the probability of exporting but is important in explaining the extent of firms' export activities. Similarly, Roper and Love (2002) find no significant effects of innovative sales on becoming an exporter (but positive and significant effect on export intensity). Interestingly, innovation output shows significant effect only after dropping productivity and ownership structure in specification (2). This shows that innovation output has positive and significant effect on export propensity but that there are other more

[9] However, it may not be asserted as a conclusive finding, as other studies found positive impact of innovation on both probability of exporting and intensity of export, for instance Nassimbeni (2001) in the sample of Italian small manufacturing firms.

important determinants, i.e. productivity and ownership structure. This is in line with well-established firm-selection literature, which recognizes the productivity of firms as the main driver of exporting.

Moving to export intensity, innovation output has positive and significant effect on the intensity of exporting in model specification (3). This is well in line with previous studies (Roper and Love, 2002; Lachenmaier and Wößmann, 2006; Girma et al, 2008; Harris and Li, 2009; Ganotakis and Love, 2010). There are many observations that have zero values in their export intensity[10]. This suggests that OLS may not be the best estimator. The literature used a Tobit model specification which is left-censored with zero a value to accommodate this issue (Wakelin, 1998; Sterlacchini, 1999; Basile, 2001; Roper and Love, 2002). This is reported in model specification (4) and the results remain similar to those in specification (3).

One interesting result is that it is innovation output (and not innovation input) that matters for the export behavior of firms. This means it may not really matter how much a firm invests in innovation input, but as soon as a firm succeeds to actually introduce an innovation out there, this affects its export behavior[11]. Indeed recent studies provide the same insight (Nassimbeni, 2001; Aw et al, 2007; Van Beveren and Vandenbussche, 2010).

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

As argued in empirical strategy (section 3), there might be some unobserved time-invariant heterogeneity in the basic model, i.e. an omitted variable bias in the relation between innovation and export (Caldera, 2010). Hence, Table 3 reports the Random-Effect estimator (following Caldera (2010) and Cassiman and Golovko (2011)). We used Random-Effect estimator rather than Fix-effect (FE), because using FE would wipe out the time-invariant RHS variables, such as ownership variables and sector dummies. For the Random-Effect Tobit (specification (8)), we used a pooled Tobit with clustered standard errors on firms' ID.

[10] There were also several observations that had missing values in their exporting, which were transformed to zero values.

[11] Neither dropping innovation input nor using innovation input and output in separate regressions do not change the main result.

This is an alternative to the panel estimator of Tobit, since the initial value was not identified for maximum likelihood estimation[12].

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

Table 3 reports very similar results as Table 2. This indicates that the results of the basic model in Table 2 are robust, when accounting for unobserved-time invariant heterogeneity in the model.

As discussed in the empirical strategy (Section 3.2), there are theoretical arguments and empirical evidences showing that there is a potential endogeneity for innovation in innovation-export association. To test the robustness of the results, an instrumental variable approach and a 2SLS estimator is used (following Lachenmaier and Wößmann, 2006; Harris and Li, 2009; Ganotakis and Love, 2010; Caldera, 2010; Van Beveren and Vandenbussche, 2010). This implies that the innovation output is estimated using some instruments plus other exogenous variables in the 1$^{st}$ stage. Then the predicted value of the innovation output (obtained from the 1$^{st}$ stage) is used in the 2$^{nd}$ stage to yield the unbiased causal effect of innovation output on export. The main issue in using the instrumental variable approach is finding proper instruments(s). A valid instrument in our case is the one which is correlated with innovation but not with exports. Following previous studies dealing with endogeneity of innovation in the innovation-export association, we used six instruments[13]. The first three are investments in internal R&D, external R&D, and other knowledge sources. Ganotakis and Love (2010) used internal R&D investment as an instrument and argued that a firm's R&D department is not directly related to its sales or marketing departments (which may or may not have contacts with abroad customers) and therefore it is unlikely that it will receive impulses for the R&D of products specifically from overseas customers (Lachenmaier and Wößmann, 2006; Ganotakis and Love, 2010). Van Beveren and Vandenbussche (2010) used internal and external R&D investment as two instruments in their study and argued that internal and

[12] As expected, the value of clustered pooled Tobit pooled (specification 8) is the same as Tobit in Table 2 (specification 4) except the standard errors.

[13] There are other potential instruments that used in previous studies, but unfortunately not available in Swedish CIS, for example governmental support, used in Ganotakis and Love (2010) and Caldera (2010). Moreover, there are some potential instruments used in previous studies that showed unexpected sign in our case, therefore not used.

external R&D are inputs to innovation output (so they should be correlated), while there is no evidence that they should be correlated with exporting. These two instrumental variables are part of the *Innovation Input* in our case and indeed the effect of *Innovation Input* on exporting in our analysis turns out to be insignificant (Table 2 and 3). This provides the evidence for internal and external R&D to be valid instruments. The fourth and fifth instruments are the obstacles for innovation output, following Lachenmaier and Wößmann (2006)[14]. The two instruments are the extent to which lack of outside funds was an obstacle for innovation (0-3 scale) in 2004 (& 2006) and the extent to which the lack of necessity of doing innovation due to prior innovation was an obstacle for innovation (0-3 scale) in 2004 (& 2006). They argued that these two instruments should have a negative effect on innovation output, while no effect on exporting. The last instrument is human capital, measured as the fraction of the employees with three or more years of university education. While there are well-established theoretical and empirical evidence that human capital is strongly associated with innovation (Lucas, 1998; Carbonara and Tavassoli, 2013), the evidence for an association between human capital and exports seems to be less strong. This may qualify human capital as a potential instrument. However, it should be acknowledged that such a claim cannot be asserted firmly, as previous studies did not use this instrument. Nevertheless, once we accept that at least one of the suggested instruments is exogenous to export performance, we can test for the exogeneity of the other instruments by use of over-identification tests (Lachenmaier and Wößmann, 2006). The result of the 2$^{nd}$ stage of 2SLS estimation is reported Table 4 (the result of 1$^{st}$ stage is reported in the appendix in Table A3).

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

Table 4 reports only the 2$^{nd}$ stage of 2SLS estimation (result of 1$^{st}$ stage is reported in Appendix A1). Innovation output is the predicted value obtained from 1$^{st}$ stage estimation. More specifically, in the 1$^{st}$ stage, innovation output is instrumented by six instruments in specifications (9) & (11) and by 3 instruments in specifications (10) & (12). The reason for these specifications is that the over-identification test (Sargan test) showed evidence of over identification in specification (11). Therefore, the insignificant IVs are dropped one by one in

[14] Lachenmaier and Wößmann (2006) used three obstacles and three impulses for innovation as instruments. We only used two of them, since the rest of them are either insignificant in 1$^{st}$ stage of 2SLS or have unexpected signs.

specification (12') until the Sargan test reject the null hypothesis of over-identification. This implied dropping three instruments in specification (12'), which eventually leaves the specification without any evidence of over-identification. Moreover, although the Sargan test does not show evidences of over-identification in specification (9), the same three IVs which were dropped in specification (12') are also dropped in specification (10') for the sake of consistency of specifications. Therefore, there is no evidence of over-identification in specification (9), (10), and (12). The results in specification (9) and (10) implies that if the amount of innovation output of a firm is driven by the amount of internal R&D, external R&D, and amount of human capital, then the probability of a firm engaging in exporting will increase by almost 20% to 23%. Interestingly, the null hypothesis of the DWH (Durbin-Wu-Hausman) test is strongly rejected in all specifications, indicating that the effects of endogenous regressors on the basic OLS estimates are meaningful, and that instrumental variables technique is indeed required to have an unbiased estimate.

The results in Table 4 show that the innovation output is a strong predictor of both export propensity and export intensity. This implies robustness of the results of the previous models (Table 2 and 3), when the endogeneity of the innovation-export association is taken into account. More importantly, the effect of innovation output on the export behavior of firms can be seen as a causal effect, since the IV approach allows considering the variation in innovation which is exogenous to exports. Moreover, in order to further provide the evidence for causal effects of innovation output on export behavior, we used an alternative dependent variable for export propensity, i.e. a firm being an *export starter*, as discussed in Section 3.2[15]. The results of such an alternative specification are reported in Table A4 in the appendix, which again shows the positive effect of innovation output on becoming an exporter two years later. This can be interpreted as that the innovation output of a firm indeed induces it to become an exporter two years later.

Once again there is no positive effect of the innovation input on the export behavior of firms in Table 4 (even a negative effect on export propensity). Interestingly, productivity is not a

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15 In 2006, out of 1586 firms in the sample, 1080 were exporter and 78 of them were export starter. In 2008, out of 1586 firms in the sample, 1070 were exporter and 92 of them were export starter.

significant predictor of export behavior anymore, while ownership structure still is. All in all, the null of both hypotheses in this paper is rejected.

Finally, in order to provide insight concerning the *magnitude* of the effect of innovation output on the export behavior of firms, the average marginal effect (AME) is calculated (in case of non-linear estimator) for more preferred model specifications. The more preferred model specifications in the case of export propensity are model specification (6), where time-invariant unobserved heterogeneity is controlled for, and model specifications (9) and (10) where it is possible to have causal interpretations. Accordingly, a 1% increase in innovation output of firms (sales due to innovative products) would lead to 20% to 23% increase in the probability of engagement in exporting (export propensity), depending on model specification. In addition, the more preferred model specifications in the case of export intensity are model specification (8), where time-invariant unobserved heterogeneity as well as left-censored data are controlled for, and also model specification (12) where it is possible to have causal interpretations, while there is no evidence of over identification of the used instruments. Accordingly, a 1% increase in innovation output of firms (sales due to innovative products) is associated with 0.32% increase in the amount of sales due to exporting (export intensity) based on model (8). The effect is more pronounced when the endogeneity of innovation-export association is taken into account in model (12): a 1% increase in the innovation output of firms (sales due to innovative products) would lead to 2.7% increase in the amount of sales due to exporting (export intensity). Such a more-pronounced effect of innovation on export after controlling for endogeneity is indeed in line with previous studies (Lachenmaier and Wößmann, 2006).

## 6. Conclusion

The purpose of this paper was to analyze the effect of product innovation on export behavior of firms by empirically testing the prediction of product-cycle models of international trade with micro-level data. The main contribution of the paper is to distinguish between the effect of innovation input and innovation output on export behavior of firms. Accordingly, an attractive measure of the actual innovation output as a measure of product innovation (i.e. the amount of sales due to innovative products per employee), is used. Moreover, the analysis so took into account several sources of endogeneity in the innovation-export association, i.e., omitted variable bias, bi-directional correlation, and simultaneity bias. The empirical analysis was based on two waves of the Swedish CIS data which was merged with registered data on firm characteristics.

Both hypotheses of this paper concerning the effect of innovation input and innovation output on export behavior of firms are confirmed. We find micro-evidence that the innovation output of firm has a significant, positive, and causal effect on two years later export behavior of firms, in terms of export propensity and export intensity. This finding means that product upgrading allows firms to differentiate their products from rival firms, which may give a better advantage over competitors in export markets. Interestingly, innovation input has no significant effect on export behavior of firms. An interpretation of this finding is that what really matters for the export behavior of firms are their actual innovation output, and not the mere innovation efforts (measured as six types of investments in innovation activities). Moreover, the effect of innovation output on export propensity (probability of entering the export market) is, however, less pronounced after controlling for productivity level and ownership structure of the firm. This shows the strong association of productivity and ownership structure of firms with the probability of export participation. Concerning policy implication, the findings of the paper suggest that in order to improve the export behavior of firms, it is necessary to improve the innovation behavior of firms. This is particularly vital for small and export-oriented economies like Sweden. When it comes to innovation, it is indeed the actual innovation output that matters for improving the export behavior, not the mere innovation input (investment). This triggers the attention to improve the national innovation system and mitigating the classic Swedish paradox (Edquist, 2005).

This paper opens up some suggestions for further research. At the moment, export intensity of firms are measured based on the monetary value of their export. One could pursue further and consider the both value and volume dimensions of the export intensity of firms. Then it would be interesting to examine whether product innovation output of firms would lead to higher volume-higher value of export, or lower volume-higher value of export, or higher volume-lower value of export. Intuitively, the first case scenario would be the most desirable one.

**Table 1-** Cross tabulation of innovation status and export status of firms in the sample

| | **Total** | | **Exporter** (t=2004, 2006) | | **Exporter** (t=2006, 2008) | | **Non-Exporters** (t=2006, 2008) | |
|---|---|---|---|---|---|---|---|---|
| | Firms | % of total sample | Firms | % of Innovator/ non-innovator | Fir ms | % of Innovator/ non-innovator | Fir ms | % of Innovator/ non-innovator |
| **Innovators** (2004) | 689 | 43% | 553 | 80% | 556 | 81% | 133 | 19% |
| **Non-Innovators** (2004) | 897 | 57% | 524 | 58% | 524 | 58% | 373 | 42% |
| **Innovators** (2006) | 623 | 39% | 505 | 81% | 503 | 80% | 120 | 20% |
| **Non-Innovators** (2006) | 963 | 61% | 575 | 64% | 564 | 59% | 299 | 41% |

**Table 2-** Export determinants (pooled).
***Dependent variables***: Export propensity and Export intensity in 2006 & 2008

| | **Export propensity** (t=2006, 2008) | | **Export intensity** (t=2006, 2008) | |
|---|---|---|---|---|
| | (1) pooled Probit | (2) pooled Probit | (3) pooled OLS | (4) pooled Tobit |
| Innovation output (t=2004, 2006) | 0.049<br>(0.061) | 0.114**<br>(0.057) | 0.288**<br>(0.118) | 0.318**<br>(0.132) |
| Innovation input (t=2004, 2006) | -0.021<br>(0.033) | -0.007<br>(0.028) | 0.049<br>(0.049) | 0.040<br>(0.053) |
| Productivity (t=2004, 2006) | 0.971***<br>(0.204) | | 2.143***<br>(0.393) | 2.286***<br>(0.434) |
| Size (t=2004, 2006) | 0.172*<br>(0.088) | 0.352***<br>(0.073) | 0.152<br>(0.103) | 0.170<br>(0.112) |
| Physical capital (t=2004, 2006) | 0.134**<br>(0.058) | 0.170***<br>(0.056) | 0.177<br>(0.130) | 0.217<br>(0.146) |
| Uninational | 0.276<br>(0.173) | | 1.245**<br>(0.496) | 1.425**<br>(0.566) |
| Domestic MNE | 0.848***<br>(0.223) | | 3.194***<br>(0.462) | 3.473***<br>(0.522) |
| Foreign MNE | 0.698***<br>(0.260) | | 3.034***<br>(0.497) | 3.293***<br>(0.555) |
| Cooperation (t=2004, 2006) | -0.244*<br>(0.138) | -0.207<br>(0.128) | -0.046<br>(0.264) | -0.086<br>(0.292) |
| Sector Dummy | YES | YES | YES | YES |
| Year Dummy | YES | YES | YES | YES |
| Observation | 812 | 866 | 941 | 941 |
| R-squared | | | 0.348 | |
| Sigma | | | | 4.064***<br>(0.170) |

**Note**: Robust standard errors in parenthesis. *** p<0.01, ** p<0.05, * p<0.1

**Table 3-** Export determinants (Random Effect)
***Dependent variables***: Export propensity and Export intensity in 2006 & 2008

| | **Export propensity** (t=2006, 2008) | | **Export intensity** (t=2006, 2008) | |
|---|---|---|---|---|
| | (5) Probit (RE) | (6) Probit (RE) | (7) OLS (RE) | (8) Tobit (RE) |
| Innovation output (t=2004, 2006) | 0.096<br>(0.133) | 0.216*<br>(0.128) | 0.088**<br>(0.036) | 0.318**<br>(0.139) |
| Innovation input (t=2004, 2006) | -0.035<br>(0.077) | -0.021<br>(0.073) | 0.040*<br>(0.022) | 0.040<br>(0.055) |
| Productivity (t=2004, 2006) | 2.004***<br>(0.585) | | 0.811***<br>(0.168) | 2.286***<br>(0.473) |
| Size (t=2004, 2006) | 0.416**<br>(0.204) | 0.865***<br>(0.223) | 0.186***<br>(0.070) | 0.170<br>(0.127) |
| Physical capital (t=2004, 2006) | 0.336**<br>(0.160) | 0.424***<br>(0.161) | 0.046<br>(0.073) | 0.217<br>(0.167) |
| Uninational | 0.747*<br>(0.440) | | 0.585*<br>(0.303) | 1.425**<br>(0.631) |
| Domestic MNE | 1.900***<br>(0.687) | | 1.121***<br>(0.323) | 3.473***<br>(0.596) |
| Foreign MNE | 1.696**<br>(0.717) | | 1.365***<br>(0.325) | 3.293***<br>(0.631) |
| Cooperation (t=2004, 2006) | -0.486<br>(0.319) | -0.452<br>(0.311) | 0.051<br>(0.114) | -0.086<br>(0.302) |
| Sector Dummy | YES | YES | YES | YES |
| Year Dummy | YES | YES | YES | YES |
| Observation | 941 | 956 | 841 | 941 |

**Note**: Robust standard errors in parenthesis for specification 4 and 5. *** p<0.01, ** p<0.05, * p<0.1 For Random-Effect Tobit, pooled Tobit with clustered standard errors on firms' ID is used. This is an alternative to panel estimator of Tobit, since the initial value was not identified for maximum likelihood estimation.

**Table 4-** Accounting for endogeneity of innovation

***Dependent variables*** (in 2nd stage of 2SLS): Export propensity and Export intensity 2006 & 2008

| | **Export propensity** (t=2006, 2008) | | **Export intensity** (t=2006, 2008) | |
|---|---|---|---|---|
| | (9) 2SLS | (10) 2SLS | (11) 2SLS | (12) 2SLS |
| Innovation output (*predicted*) (t=2004, 2006) | 0.198*** (0.073) | 0.233*** (0.084) | 2.341** (0.915) | 2.789*** (1.046) |
| Innovation input (t=2004, 2006) | -0.023** (0.009) | -0.026*** (0.010) | -0.155 (0.112) | -0.199 (0.125) |
| Productivity (t=2004, 2006) | 0.004 (0.045) | -0.012 (0.051) | 1.104* (0.572) | 0.903 (0.633) |
| Size (t=2004, 2006) | 0.016 (0.010) | 0.017 (0.011) | 0.204 (0.129) | 0.208 (0.137) |
| Physical capital (t=2004, 2006) | 0.013 (0.011) | 0.011 (0.012) | 0.124 (0.141) | 0.107 (0.152) |
| Uninational | 0.091** (0.037) | 0.093** (0.039) | 1.362*** (0.461) | 1.384*** (0.492) |
| Domestic MNE | 0.132*** (0.039) | 0.128*** (0.042) | 3.026*** (0.496) | 2.974*** (0.531) |
| Foreign MNE | 0.095** (0.044) | 0.087* (0.047) | 2.565*** (0.551) | 2.467*** (0.593) |
| Cooperation (t=2004, 2006) | -0.055** (0.027) | -0.061** (0.029) | -0.331 (0.338) | -0.401 (0.365) |
| Sector Dummy | YES | YES | YES | YES |
| Year Dummy | YES | YES | YES | YES |
| Observation | 938 | 938 | 938 | 938 |
| Sargan test | 7.45 (0.281) | 0.517 (0.915) | 11.15 (0.083) | 3.031 (0.386) |
| DWH test | 10.56 (0.001) | 12.95 (0.000) | 7.11 (0.007) | 9.21 (0.002) |
| F-test of 1st stage | 5.17 (0.000) | 5.57 (0.000) | 5.17 (0.000) | 5.57 (0.000) |

**Note 1**: The table reports only the 2nd stage of 2SLS estimation (result of 1st stage is reported in Appendix A1). Innovation output is the predicted value obtained from 1st stage estimation. More

specifically, in the 1st stage, innovation output is instrumented by six instruments in specifications 9 & 11 and by 3 instruments in specifications 10 & 12.

**Note 2**: Sargan test is an over-identification test with its p-value in the parentheses. Except specification (11), the null hypothesis is not rejected, meaning that there is no evidence of over-identification in specification (9), (10), and (12).

**Note 3:** DWH test is the Durbin-Wu-Hausman test of endogeneity with its p-value in the parentheses. The null hypothesis is strongly rejected in all specifications, indicating that the effects of endogenous regressors on the basic OLS estimates are indeed meaningful, and instrumental variables techniques are required.

**Note 4:** F-test of 1st stage with its p-value in the parentheses shows the overall fitness of model specifications using the instruments. In all model specifications, the null is rejected, meaning that instruments are strongly related to the innovation output.

# Appendix

**Table A1-** Variable descriptions

| Variables | Descriptions |
|---|---|
| ***Export propensity 2006(&2008)*** | 1 if a firm is an exporter in 2006 (&2008), 0 otherwise |
| ***Export intensity 2006 (&2008)*** | The amount (value in SEK) of export per employee in 2006 (&2008) (log) |
| ***Export starter 2006 (&2008)*** | 1 if a firm starts to become an exporter in 2006 (&2008), 0 otherwise |
| ***Innovation output 2004(&2006)*** | The amount of sales due to innovative product per employee during 2002-2004 (2004) and during 2004-2006 (2006)[16] (log) |
| ***Innovation input 2004(&2006)*** | The amount of investment in six innovation expenditure per employee during 2002-2004 (2004) and during 2004-2006 (2006). The six innovation expenditure are in: intramural R&D, extramural R&D, acquisition of machinery, other external knowledge, training of employees, and market introduction of innovation (log) |
| ***Productivity 2004(&2006)*** | Value added per employee 2004 & 2006 (log) |
| ***Size 2004(&2006)*** | Number of employees (log) |
| ***Uninational*** | 1 if firm belongs to group and is uninational, 0 otherwise (Non-affiliated as based) |
| ***Domestic MNE*** | 1 if firm belongs to group and is a domestic MNE, 0 otherwise |
| ***Foreign MNE*** | 1 if firm belongs to group and is a foreign MNE, 0 otherwise |
| ***Cooperation 2004(&2006)*** | 1 if firm had any cooperation with other customers, suppliers, competitors in 2004 (& 2006), 0 otherwise |
| ***Physical capital 2004(&2006)*** | Buildings and Machines costs at year's end in 2004 (& 2006) (log) |
| ***Time-specific component*** | Time dummies |
| ***Sector-specific component*** | Sector dummies |
| ***IV1: RRdInX 2004(&2006)*** | Expenditure in intramural R&D in 2004 (& 2006) (log) |
| ***IV2: RRdExX 2004(&2006)*** | Expenditure in external R&D in 2004 (& 2006) (log) |
| ***IV3: ROEkX 2004(&2006)*** | Expenditure in other external knowledge in 2004 (& 2006) (log) |
| ***IV4: HFout 2004(&2006)*** | The extent which lack of outside funds was an obstacle for innovation (0-3 scale) in 2004 (& 2006) |
| ***IV5: HPrior 2004(&2006)*** | The extent which lack of necessity of doing innovation due to prior innovation was an obstacle for innovation (0-3 scale) in 2004 (& 2006) |
| ***IV6: Human Capital 2004(&2006)*** | Share of employees with 3 or more years of university educations in 2004 (& 2006) |

[16] Specifically, it is calculated as: "portion of sales due to *innovative products*" (a self-reported data by firms in CIS) multiplied by "total turnover of firm during 2002-2004", divided by "number of employees". *Innovative product* is defined by CIS survey as: "the market introduction of new or significantly improved good or service with respect to its capabilities. The innovation must be new to enterprise, but not necessarily to the market"

**Table A2**- Descriptive statistics and Correlation matrix

| Variables | *ExpInt* | *Inn_O* | *Inn_I* | *Prod* | *Size* | *PhysC* | *Uni-n* | *D.MNE* | *F.MNE* | *Coop* |
|---|---|---|---|---|---|---|---|---|---|---|
| *Export Intensity* | 1 | | | | | | | | | |
| *Innovation_O* | 0.190 | 1 | | | | | | | | |
| *Innovation_I* | 0.106 | 0.196 | 1 | | | | | | | |
| *Productivity* | 0.267 | 0.243 | 0.009 | 1 | | | | | | |
| *Size* | 0.099 | 0.044 | 0.008 | 0.246 | 1 | | | | | |
| *Physical Cap* | 0.275 | 0.043 | 0.074 | 0.203 | 0.216 | 1 | | | | |
| *Uni-National* | -0.19 | -0.13 | -0.06 | -0.16 | -0.28 | -0.03 | 1 | | | |
| *Domestic MNE* | 0.178 | 0.033 | 0.061 | 0.081 | 0.173 | 0.005 | -0.37 | 1 | | |
| *Foreign MNE* | 0.116 | 0.088 | -0.03 | 0.181 | 0.335 | 0.066 | -0.35 | -0.47 | 1 | |
| *Cooperation* | 0.161 | 0.114 | 0.171 | 0.196 | 0.259 | 0.114 | -0.12 | 0.119 | 0.026 | 1 |
| Obs. | 3172 | 3172 | 3172 | 3172 | 3172 | 3172 | 3172 | 3172 | 3172 | 3172 |
| Mean | 11.36 | 12.21 | 2.49 | 13.26 | 3.86 | 11.66 | 0.30 | 0.22 | 0.23 | 0.50 |
| S.D | 3.35 | 1.32 | 4.09 | 0.50 | 1.44 | 1.66 | 0.45 | 0.41 | 0.42 | 0.50 |
| Min | 0 | 5.72 | 0 | 9.59 | 0 | 4.12 | 0 | 0 | 0 | 0 |
| Max | 17.45 | 20.41 | 16.34 | 18.51 | 10.44 | 18.55 | 1 | 1 | 1 | 1 |

**Note**: The log values of continuous variables are reported (refer to Table A1).Only observed values in innovation output are reported. Few observations in Innovation input and Export intensity get the negative value, after the log-transformation. Nevertheless, the results are not sensible to those observations.

**Table A3-** 1st stage of 2SLS

***Dependent variable***: Innovation Output in 2004 & 2006 (innovative sales per employees)

| | Innovation Output (t=2004, 2006) | | | |
|---|---|---|---|---|
| | (9') 2SLS | (10') 2SLS | (11') 2SLS | (12') 2SLS |
| IV1: RRdInX (log) (t=2004, 2006) | 0.021** (0.011) | 0.020* (0.010) | 0.021** (0.011) | 0.020* (0.010) |
| IV2: RRdExX (log) (t=2004, 2006) | 0.004 (0.008) | | 0.004 (0.008) | |
| IV3: ROEkX (log) (t=2004, 2006) | 0.010 (0.009) | | 0.010 (0.009) | |
| IV4: HFout (t=2004, 2006) | 0.017 (0.042) | | 0.017 (0.042) | |
| IV5: HPrior (t=2004, 2006) | -0.033 (0.082) | -0.034 (0.082) | -0.033 (0.082) | -0.034 (0.082) |
| IV6: Human Capital (t=2004, 2006) | 1.020*** (0.383) | 1.041*** (0.380) | 1.020*** (0.383) | 1.041*** (0.380) |
| Innovation input (t=2004, 2006) | 0.057*** (0.022) | 0.065*** (0.021) | 0.057*** (0.022) | 0.065*** (0.021) |
| Productivity (t=2004, 2006) | 0.386*** (0.107) | 0.380*** (0.107) | 0.386*** (0.107) | 0.380*** (0.107) |
| Size (t=2004, 2006) | -0.045 (0.036) | -0.037 (0.035) | -0.045 (0.036) | -0.037 (0.035) |
| Physical capital (t=2004, 2006) | 0.052 (0.037) | 0.050 (0.037) | 0.052 (0.037) | 0.050 (0.037) |
| Uninational | -0.031 (0.122) | -0.030 (0.121) | -0.031 (0.122) | -0.030 (0.121) |
| Domestic MNE | 0.102 (0.129) | 0.105 (0.128) | 0.102 (0.129) | 0.105 (0.128) |
| Foreign MNE | 0.220 (0.136) | 0.212 (0.136) | 0.220 (0.136) | 0.212 (0.136) |
| Cooperation (t=2004, 2006) | 0.083 (0.085) | 0.103 (0.082) | 0.083 (0.085) | 0.103 (0.082) |
| Sector Dummy | YES | YES | YES | YES |
| Year Dummy | YES | YES | YES | YES |

| | | | | |
|---|---|---|---|---|
| Observations | 938 | 938 | 938 | 938 |

**Note 1**: In addition to previous exogenous RHS variables, 6 instruments (IV1-IV6) are added in the first stage in order to exogenously determine the innovation output.

**Note 2:** In the 1st stage of 2SLS, one may argue for multicollinearity between *Innovation Input* and *IV1-IV3*. Nevertheless, removing *Innovation Input* from the 1st stage did not change the result. Furthermore, Sargan test in specification (11') shows the evidence of over identification. Hence in specification (12') the insignificant instruments are dropped one by one until the Sargan test reject the null of over identification. Moreover, although the Sargan test does not shows the evidence of over identification in specification (9'), the same three IVs which were dropped in specification (12') are also dropped in specification (10') for the sake of consistency of specifications.

**Table A4-** 2SLS estimation 2nd stage

***Dependent variable***: Export starter: 1 if a firm become an exporter for the first time in 2006 (&2008), 0 otherwise.

| | **Export starter** (t=2006, 2008) |
|---|---|
| Innovation Output<br>(t=2004, 2006) | 0.074*<br>(0.041) |
| Innovation Input<br>(t=2004, 2006) | -0.013**<br>(0.005) |
| Productivity<br>(t=2004, 2006) | -0.053**<br>(0.025) |
| Size<br>(t=2004, 2006) | -0.011*<br>(0.006) |
| Physical Capital<br>(t=2004, 2006) | -0.002<br>(0.006) |
| Uninational | -0.000<br>(0.021) |
| Domestic MNE | -0.023<br>(0.022) |
| Foreign MNE | -0.012<br>(0.025) |
| Cooperation<br>(t=2004, 2006) | -0.023<br>(0.015) |
| Sector Dummy | YES |
| Year Dummy | YES |
| Observations | 938 |
| Sargan test | 3.88<br>(0.692) |
| DWH test | 4.953<br>(0.026) |
| F-test of 1st stage | 5.17<br>(0.000) |

**Note:** The 1st stage of above estimation is the same as specification (9') in Table A3.

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